Autism and Child Psychopathology Series
Series Editor: Johnny L. Matson

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Handbook of Applied Behavior Analysis

Integrating Research into Practice

Springer

Autism and Child Psychopathology Series

Series Editor

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Brief Overview

The purpose of this series is to advance knowledge in the broad multidisciplinary fields of autism and various forms of psychopathology (e.g., anxiety and depression). Volumes synthesize research on a range of rapidly expanding topics on assessment, treatment, and etiology.

Description

The **Autism and Child Psychopathology Series** explores a wide range of research and professional methods, procedures, and theories used to enhance positive development and outcomes across the lifespan. Developments in education, medicine, psychology, and applied behavior analysis as well as child and adolescent development across home, school, hospital, and community settings are the focus of this series. Series volumes are both authored and edited, and they provide critical reviews of evidence-based methods. As such, these books serve as a critical reference source for researchers and professionals who deal with developmental disorders and disabilities, most notably autism, intellectual disabilities, challenging behaviors, anxiety, depression, ADHD, developmental coordination disorder, communication disorders, and other common childhood problems. The series addresses important mental health and development difficulties that children and youth, their caregivers, and the professionals who treat them must face. Each volume in the series provides an analysis of methods and procedures that may assist in effectively treating these developmental problems.

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ISSN 2192-922X ISSN 2192-9238 (electronic)
Autism and Child Psychopathology Series
ISBN 978-3-031-19963-9 ISBN 978-3-031-19964-6 (eBook)
https://doi.org/10.1007/978-3-031-19964-6

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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Foundations

1 History of Applied Behavior Analysis

Megan M. Callahan, Jill C. Fodstad, and James W. Moore

Broadly, behavior analysis is the experimental evaluation of the behavior of living organisms. It is considered by many to overlap with the field of psychology; however, there are key distinctions, making behavior analysis a separate field of study. The underlying tenets of behavior analysis are evident in behaviorism, the experimental analysis of behavior (EAB), and applied behavior analysis (ABA). ABA relies on the principles of learning and behavior to increase or decrease socially significant behaviors in human beings. Over the course of several decades, the field of ABA continues to evolve. ABA has a rich history. Although impossible to discuss the history of ABA in one chapter, our goal is to provide an overview of some of the key turning points in the history of ABA.

Early Beginnings

The precise beginning of Applied Behavior Analysis (ABA) is an open topic of discussion. Although the first published account of ABA was made by Allyon and Michael (1959), the roots of the field run much deeper. In order to find clues to the precise background of ABA, it is helpful to realize that the discipline takes a *natural science approach* to the study of human behavior which is distinct from the social science approach of fields, such as psychology. This is unique given that social science is usually synonymous with behavioral science. In behavior analysis, however, emphasis is placed upon objective measurement that stems from a basic unit, the operant.

While Edward Thorndike is not considered a true behaviorist, his work set the stage and influenced behaviorism that was to come. At the time, mentalism, the belief that causes the mind account for behavior, was prevalent. In contrast to this, Thorndike believed mental life is also behavior, rather than the cause of behavior. He worked under William James at Harvard University studying how animals learn with behavioral applications in education (Malone, 2014).

Thorndike was critical of comparative psychologists at the time, as they often used small samples, anecdotal data, and only reported "marvelous" findings. To combat this, he systematically studied cats' behaviors in puzzle boxes as his doctoral dissertation, published in the same year in 1898. He used 15 different puzzle boxes and 13 cats. Thorndike described the behavior of the cats initially placed in the boxes as a series of random acts, such as clawing, biting, etc.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_1

Eventually, the cats, by accident, land upon the correct behavior to be released from the box. In future trials, the successful behavior occurs earlier in the sequence, while the failed behaviors are eliminated until eventually the cat has learned to get out of the box in seconds. Thorndike methodically graphed these escapes, which showed a gradual decline in the escape time. From these studies, Thorndike developed the *Law of Effect*.

> Of several responses made by the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to recur. The greater the satisfaction or discomfort, the greater the strengthening or weaking of the bond. – Thorndike (1911/2000)

Thorndike later modified this, placing a greater emphasis on rewards being more effective than punishments in increasing learning (Goodwin, 2010, p. 53). Skinner wrote of this law, it was "[o]ne of the first serious attempts to study changes brought about by the consequences of behavior" (Skinner, 1953, p. 59).

Across the world, Russian physiologist Ivan P. Pavlov was studying conditioned reflexes in animals in a lab at the Military Medical Academy. He had graduated with a license to practice medicine and later received his degree of Doctor of Medicine following his dissertation completion in 1883 (Liddell, 1936). Starting in 1886, he conducted experiments under S. P. Botkin, results from which Botkin would interpret and apply. However, this position allowed Pavlov the freedom to independently conduct experiments, leading to his sham feeding experiments. In these experiments, the dog's esophagus is divided so the "mouth is cut off from all communication with the cavity of the stomach" (Pavlov, 1910 p. 50). As the dog eats, the food does not reach the stomach and as such, "pure gastric juice" is produced.

In 1891, the Prince of Oldenburg founded the Institute of Experimental Medicine, for which Pavlov directed the construction of a surgical ward for dogs, allowing him to perform surgeries and study the digestive system in healthy dogs. Liddell (1936) credits Pavlov in motivating "young psychologists to familiarize themselves with the structure of the body and with its simpler operations as a preparation for the arduous task of analyzing those highly complex functions which are traditionally regarded as physical."

In 1909, Robert M. Yerkes and Sergius Morgulis described Pavlov's conditioning method in "The method of Pavlov in animal psychology" (Windholz, 1983; Yerkes and Morgulis, 1909). Subsequently, Morgulis (1914) published another article in which he described Pavlov's view that the "seat" of the conditional reflexes are the cortical hemispheres. Further, in this article, Morgulis outlines that Pavlov viewed "consciousness as a purely physiological phenomenon," which sparked early behaviorists. Although he had great influence in early behaviorism, he was not a behaviorist, nor did he necessarily support psychology. Pavlov believed psychology lacked clear goals and methods and preferred physiology for both methodological and practical reasons as phenomena in physiology occur in both space and time, whereas psychology phenomena only occur in time and he disagreed with the anthropomorphizing of conditioning phenomena (Windholz, 1983).

Another precursor, and perhaps the catalyst, to behaviorism, was James B. Watson. In 1913, Watson gave a lecture at Columbia University, titled "Psychology as the Behaviorist Views it," which was published under the same title that year. In this lecture, known as the Behaviorist Manifesto, he coined the term "behaviorism" as a new discipline and applied it to behavior psychology. He outlined four foundational points, which were later expanded to 13. These points included (1) advocating for psychology as a natural science rather than a subset of mentalist or spiritual science, (2) using objective, observable data rather than introspective data, (3) moving away from discussing purposes and teleological goals and moving toward formulating deterministic laws, and (4) rejecting psychophysical dualism and mentalism to explain behavior (Watson, 1913).

The following year, Watson rejected Thorndike's *Law of Effect*, relying on the frequency and recency in the formation of connections, rather than the emphasis of rewards (O'Neil, 1995). In 1916, he adopted Pavlov's conditioned reflex, which made the S-R analysis more explicit in his work. Watson viewed learned behavior as conditioned reflexes in complex sets of stimuli, and as such, he considered reflex conditioning as the basis of learning.

In 1916, Watson suggested that Pavlov's conditioned secretion reflexes could also be used to investigate sensory characteristics and memory processes in animals (Windholz, 1983). Later, in 1926, Watson wrote: "Complex human behavior is the conditional response to (social) stimuli", thus, "securing the conditional reflex an integral position within the framework of early behaviorism" (Windholz, 1983).

Watson saw learned behavior as consisting of conditioned reflexes operating in complex sets of conditioned stimuli and considered reflex conditioning the basis of learning with contiguity of the unconditioned and conditioned stimuli and of the response (O'Neil, 1995). He formulated a theory of emotion, which posits that humans have three emotions: fear, rage, and love, which are first evoked by simple actions. These three simple emotions develop into the wide spectrum of emotions as adults through conditioned reflexes. This theory inspired the Little Albert experiment, which Moore (2017) notes "was more a 'proof of concept' demonstration than a formally designed experiment."

The Little Albert study was his last published work in academia, in which Watson sought to investigate if one could condition fear to an animal and if that fear would generalize. Little Albert was assessed between 8 and 12 months of age (Watson & Rayner, 1920) during the winter of 1919 to 1920. During baseline, he was introduced to a white laboratory rat, a rabbit, a dog, a monkey, masks, cotton, and burning newspaper. Two months later, they conducted the conditioning trials, which consisted of seven trials over two sessions of hitting a metal bar directly behind Little Albert's head as he reached for the white rat. To test generalization, after 5 days, he was presented with wooden blocks, the rat, a rabbit, a dog, a fur coat, the cotton, Watson's and his assistants' hair, and Santa mask. Watson and Rayner reported Little Albert reacted negatively to the rat, the rabbit, the dog, fur coat, cotton, Watson's hair, but not his assistants' hair or the Santa mask. After an additional 5 days, they presented the rabbit and dog alone, which induced a mildly negative reaction, and then hit the metal bar behind him. On the same day, they moved Little Albert into a different room and presented the rat, rabbit, and dog alone. Watson and Rayner concluded the fear generalized. One month later, Little Albert was tested again and reacted negatively to the Santa mask, the rat, the rabbit, and the dog, which Watson and Rayner cited as proof that conditioned emotional responses persist.

Since the original publication of the study, it has been cited and recounted hundreds of times. Watson and the study have also been subject to many controversies, starting with Watson's affair with Rayner, which led to him leaving academia for a career in advertising. Additionally, many of these retellings of the original study have been inaccurate, as Harris outlined (1979), including facts about Little Albert's age and name. Further, some publications incorrectly reported the initial conditioning was with a rabbit instead of the rat. Other inaccuracies change the methodology and the results of the original study, such as expanding the list of stimuli Little Albert's fear generalized to and including that Watson reconditioned Albert's fear. In a follow-up article, Harris (2011) notes that these myths convey the notion that psychologists can impose order and have social power with data supporting their claims.

Beck et al. (2009) investigated the true identity of Little Albert and concluded it was Douglas Merritte, who died at 6 years of age, due to hydrocephalus and convulsions (Fridlund et al., 2012). Fridlund et al. (2012) note that documents show Douglas contracted hydrocephalus in 1922; however, they hypothesize it could have been congenital. Fridlund et al. (2012) also raised concerns regarding Little Albert's functioning, as reported by Watson and as seen in a video recording of the experiments. They reference his general unresponsiveness, lack of social smiling, delayed speech, and lack of social referencing or eye contact, supporting the theory Little Albert was not the "healthy" child Watson and Rayner reported. However, this claim is disputed, as Powell et al. (2014) believed Little Albert to be William Albert Martin who might have been known as Albert Barger before his mother Pearl married.

Although Watson knew of Little Albert's impending departure, they did not decondition him. Rather, a follow-up study by Mary Cover Jones (1924) investigated deconditioning fear responses in three-year-old Peter. In the experiment, Jones attempted to decondition Peter with one animal (i.e., rabbit), to also investigate if the deconditioning would transfer to his other fears (e.g., a rat, fur coat, a feather). Every day, a rabbit was present during a play period with Peter and three other control children. Then, Jones proceeded to expose Peter through progressive "degrees of toleration". Peter was taken to the hospital for 2 months. Upon returning, Jones switch methods, beginning "direct conditioning," in which Peter was given preferred food and an experimenter brought the caged rabbit as close to Peter without disrupting his eating, which Jones reported was successful in reducing his fear and that this reduction in fear generalized to the cotton, fur coat, and feathers.

Skinner (1978) argued that the study of behavior should be conducted in the same manner and with the same rigor as biology, physics, chemistry, and other "hard" sciences. In behavior analysis, behavior is the subject of study. In social science approaches, behavior is viewed as an indicator of some other process, usually seen within the organism. Given this focus, it could be argued that the seeds of behavior analysis were planted in Ancient Greece as philosophers moved away from mysticism and focused on physical determinants that influence human behavior (see Bishop et al., 2020 for a more detailed discussion). Ultimately, the work of the American psychologist Burrhus Frederic Skinner laid the ultimate foundation upon which ABA was built. In order to appreciate the history of ABA, however, one must consider the scientific history and life experiences that influenced Skinner. Through an analysis of the life of B.F. Skinner, the history of ABA comes into clearer focus.

Skinner and His Influence on the Field of ABA

On March 20, 1904, Burrhus Frederic Skinner, known to most as Fred, was born in Susquehanna, Pennsylvania, to William and Grace Skinner. Both of his parents exuded a tremendous influence over Skinner, talking to him at an early age about the consequences of good and bad behavior (Skinner, 1967). On two occasions, his father exposed Skinner to the penal system, once visiting the county jail and then attending a lecture on life at Sing Sing Prison. Even as a boy, Skinner showed talent with inventing and building, including crafting a flotation system for separating ripe from green elderberries. Throughout his life, Skinner often manipulated his physical environment in order to make day to day activities more effective and efficient. Vaughn (1990) described the office of Skinner as "a labyrinth of switches, pulleys, extension cords, lights, magnifying glasses, cardboard boxes, and cubbyholes" (p. 101).

During his early schooling, Skinner showed a strong interest in language arts, leading to a major in English at Hamilton College. Despite this focus, he followed a course of study that he deemed "absurd" (Skinner, 1967, p. 391), including classes in public speaking, mathematics, Romance languages, biology, and embryology. Interestingly, Skinner did not take a single psychology course while at Hamilton. This eclectic course of study, though diverse, provided major influences on the young college student. He remarked later in life, "At some time or other I have used something from every course" (Skinner, 1983, p. 25). As part of these early educational experiences, Skinner was exposed to the work of Charles Darwin, which would later have a tremendous impact on the development of the philosophy of science that undergirds behavior analysis.

Thankfully for the field, Skinner was not successful in his first ambition after Hamilton College, which was aspirations of writing a great novel. After having continued difficulty when switching to short stories, Skinner considered many alternatives in order to make a living, including working as a landscaper. The field he would later establish was again fortunate that Skinner had an allergy to grass (Skinner, 1967). As he considered his failures as a writer, Skinner realized that his lack of success may have been attributed to the focus of his writing: investigating human behavior. Skinner determined that he could not write about this subject matter because he truly did not understand the behavior of humans. This brought the field of psychology into his view. In order to investigate psychology, Skinner first turned to philosophy, specifically Bertrand Russell's book, *Philosophy*. It was reading this work that introduced Skinner to the behaviorism of John Watson, leading Skinner to purchase Watson's book *Behaviorism*, which was originally published in 1913. Given his educational background, which was heavily littered with mathematics and natural science, Skinner immediately found Watson's empirical and scientific approach to human behavior appealing.

As fate would have it, Skinner soon happened upon an article by H. G. Wells that lauded the work of Ivan Pavlov, the Russian physiologist who serendipitously discovered respondent conditioning. Once again, encountering a scientific approach to human behavior solidified Skinner's decision to pursue graduate studies in psychology and he was accepted to Harvard University in the Fall of 1928. It was at this time that Skinner met the already committed behaviorist, Fred Keller. The two challenged and enriched each other's studies, which predominantly focused on abnormal psychology (with a distinct Freudian slant) and the "new" discoveries about respondent behavior. A contemporary, Jacob Robert Kantor, had just published his book *Principles of Psychology*, which would later become described as an approach known as interbehaviorism. Around the same time, the American psychologist Edward Thorndike built a bridge from the stimulus-response respondent conditioning of Pavlov into what Skinner would develop into operant conditioning and radical behaviorism. Similar to Pavlov, Thorndike studied the behavior of animals, such as placing food-deprived cats into puzzle boxes that required escape in order to obtain food.

These influences on Skinner established a strong belief; "control the environment and you will see order in behavior" (Skinner, 1967, p. 399). Although Skinner's dissertation studied reflexive behavior and respondent conditioning, the work of Thorndike shaped Skinner's subsequent work that examined the effect of consequences on behavior. His early work at the University of Minnesota focused on the behavior of rats in a device he invented and termed an operant chamber. Skinner found that depriving a rat of food could set the occasion to condition a lever press from a rat if that behavior produced food. Skinner also discovered that lever pressing could be shaped if that behavior terminated an aversive stimulus, such as an electric shock. Furthermore, Skinner learned that rats could learn to discriminate between behaviors in the presence of different stimuli, such as colored lights, if those lights consistently occasioned specific consequences. Skinner outlined his initial findings in his first published work, *The Behavior of Organisms*, which appeared in 1938.

Around the time *The Behavior of Organisms* appeared, there were many theories regarding human behavior, in particular motivation. Most of these theories focused on an internal state or condition that serves as a catalyst of behavior. Little attention was given to either behavior as the exact subject matter, or the impact of the environment on human behavior. In *The Behavior of Organisms*, Skinner devoted two chapters to the internal construct of "drive." Skinner suggested that an analysis of functional relationships between the environment and behavior would offer a more parsimonious and effective explanation of human behavior than internal causal variables (Sundberg & Michael, 2001). Skinner focused on the evocative effects of deprivation and the abative effects of satiation on behavior.

He proposed a basic unit in the study of behavior that he termed the *operant*. Skinner used the terms positive reinforcer and negative reinforcer to describe consequent events that would impact the future probability of behavior. Originally, he viewed these as the two main sources of operant conditioning, stating, "the cessation of a positive reinforcement acts as a negative, the cessation of a negative as a positive" (Skinner, 1938, pp. 65–66). This replaced the layman terms "reward" and "punishment" with "positive" and "negative" reinforcement (Michael, 1975). Although a major landmark in the study of behavior, this two-term contingency had some logical problems. As Michael (1975) pointed out, "'reinforce' is synonymous with 'strengthen' in a number of usages, and although 'negatively strengthen' as a synonym for 'weaken' is not logically unreasonable, it is somewhat confusing, as would be such a term as 'positively weaken.'" (p. 35).

Skinner's former graduate school colleague, Fred Keller, who had himself embarked on a career in research academia dedicated to this new emerging field Skinner termed the experimental analysis of behavior, helped push the conceptualization of operant conditioning forward. In 1950, along with his colleague William Schoenfeld, Keller published *Principles of Psychology*, which remains a highly influential text to this day. In this work, Keller and Schoenfeld created a synthesis of Thorndike's past work, Skinner's work, as presented in *The Behavior of Organisms*, and the work of Estes (1944), which was conducted as a follow-up to Skinner's text. From this analysis, Keller and Schoenfeld clarified Skinner's terminology:

> Certain stimuli (electric shocks, loud sounds, strong lights, etc.) serve to *decrease* the frequencies of responses in the wake of which they follow. Nowadays, we call them *negative reinforcers,* but they are not best defined in terms of their weakening function….Another, and probably better way of handling the matter is to define *positive* reinforcers as those stimuli which strengthen responses when *presented* (e.g., food strengthens bar-pressing or loop-pulling behavior), and *negative* reinforcers are those which strengthen when they are *removed* (Keller & Schoenfeld, 1950, p. 61).

Keller and Schoenfeld were also comfortable using the term "punishment" and introduced the concept of extinction, or the phenomenon in which the occurrence of a previously reinforced response without its reinforcement would ultimately describe or extinguish response frequency. Influenced by this text, Skinner published *Science and Human Behavior* in 1953 in which he revised his terminology. In this work, Skinner proposes *positive reinforcement* as the presentation or increase in some consequent stimulus event that serves to increase the future probability of a behavior. He offered *negative reinforcement* as the removal or lessening in some consequent stimulus event that also increases the future probability of behavior. He also offered the terms *positive punishment* and *negative punishment*, which both describe contingencies that decrease the future probability of behavior. Again, the term *positive* refers to the presentation or increase in a stimulus event, whereas *negative* refers to the removal or lessening of a consequent stimulus. Skinner's definition of negative reinforcement remained opposed to the one offered by Keller and Schoenfeld (1950). In 1961, Skinner published *The Analysis of Behavior* with J.G. Holland (Holland and Skinner, 1961), which meant to replace the Keller and Schoenfeld work as a basic text and further cemented the terms introduced by Skinner (1953).

Another major contribution of *Science and Human Behavior* was the establishment of behavior analysis as a natural science approach to behavior, led by what Skinner deemed six attitudes of science. Skinner (1953) defined sciences as living within the behavior of scientists, not the materials they used. According to Skinner, science is only known as such due to an overriding idea of the *scientific method*. These attitudes included determinism (the universe is an orderly and lawful place in which all phenomena occur as the result of other events), empiricism (practice of objective measurement of the behavior of interest), experimentation (a structured analysis of the effects of an independent variable on a dependent variable), replication (the repeating of experiments to determine the accuracy and usefulness of findings), parsimony (the idea that less complex, objective, logical explanations must be ruled out before more complex, abstract explanations are considered), and philosophical doubt (the constant questioning of the truthfulness and validity of all scientific theory and knowledge).

When considering other roots that fed the history of ABA, the influence of Charles Darwin on Skinner's perspective must be taken into account. At its core, Darwinian evolution and natural section occur at the phylogenic level, meaning that selection and variation occur within the species to support survival. In proposing the operant as the basic unit of measurement, and giving credence to the idea that variation and selection of behavior happen within the life of the organism, or at the ontogenic level, Skinner extended natural selection from a simple stimulus-response at the genetic level to the explanation of selection of behavior through consequences (see Skinner, 1981, for a more thorough discussion). According to Skinner (1953), the term operant "emphasizes the fact that behavior operates upon the environment to generate consequences" (p. 65). The notion of selection is paramount in behavior analysis, as it demonstrates the role of the environment on human behavior, particularly the consequences of behavior. In ontogenic selection, behavior is acquired, shaped, and maintained by *direct-acting* contingencies of reinforcement, meaning that a reinforcing consequence closely follows the behavior that is selected. Skinner noted that not all human behavior could be accounted for by phylogenic or ontogenic selection and offered a third type of selection, cultural selection, in which behaviors are passed from person to person across space and time via rules (see Catania, 2001 for a more detailed account). Through the influence of his own experiences, as well as the data collected in his lab, Skinner built the philosophy of the science that guides ABA: radical behaviorism (for a more detailed account of radical behaviorism, see Skinner, 1983, and Lundy et al., 2020).

This natural science approach led by the philosophy of radical behaviorism quickly took hold in the clinical world. Just 11 years after the publication of *Behavior of Organisms*, Fuller (1949) published the first demonstration of operant conditioning with an individual who was developmentally delayed. The first large-scale demonstration of the approach that would evolve into ABA came in 1959 from Ayllon and Michael in the study, *The Psychiatric Nurse as a Behavior Engineer.* Without a journal dedicated to the application of behavior analysis in applied settings, this seminal article appeared in the *Journal of the Experimental Analysis of Behavior.* Ayllon and Michael taught the nurses at a psychiatric hospital how to use a token economy to reduce psychotic speech in patients with schizophrenia.

Around the time that applied work began to emerge in the research literature, faculty at the University of Washington started using the principles of ABA to teach developmentally delayed children. These faculty, which included Donald Baer, Sidney Bijou, Bill Hopkins, Jay Birnbrauer, Todd Risely, and Montrose Wolf, also used behavior analytic principles in juvenile detention centers and even the workplace. In 1968, Baer, Bijou, Risley, Birnbrauer, and Wolfe left Washington to join the Department of Human Development and Family Life at the University of Kansas, which remains one of the top academic centers for behavior analysis to this day.

Quickly after joining the faculty at the University of Kansas, Baer, Wolf, and Risley launched the *Journal of Applied Behavior Analysis (JABA)*, with its first published study demonstrating the use of teacher attention to increase study behavior in general education classrooms (see Hall et al., 1968). The inaugural volume of *JABA* ended with a discussion about the characteristics, or dimensions of ABA by Baer et al. (1968). In this article, the authors established seven defining characteristics of ABA (i.e., applied, behavioral, analytical, technological, conceptually systematic, effective, generality) that still endure to this day.

The first of the characteristic defined by Baer et al. (1968) is that ABA is *applied*, meaning that ABA seeks to address problems deemed significant by society. The principles of behavior analysis have the ability to change any behavior, but within the field of ABA, efforts should be specific to behaviors that have social significance. Given that behavior is the subject matter of study within behavior analysis, methods within ABA should be *behavioral*, meaning that the focus of intervention is comprised of physical events that can be measured with as much precision as possible. The procedures, including assessment and intervention, should also be *analytical*, meaning that applied behavior analysts demonstrated functional relations between a behavior of interest and aspects of the environment that yield control over the behavior. Within this ideal, Baer et al. (1968) make a strong statement about the use of experimental designs in ABA work in order to show functional control. The authors specifically describe reversal and multiple baseline designs as effective ways to achieve the analytical dimension in applied work. Practitioners in ABA should also objectively and specifically identify and describe methodologies employed in order to meet the *technological* dimension of behavior analysis. In describing this aspect of ABA, Baer et al. state, "the best rule of thumb for evaluating a procedure description as technological is to ask whether a typically trained reader could replicate that procedure well enough to produce the same results" (p. 95). While procedures should be objectively defined and described, they also should show a *conceptually systematic* application of basic principles of behavior. By basing all procedures and describing outcomes in terms of the behavioral principles that undergird the field, "this can have the effect of making a body of technology into a discipline rather than a collection of tricks" (p. 96). Behavioral procedures should also demonstrate large enough change to show practical value, or in other words, they are *effective*. This ideal instills tremendous accountability for the clinician practicing ABA. Finally, and perhaps most importantly from a pragmatic standpoint, behavioral procedures should show *generality*, meaning "it proves durable over time," and are seen across environments, different people, and different situations (p. 96).

Within the years following the inaugural issue of JABA, the field of ABA experienced rapid growth. Throughout the 1960s and 1970s, a number of additional journals and books were published to disseminate behavior analytic research. Notably, in 1972, Willard Day created the journal "Behaviorism." In 1974, Azrin and Foxx published "Toilet Training in Less than a Day," demonstrating the effectiveness of a toilet training protocol, which had socially significant implications for the mainstream. This same year, the reach of behavior analysis started to extend beyond the United States when the "Mexican Journal of Behavior Analysis" began publication. These publications helped to create a means to disseminate research findings. Furthermore, the 1960s marked the beginning of research outside of the laboratory in applied settings such as the home, schools, or hospitals. With a rapidly growing interest in the science of behavior analysis, the first doctoral programs in behavior analysis were established in the 1960s and 1970s, allowing the field to further accelerate.

In 1974, the Midwestern Association for Behavior Analysis was founded as an interdisciplinary group of researchers, professionals, and students following a lack of representation of the science of behavior analysis at the existing psychology conferences (Peterson, 1978). The first elected president was Nathan Azrin (Peterson, 1978). This organization is known today as the Association for Behavior Analysis International (ABAI) and is one of the largest professional organizations dedicated to the dissemination of the "philosophy, science, application, and teaching of behavior analysis" (ABAI, n.d.).

ABA and Autism Spectrum Disorder

O. Ivar Lovaas was instrumental in establishing ABA as a prevalent intervention in children with autism. In 1961, Lovaas arrived at UCLA, as an assistant professor in the psychology department. In that following year, he primarily worked with one client, Beth, where he developed a system to score multiple behaviors and interventions with single-subject experimental designs (Smith & Eikeseth, 2011). He went on to publish a series of articles regarding the system to code behaviors, and a precursor to what is known as functional assessment, investigating the maintaining variables in antecedents and consequences.

His great impact is not without controversy, however. Lovaas promoted positive reinforcement, but would use aversive stimuli, such as low doses of electric shock and slaps on the thighs, to treat self-injury or aggression (Smith & Eikeseth, 2011). He reportedly ceased using these techniques during the late 1980s, when the interventions in the field had progressed so that aversive stimuli were not needed.

Early intensive behavioral intervention (EIBI) is widely researched and empirically supported to help children with autism make the greatest strides in learning skills and decreasing challenging behaviors (Eldevik et al., 2009). Much of this research owes thanks to Lovaas' work with the UCLA Young Autism Project (1987). The Young Autism Project was a home-based early intervention clinic. It was here that he produced research on "stimulus overselectivity," which is where children respond to only one detail of a stimulus and can prevent children with autism from learning and generalizing skills (Lovaas et al., 1971). Lovaas' intervention programs consisted of 30–40 hours of individual intervention per week, much higher than was common at the time (Smith & Eikeseth, 2011).

Lovaas published one of the first follow-up studies on ABA interventions and found that in a sample of 20 children with autism, the differences between children were due to environment, such that the institution group performed worse than children whose parents were trained to implement therapy at one-to-four-year follow-ups (Lovaas et al., 1973). He found that these differences could be temporarily mitigated by briefly resuming therapy. Lovaas later published a controversial follow-up study, in which he claimed almost half of the treatment group achieved "normal intellectual and educational functioning," compared to 2% of the control group (Lovaas, 1987).

Discrete Trial Training

The method Lovaas established is now referred to as discrete trial training (DTT). Discrete trial training consists of one-on-one learning events, typically at a table or in another structured, distraction-free environment. Smith (2001) outlines the five parts of each discrete trial: cue, prompt, response, consequence, and intertrial interval. A cue, also known as a discriminative stimulus, is the initial instruction or question. This is followed by a prompt, in which the teacher guides the child to the correct response. There are various types of prompts, such as verbal, gestural, and physical. This prompt will be faded out as the child becomes more independent in answering the cue. Following the prompt is the response, in which the child either answers correctly or incorrectly. The consequence of a correct response is reinforcement, which could consist of edibles, access to tangibles, or social reinforcers such as hugs, tickles, and praise. If the child answers incorrectly, the consequence is an error correction procedure. Last is an intertrial interval following the consequence, which is a brief moment before presenting the next cue, and thus repeating this cycle.

Discrete trial training can be used to teach a variety of skills and abilities to children with autism. A meta-analysis on EIBI in children with autism found it was effective in improving expressive and receptive language and adaptive behavior, in addition to IQ and nonverbal IQ (Peters-Scheffer et al., 2011). While DTT is an important aspect of ABA, it is not the only aspect of ABA (Smith, 2001).

Pivotal Response Treatment

Pivotal response treatment (PRT) is a technique to apply the principles of ABA, developed by Lynn and Robert Koegel (1987), also known as pivotal response training or pivotal response therapy. As opposed to Lovaas' technique, PRT is more naturalistic and child-directed. A core component of PRT is establishing motivation and rewarding attempted responses or behaviors (e.g., attempted speech) with preferred items. Compared to EIBI's 35–40 hours per week of intervention with qualified technicians, PRT requires a minimum of 25 hours per week. However, it also includes family members to employ PRT methods at home to help with generalization and better outcomes for the child.

PRT focuses on five core areas: motivation, responsiveness to multiple cues, self-management, self-initiation, and empathy (Koegel & Koegel, 2006). These areas are considered "pivotal" and are taught with the hopes that skills will then improve more "peripheral" areas, such as language and self-help skills. Bozkus-Genc and Yucesoy-Ozkan (2016) conducted a meta-analysis on 34 studies on PRT and found it to be an effective method in teaching children with ASD a variety of skills. They calculated the mean effect size using PND (76.10%), PNDC (78.03%), and PEM (89.34%) methods, which indicated the treatment was fairly to highly effective.

Functional Analysis

Another influential researcher is Brian Iwata, who is currently at the University of Florida. Iwata developed the functional analysis procedure used today. Functional analysis is a procedure used to empirically identify the conditions which maintain challenging behavior. Iwata and colleagues published "Toward a Functional Analysis of Self-Injurious Behavior" (1982/1994), which employed a multielement design to assess the function of self-injurious behavior (SIB) in nine children and adolescents with developmental disabilities. The design included four experimental conditions, with 15-minute sessions per condition: academic, alone, social disapproval, and play. The academic condition, also known as an "escape" or "demand" condition, represents the "negative reinforcement" function. In this condition, the experimenter and participant are made to sit at a desk together and the experimenter presents tasks. If the participant responded correctly, they received brief praise. If they did not respond correctly, the experimenter used a "three-step" prompt, such that they first repeated the task after 5 seconds, then they repeated the task and modeled the appropriate response after 5 seconds, finally they physically prompted the participant. If the participant engaged in SIB, the experiment removed task demands for 30 seconds and turned away from the participant. The alone condition represented automatic reinforcement, where the participant was in a room alone, without toys or any items. The social disapproval condition, also known as an "attention" condition, represented the positive reinforcement function. In this condition, the participant was told to play with toys, while the experimenter "worked" and ignored all behaviors. If the participant engaged in SIB, the experimenter would deliver attention to the participant (e.g., say "don't do that" and patting them on the shoulder). Lastly, the play condition served as a control condition, which allowed the participant to play with various toys and no demands were placed. Instances of SIB were ignored and if there were no instances of SIB for 30 seconds, the experimenter delivered brief social and physical attention.

This functional analysis was conducted until experimenters observed stability of SIB levels, the levels of SIB was unstable for 5 days, or sessions were conducted for longer than 11 days; the required number of sessions ranged between 24 and 53. The results from this study found that it successfully identified functions of behavior. In addition, this function was not correlated with the rate or severity of the SIB, indicating that function and topography were distinct and need to be assessed separately. Since its publication, the basic method of functional analysis has not changed much, although the behaviors the method has been applied to has expanded (Hanley, Iwata, and McCord, 2003). In addition, the original positive, negative, and automatic functions of behavior have expanded to escape, attention, tangible, and automatic (Dixon et al., 2012, p. 16).

Some concerns arose due to the perceived training needed and the time-consuming nature of functional analyses. However, Iwata et al. (2000) found that basic clinical skills for conducting functional analyses could be acquired in less than 14 sessions with individuals with Bachelor of Arts degrees. Of the baseline scores, 33 out of 51 sessions were below 80%. Of the post training scores, in comparison, 66 out of 99 were at 100%.

In addition, to address the time concern, individuals developed other means to identify functions of challenging behavior. One method is standardized tests, such as the Motivation Assessment Scale (MAS; Durand & Crimmins, 1988), the Functional Assessment Checklist (FACTS; March & Horner, 2002), and Questions About Behavior Function (QABF: Matson et al., 2012). These measures, and others, will be discussed in more length in a later chapter (see Standard Tests and Interviews for Functional Assessment). Another method, proposed by Hanley and colleagues (2014), is an open-ended interview paired with a 15-to-30-minute structured observation across two conditions, test and control, in order to establish functions of behavior.

Criticisms of ABA

Perhaps stemming from the availability of funding in the 1990s for ABA therapy for autistic individuals, contemporary ABA has erroneously become synonymous with "autism therapy." ABA has broader implications reaching beyond a therapy for individuals with autism spectrum disorder.

Since the inception of ABA, specifically in treating children with autism, it has received criticism and pushback, from both the academic and public spheres alike. From an academic standpoint, some argue the effects of ABA are inflated (Kirkham, 2017). Some researchers have criticized the low quality of research regarding ABA and the lack of randomized controlled trials (RCTs) (Kirkham, 2017; Gresham & MacMillan, 1998). Further, some have tried to replicate Lovaas' results, to no avail (Shea, 2005).

The public criticisms have come from mostly autistic individuals, many of whom received ABA in early childhood. With the growing body of the neurodiversity movement, the push for ABA as a treatment for autism has been contended. The first point of contention is the use of language regarding a person's diagnosis. Autistic self-advocates argue against person-first language (i.e., "person with autism"), as it suggests a person can be separate from their autism diagnosis. Rather, they consider autism an integral part of their identity and personhood (Kirkham, 2017). As such, in order to accurately and respectfully report the criticisms from this community, for the remainder of the chapter 'individuals with autism' will be referred to as 'autistic individuals.' This view goes hand-in-hand with individuals who reject the 'medical model,' and thus reject the notion of needing an intervention at all (Kirkham, 2017). As such, some individuals compare ABA with behavioral interventions once used to treat homosexuality, which is no longer considered an illness. Further, ABA maintains rooted primarily in behaviorism, whereas interventions for other conditions have adopted a cognitive and behavioral approach (Kirkham, 2017).

Further, autistic individuals have argued that ABA therapy is abusive. The argument goes back to Lovaas' days, when he would implement aversive stimuli, such as electric shocks. Beyond the use of aversives, autistic individuals argue ABA is psychologically abusive. Self-advocates note that behavior is communication, and by ABA teaching a child not to engage in a target behavior, they in essence take away an autistic individual's form of communication. ABA can also focus on decreasing repetitive behaviors, referred to as 'stimming', which often serve as methods to self-soothe. Overall, self-advocates argue against ABA on the basis that it aims to decrease 'autistic behavior,' which many view as, "authentic and harmless representations of their personality" (Kirkham, 2017). Ari Ne'eman, autistic self-advocate and president and co-founder of the Autistic Self Advocacy Network, states, "the emphasis on things like eye contact or sitting still or not stimming is orientated around trying to create the trappings of a typical child… It can be actively harmful when we teach people from a very early age that the way they act, the way they move is fundamentally wrong" (Child Mind Institute, n.d.). Opponents of ABA also cite the implementation of ABA as problematic, namely criticizing the repetitive nature and citing that some skills don't generalize. However, Dr. Lord has argued the programs should be more play-based and therapists are trained to make the treatment fun for the child (Child Mind Institute, n.d.).

Contemporary Applied Behavior Analysis

One of the most exciting advances in the field of ABA is the emergence of the field of clinical behavior analysis and specifically acceptance and commitment therapy (ACT). ACT is based on Relational Frame Theory (RFT), which has been described as a behavioral psychology of language and cognition. RFT shares overlap with Sidman's stimulus equivalence, which is an alternative view to Skinner's verbal behavior. Based on the theory of stimulus equivalence, following specific training, relations may emerge that had not been explicitly taught. This relationship between stimuli is the basis of RFT. There are multiple types of relationships. For example, there are causal relationships, relationships of coordination or rough equivalence, and hierarchical relationships. RFT also incorporates thoughts, emotions, physical sensations, and overt behaviors, which form the relationships. Relational responding in RFT is the discrimination of relationships between stimuli, which is important because it allows greater access to information than discriminating between the stimuli alone. Derived relational responding is the ability to relate stimuli in a variety of ways, when one stimulus has not been directly taught. This concept can be divided into two types: mutual entailment and combinatorial entailment. Mutual entailment can be explained by the fact that if stimulus A is related to stimulus B in a specific way, then stimulus B is related to stimulus A in a similar way. Blackledge (2003) provides the example of being taught that the cognition "I'm afraid" is the cause for the action of running away, then running away is an effect of thinking "I'm afraid". Combinatorial entailment involves at least three stimuli and refers to the reciprocal relationships between the two stimuli (A and C), which are not directly related to each other, based on how those stimuli are related to other, intermediate stimuli (B). For example, Blackledge (2003) states that "I/me" is related to "snake" by the fact they are both in a wooded area, and thus related to "wooded area". RFT presents an approach to language and cognition.

As mentioned previously, ACT branched from RFT. ACT uses six core processes in order to increase psychological flexibility (Hayes et al., 2006). These processes include acceptance, cognitive defusion, being present, self as context, values, and committed action. Acceptance is an active and aware recognition of internal events without trying to change the form or frequency of such events. This method is implemented in an attempt to increase values-based action (Hayes et al., 2006). Cognitive diffusion alters the function of internal events, rather than altering the form or frequency, such that it creates a context in which an individual can interact with thoughts and previous, maladaptive functions are decreased. Techniques to do this are used to weaken the quality of the internal event, and thus, decrease the credibility or attachment to said event. Being present refers to nonjudgmental interaction with internal and external events as they unfold. This method is implemented to encourage the individual to engage in more flexible behavior, and therefore, have their actions correspond with their values. Next, self as context involves "I" as a context for experience, from which an individual can objectively engage and evaluate thoughts and experiences. Values are activities or qualities which help guide an individual's choices, related to various domains such as family, career, or spirituality. Lastly, committed action is a pattern of behavior in which an individual acts in accordance with their values. While values can never be "accomplished," committed action includes concrete goals. This process can involve exposure, skill acquisition, shaping, and goal setting. Although they are introduced and conceptualized individually, the core processes are interrelated and thus, each supports the other. Therefore, most research has investigated ACT as a whole, rather than individual processes.

A meta-analysis by Powers et al. (2009) found that ACT is a successful intervention, with small to medium effect sizes, compared to placebo and control conditions. It has a small effect size (0.42) compared to control conditions, with an average improvement of 66%. Compared to waitlists and psychological placebos, ACT yielded a medium effect size of 0.68, and a small effect size (0.42) compared to treatment as usual. However, ACT was not more effective than established treatments (effect size = 0.18) or control conditions for distress problems (e.g., anxiety and depression, effect size = 0.03). A more recent meta-analysis by A-tjak et al. (2015) found similar results. Their analysis yielded medium to large effect sizes in primary outcomes in treating anxiety, depression, addiction, and somatic health problems compared to control (0.57), waitlist (0.82), psychological placebo (0.51), and treatment as usual (0.64). Additionally, they found small to medium effect sizes on secondary outcomes for life satisfaction and quality measures (0.30) and process measures (0.56) compared to controls. They also found no significant difference between ACT and established treatments (i.e., cognitive behavioral therapy). These studies indicate ACT is an effective treatment compared to controls, waitlist, and psychological placebos and may be as effective as currently implemented interventions.

Summary and Conclusions

Since its inception, the field of ABA has evolved considerably as our knowledge of the principles of behavior analysis has grown. Edward Thorndike and Ivan P. Pavlov contributed significantly in establishing research which resulted in the establishment of behaviorism. Thorndike is known for his work with puzzle boxes which developed the Law of Effect, which, in essence, states that behaviors which precede rewards are more likely to reoccur (Thorndike, 1911). Meanwhile, Pavlov's lab in Russia produced research on classical conditioning with dogs and salivation. Both served to create a basis for which behaviorism took root in. John B. Watson adopted Pavlov's conditioned reflex and applied it to learned behavior in humans. He is most well-known for his lecture referred to as a Behaviorist Manifesto and his work with Little Albert. B. F. Skinner expanded the field further, influenced by his predecessors, Thorndike, Watson, Pavlov, and Charles Darwin.

O. Ivar Lovaas furthered the field as he implemented ABA techniques as an intervention for autism. His method is referred to as DTT and he was instrumental in establishing EIBI as a widely researched and implemented therapy. However, his original methods, specifically his use of electric shock and other aversives, have received warranted pushback and criticisms. Brian Iwata had further influence as he developed functional analysis procedures to experimentally establish functions of challenging behaviors.

Although today ABA is synonymous with autism, it has been implemented with a variety of populations and communities. ABA has been researched in schools, such as within special education classrooms (Trump et al., 2018) and more widespread issues such as violence and discipline problems within a school (Anderson & Kincaid, 2005). Behavior analysis has also been used in foster care to reduce running away (Crosland & Dunlap, 2015). Further, the subfield of behavioral gerontology has developed which focuses on applying behaviorist strategies to aging populations (Burgio & Burgio, 1986). Behavior analysis has also found use in treating and studying a range of addictions, from cigarettes and illicit drugs (Silverman et al., 2008) to gambling (Weatherly & Dixon, 2007). Applied behavior analysis is ever expanding, by developing new techniques or finding applications in new populations or to treat various disorders and challenging behaviors.

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Ethics and Legal Issues

2

Sara Gershfeld Litvak and Darren J. Sush

Applied behavior analysis (ABA) has established itself as a well-regarded and scientifically grounded field of study and area of practice. Though it has grown steadily in both application and practitioner-base, recent years have seen a meteoric rise in those pursuing careers as professional behavior analysts and working within the discipline (BACB, 2021c). Ethical challenges and questions are in no way new to the field of behavior analysis. In many ways ethical challenges have helped guide the direction and course of professional behavior, the increase in those identifying themselves as behavioral analysts, representing the field to the public, and engaging in clinical and professional relationships. These trends not only solidify the significant need for comprehension of ethical behavior but also an understanding of what may be defined as unethical conduct.

As with most major respected human-service organizations and healthcare professions, identification and differentiation of ethical behavior must not be left solely to the interpretation of a field's individual representatives without proper consideration of the entirety of the field's membership. The establishment of a universal framework from which ethical practice can be determined and understood acts as the foundation for clinical and professional practice and is highly dependent on the goals and objectives set forth by the field itself, and the principles from which those who form the field establish as priorities.

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The Development of Ethical Standards and Guidelines in ABA

Applied Behavior Analysis has had a complex relationship with the field of ethics. In 1987, the Florida Association of Behavior Analysis (FABA) was the first state to develop an ethical code. Shortly after, the Texas Association for Behavior Analysis (1990s) and the California Association for Behavior Analysis (1996) quickly followed. In 2002, the Association for Behavior Analysis International (ABAI) adopted the American Psychological Association's ethical code until the Behavior Analyst Certification Board (BACB) created an ABA-specific ethics code in 2004. While many of these organizations have taken it upon themselves to outline ethical behavior in the field, it's important for anyone learning about ABA to understand that the profession comprises a variety of independent professional and standard-setting organizations which exist to serve and support their stakeholders. Currently,

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_2

there are four independent types of professional organizations within ABA, some of which have been named above. The four types of organizations are (a) professional associations, (b) trade associations, (c) certifying bodies, and (d) accrediting bodies. Together, these organizations provide a variety of necessary functions for their respective constituents, including creating ethical codes, standards, and practice guidelines. Below, we provided a brief overview of each organization and the roles they play in ethics of behavior analysis services.

Certifying Body

Certification and licensure bodies exist to meet the professional licensure needs of the people who hold such a license or certificate. A certifying body verifies that individual professionals have the appropriate level of competence and expertise to effectively perform their roles. Additionally, certifying bodies are often at the forefront of industry research and training. They work with federal, state, government, and third-party entities to enhance recognition of their certified professionals. A hallmark of a credible credentialing program is that they hold accreditation by the National Commission for Certifying Agencies (NCCA) of the Institute for Credentialing Excellence (ICE) or the American National Standards Institute (ANSI).

The Behavior Analyst Certification Board (BACB) is the largest certifying body in behavior analysis and regulates any individual who has earned the Board Certified Behavior Analyst (BCBA©), Board Certified Assistant Behavior Analyst (BCaBA©), or Registered Behavior Technician (RBT©) certification. The BACB is also responsible for releasing the first Professional Disciplinary and Ethical Standards and Guidelines for Responsible Conduct for Behavior Analysts (2004) and the Professional and Ethical Compliance Code for Behavior Analysts (2014), now known as The Ethics Code (2020).

Professional Association

Professional associations come in many shapes and sizes. They are characterized typically by shared interest in a particular job or field. Professional associations place great effort on the development, training, and education of their constituents. Their aim is to improve their respective industry's capabilities and effectiveness.

A well-known hallmark of professional associations is the offering of conferences and training, designed to elevate the knowledge among a shared group. They also advocate for the right to practice via legislative efforts. These offerings can provide professional association members with continuing education units (CEUs) to meet the licensing and credentialing needs of certifying bodies, like those addressed above. Professional associations in ABA can be national or local. Regional professional associations, such as the state-specific Texas Association of Behavior Analysis (TxABA) and California Association of Behavior Analysis (CalABA), represent the interests and priorities of its constituents, which include behavior analysts practicing within the organization's locality, as well as those accessing behavior analytic services across the represented area. These regional associations often work in tandem, and with significant collaboration, from national organizations. Behavior analysts rely heavily on national organizations such as Association for Behavior Analysis International (ABAI) and Association for Professional Behavior Analysts (APBA) for guidance on practitioner ethical issues.

Trade Associations

A trade association engages in activities, such as advertising, education, publishing, and political donations, though its focus often hinges on collaboration between companies. These groups also work to influence public policy through lobbying and leveraging regulatory measures within their particular industry for the benefit of their members.

A trade association is founded and funded by the businesses it represents and often acts as a collective voice for companies. A large, common example is the WTO (World Trade Association) that oversees trade rules between countries. In the ABA industry, there are local trade association such as the Massachusetts Coalition for Behavior Analysis Providers (MassCAP) and Indiana Providers of Effective Autism Treatment (InPEAT), and national association such as Council of Autism Service Providers (CASP) and National Coalition for Access to Autism Services (NCAAS).

Accrediting Body

An accrediting body defines and measures quality in a particular field. These institutions represent objective, external groups that examine and evaluate a program or institution to ensure they meet a set of standards established by experts in the field. A hallmark of a credible accreditation program is that they hold accreditation by the American National Standards Institute (ANSI), which promotes transparency of how standards are developed and an opportunity for public commentary. To date, the only accrediting body in ABA is the Behavioral Health Center of Excellence (BHCOE), which administers a BHCOE Accreditation decision. The BHCOE is also responsible for releasing the first Code for Effective Behavioral Organizations (2015), now the BHCOE Standards of Excellence (Effective January 1, 2021).

The Foundation for Growth of ABA

While many of these professional and regulatory organizations which exist today aim to protect consumers of ABA services, up until the 2000s, most of these organizations did not exist. In 2016, Deochan and Fuqua released a paper that outlined the BACB certification trends between 1999 and 2014. Since the Behavior Analyst Certification Board was officially established in 1998, the number of individuals certified has grown exponentially, especially in the United States. As growth continued, a group of parents noticed that when their children were diagnosed with Autism Spectrum Disorder (ASD), many health insurance plans would deny coverage for ABA therapy. As a result, only those who could afford to pay out of pocket were able to afford paying for Applied Behavior Analysis. As a result, a group of parents and advocates in Indiana, including The Arc of Indiana (Kim Dodson), The Indiana Resource Center for Autism (Dr. Cathy Pratt), and a group of scientists and parents led by parent advocate, Michele Trivedi, asked the Indiana State General Assembly to pass the first comprehensive autism treatment coverage law.

In 2001, thanks to the hard work of Michele Trivedi and others, the first Autism Health Insurance Mandate law was passed in Indiana mandating coverage for ASD, requiring health insurers, health care subscription plans, and health maintenance organizations to cover the diagnosis and treatment of ASD in individuals within a specified age group. An immediate result of the Autism Mandate in 2001 passing led to parents and advocacy groups in other states to begin doing the same, with South Carolina passing in 2008. This legislative activity set the groundwork for the growth the field of ABA would experience over the next two decades.

While the increased coverage for individuals with autism has been monumental for those families who would otherwise not be able to afford treatment, the insurance coverage for Applied Behavior Analysis therapy had a direct impact on the growth curve of Board Certified Behavior Analysts in the United States, leading to an increased risk for ethical issues to arise. While the field continues to grow, a significant challenge has emerged as there are more individuals needing services than there are certified individuals across most of the United States (BACB, 2021c). Due to this growth, ethics has become an important topic to address both from the perspective of historical ethics concerns in the field and current issues related to individual ethical decisions and organization's ethical decisions (Sellers et al., 2020).

Learning from the Past to Shape the Future

The field of behavior analysis has evolved and developed from one that focuses on the application of learning principles to promote and change behavior within controlled environments, to one that supports the growth and development of socially significant behaviors across settings, populations, and areas of need (Baer et al., 1968). Yet, while this advancement has led to significant benefit through numerous arenas, the progression of behavior analysis has not been without substantial controversy, missteps, and wrong-doing (Bailey & Burch, 2016).

Though it may be possible to point toward those who associated themselves with the use and implementation of behavioral sciences as the primary culprits of these infractions rather than that of actions perpetrated by actual behavior analysts, it is the humble opinion of the authors that it would be irresponsible and potentially detrimental to the continued advancement of the field of behavior analysis to not acknowledge our role in committing and perpetuating the continued demonstration of the behaviors that may be considered beyond problematic. Recognizing how the field of behavior analysis may have facilitated, inspired, or benefited from these immoral actions allows the field not only to seize responsibility and regain potential lost trust but also to learn, develop, and improve.

Behavior analysts practicing today can maintain the dual position of promoting and furthering the advancement of the field, while at the same time acknowledging and validating the experiences of those who in the past (and perhaps presently) encountered the faults and failings during their involvement with behavior analysis. By listening to concerns, and including the populations with whom we wish to support the planning and direction of the field, behavior analysis has the opportunity not only to grow by preventing the repetition of past misgivings but also to create conditions that promote opportunities to engage in more clinically and ethically appropriate interactions and behaviors. In addition to promoting more clinically and ethically sound care, today, person-centered care is considered best practice across all patient populations. Codes of ethics assist in providing guidelines and framework from which to maintain ethical conduct; however, a code itself cannot prevent disreputable activities. Only through the continued identification of areas from which the field can improve and understanding of the rules the field sets for itself can behavior analysis and behavior analysts hope to continue to evolve in an honorable and ethical manner.

Ethics from the Individual Practitioner Perspective

While specific actions and responses may be considered to be more or less appropriate based on the context of the circumstance under which they occur, the basis for driving ethical behavior is established by maintaining and facilitating the guiding values that set the foundation for ethical standards in behavior analysis. The Behavior Analyst Certification Board (BACB, 2020) recognizes four core principles from which all who identify themselves as behavior analysts should endeavor to exemplify. Representing the field as a behavior analyst, interpreting appropriate and proper courses of action, and interacting with colleagues and the general public should all be conducted with these frameworks in mind.

First, behavior analysts strive to ensure that their involvement and interaction are to the benefit of those they mean to serve and any collateral parties that may be impacted by their participation. ***Benefiting others*** puts the individual or party identified as the primary client as the behavior analyst's central focus and priority. Any interaction and intervention must be conducted in a manner that keeps in mind both the short-term and long-term impact the behavior analyst may have toward the client and their circumstance. Contributions and changes are made to safeguard the rights and welfare of the client, keeping in mind any individual or contextual factors that might lead to potential challenges throughout the course of the behavior analyst's involvement and beyond. Finally, it is the behavior analyst's ultimate responsibility to "do no harm," no matter how subtle or unintentional, by placing the client's best interest at the forefront.

Behavior analysts' venture is to treat those with whom they serve with care, ***compassion, respect, and dignity***. Many recipients of behavior analytic services are considered to be members of particularly vulnerable populations who may not yet advocate for or represent themselves. Facilitating opportunities for individuation and self-determination and affording personal choices is imperative toward creating a more equitable environment. When involvement or intervention is employed to assist in developing autonomy, behavior analysts should do so in a manner that allows for appropriate fading of interaction or service and reduces the likelihood of reliance on such supports.

It is imperative that behavior analysts understand their responsibility not only to their own reputation, but also to that of the field of ABA. In their representation as a behavior analyst, those working within the field should conduct themselves with ***integrity***, in a manner that is professional, honest, and accountable. Doing so assists in establishing trust of the behavior analyst as an individual, as well as toward the field that is reflected by the practitioner. Providing clear and accurate expectations, identifying professional roles and boundaries, and utilizing behavior analytic strategies grounded in scientific research establish and maintain the integrity of the behavior analyst.

The final foundational principle guiding behavior analysts in facilitating and interpreting their interactions focuses on ensuring ***competence*** within and throughout their professional endeavors. As ABA expands across areas and populations, those working within the field must remain within their scope of practice, continue to maintain professional development, remain current of advances and changes, increase their knowledge and expertise, and understand their own boundaries and limitations (BACB, 2020).

While ethical principles assist in forming a framework and foundation for behavior analysts to embody, these ideals guide action rather than direct behavior. The Ethics Code for Behavior Analysts (BACB, 2020) establishes specified and defined rules of conduct that must be adhered to by all Board Certified Behavior Analysts ® (BCBAs ®), Board Certified Assistant Behavior Analysts ® (BCaBAs ®), Registered Behavior Technicians ® (RBTs ®), and BACB applicants (BACB, 2014).

Ethics codes are generally established within a field in order to guide and promote behavior that is considered to be more ethical or "right," as a response to behaviors conducted by individuals previously associated with the field that are more currently considered to be problematic or "wrong," and as a means of increasing public trust in the practitioners and the field as a whole (Brodhead et al., 2018). By establishing formalized rules of practice in the form of an ethics code, the field of behavior analysis is provided a framework from which to engage in more appropriate and beneficial decision-making. Codes and standards allow behavior analysts to be better equipped to evaluate and assess potentially detrimental choices, recognize more beneficial options, and identify when additional support, guidance, or disciplinary reporting is necessary (Sellers et al., 2020).

Though ethics codes are meant to be comprehensive and to provide substantial direction and guidance, personal interpretation, ambiguity, and misunderstanding of code elements continue. To an extent, ethics codes are written in a manner that should allow for situational understanding and application where appropriate. While in other circumstances, clear application is specifically implied for the identified benefit of all those involved. However, it is important to acknowledge that it is not only impossible but also not advised for all scenarios that may be encountered within professional practice to be integrated within even the most inclusive of ethics codes (Sush & Nadjowski, 2019). As a result, ethical practitioners and the field governing them must expect the rules of ethics to be applied and understood with consistency when specific interpretation is available and with informed and responsible decision-making across all other circumstances.

Simply developing an ethics code, even one where updates are consistently implemented to reflect changing times and expectations, does not preclude the possibility that ethical challenges or blatant ethical infractions will not continue to occur. The establishment of a well-reviewed and thorough ethics code does provide a foundation of ethical expectations, as well as a resource for identified behaviors that are considered consistent and inconsistent with a well-intentioned field. However, the code itself does not prevent unethical behavior from occurring. It would be inaccurate to presume that because an issue has been addressed and defined within an ethics code, it no longer has the potential to be displayed in clinical practice (Dawson, 2004).

Ethics from the Systems Perspective

While individuals engage in ethical decision-making when providing clinical services, the organizations who manage those individuals exercise great power. It has been argued that the behaviors of managing organizations ought to be governed by a more demanding set of standards than those that apply to private individuals (Drucker, 1981). The section on ethics, integrity, and professionalism in the Standards of Excellence (BHCOE, 2021) establishes specific rules of conduct that must be adhered to by all organizations who hold BHCOE Accreditation.

Similar to those at the individual practitioner level, organizational standards are typically established at the directorial level to guide and promote the behavior of an organization that is considered to be "right" and reduce the behaviors considered to be "wrong." By establishing a formalized standard for ethics of organizations, organization owners and operators can be better equipped to make decisions that can assist those who work with them to help improve the lives of those they serve.

Leveraging the Ethics Code in Clinical Practice

Ethics codes become useful tools in enhancing the clinical strength of a field when they are utilized not simply as a means of identifying missteps and justifying disciplinary actions in response or reaction to infractions, but rather when the purpose for inclusion of their elements is understood. Keeping in mind that the function of the ethics code above all else is to ensure that the practitioner is acting in the best interest of their client (Bailey & Burch, 2016) allows for a deeper grasp of the code itself and an increased likelihood of awareness of code elements prior to and when faced with ethically precarious circumstances.

Though much of a professional behavior analyst's knowledge both clinically, and in relation to ethical challenges, will be gained through practical experience, it is recognized that even with the most diverse of practicum environments and populations, or dedicated and attentive of supervisors, it is highly unlikely that those training in behavior analysis will have the opportunity to prepare for any potential ethical challenge that may be encountered (Sush & Nadjowski, 2019). Participation in coursework specifically focused on the ethical practice of ABA is required for practitioners who wish to sit for the BACB certification exam and earn their BCBA credential (BACB, 2021a). Additionally, maintenance of certification requires continuing education specifically focused on ethics in behavior analysis (BACB, 2021b). Doing so allows for exposure to a greater variety of learning opportunities and a more in-depth analysis of the components of potential challenge and contributing factors to ethical difficulties, as well as providing a supportive and sheltered environment within which to learn, question, and grow (Handelsman, 1986).

Factors Influencing Ethical Decision-Making

A behavior analyst's capacity to respond to and manage ethical challenges in an appropriate, adaptive, and reasonable manner is likely influenced by a number of different factors. As mentioned above, exposure to ethical issues through practical experiences under the watch of a knowledgeable and supportive supervisor may assist in developing a stronger capability for both preventing and reducing ethical risk. Additionally, participation in course sequences and educational opportunities related to the identification and study of ethical issues in behavior analysis may build clinical and ethical intuition and fill in areas not otherwise covered through direct involvement. Yet, even with the most substantive training and educational experience, the ethical practice of behavior analysis is likely most predominantly influenced by the individual behavior analysts themselves.

Ethical Competence

Responding in the most advantageous manner is often necessitated upon the behavior analyst's awareness not only of what the best course of action in relation to a challenging situation may be, but also their identification that they are in the midst of an ethical issue. However, perhaps most importantly, the behavior analyst's understanding of their own limitations in determining those risks and charting the necessary course of action may be the most crucial factor (Ghezzi & Rehfeldt, 1994).

Behavior analysts may best determine their proficiency to adequately manage an ethically precarious circumstance and situation based upon their direct training in similar areas, as well as their experiences when previously faced with comparable issues (Bailey & Burch, 2016). Though there is always the potential for an ethically difficult situation to occur or become evident, the majority of these issues will likely either resolve themselves through the general course of interaction and involvement without even the behavior analyst's knowledge that the challenge was present, or with minimal corrective action (LeBlanc et al., 2020). However, even the most innocuous of ethical difficulties has the potential to progress to more impactful and potentially detrimental levels (Sush & Nadjowski, 2019). The behavior analyst's identification of such circumstances and capability of addressing these issues prior to such problematic advancement are likely most highly related to the behavior analyst's own familiarity with the ethics code itself and knowledge and fluency with code elements that will allow them to more easily attribute difficult situations with related and established ethics codes, thus, increasing the likelihood that a behavior analyst may proactively engage with an ethically troubling event and prevent further escalation (Bailey & Burch, 2016).

Fortunately, a behavior analyst does not simply need to wait for an ethical challenge to occur to strengthen and build their experience as an ethical practitioner. Similarly, though formal ethical training may have been received in graduate coursework and reinforced through continuing education, behavior analysts may create learning opportunities to increase their expertise and comfortability in preventing and managing ethical challenges on a consistent basis, and without the additional stress or pressure of responding to legitimate, real-world confrontations (Sush & Nadjowski, 2019).

Behavior analysts who work with other professionals within a behavior analytic organization have the benefit of relying upon the different points of view, areas of expertise, and perspectives of their colleagues in discussing ethical issues and ideas. Behavior agencies and organizations can also be sure to make ethics a clear aspect of everyday practice through staff trainings, in-service meetings, journal clubs, discussion sessions, or team building exercises. Such practices can be held periodically, or in preparation of feasible challenges (Handelsman, 1986). It may also be beneficial for behavior organizations to establish a clear path for reporting ethical concerns or questions. Depending on availability or the structure of the agency, this may come in the form of peer mentors, clinical directors or supervisors, or a designated ethics coordinator that may be accessed should situations arise, or as a means of monitoring continued ethical behavior (Brodhead & Higbee, 2012).

Behavior analysts who work as independent practitioners may not have the opportunity to participate in group training activities similar to those who are employed within an agency. However, these professionals may benefit from creating a network of colleagues and mentors with whom they may contact regarding ethical challenges and best practices (Smith, 2003).

Benefit and Understanding of Potential Reinforcement

Responding to ethical challenges may also be influenced by the behavior analyst's ability to acknowledge, identify, and reconcile their own personal investment in the outcome or progression of the ethical issue. Whether clearly defined within the ethics code or not, charting a particular course in relation to a potential ethical concern may certainly assist those involved, but may be of particular benefit to the behavior analyst themselves. Separating motivation and decision-making to ensure that the best interests of the client are paramount requires significant insight on the part of the behavior analyst. The potential benefit to the behavior analyst, even when perceived to be of assistance to the client, may lead professionals toward choosing less ethical or more complicated paths (Sellers et al., 2016).

The contingencies governing ethical behaviors are the same as those which inspire and maintain all other behaviors and are in place regardless of whether the individual is aware of the opportunities for reinforcing consequences (Brodhead & Higbee, 2012). However, it can be assumed that a behavior analyst is much more likely to reflect on their ethical decision-making if they are aware that an opportunity for reflection is present. Just as a behavior analyst is able to more effectively and appropriately develop strategies to reduce a maladaptive behavior or increase a replacement skill if they have a more thorough understanding of the environmental conditions and circumstances in which those behaviors are acquired and will continue to occur, a behavior analyst is more likely to engage in accurate ethical analysis if they understand the context in which ethical behaviors, and similarly unethical behaviors, occur and may thus take steps toward facilitating appropriate action and, if necessary, intervention (Sush & Nadjowski, 2019).

Acknowledging Biases in Ethical Decision-Making

Knowledge of the ethics code itself, training in areas related to ethics in behavior analysis, the potential for reinforcement, and the context under which ethical challenges occur may all influence a practitioner's utilization of the ethics code, ethical decision-making, and overall ethical behavior. However, the behavior analyst's personal biases and interpretation may underlie all of these conditions. As ethical challenges often involve multiple circumstances or situations, environmental contexts, and individual parties, the most integral factor in identifying issues and responding appropriately is likely the behavioral analyst's own moral values and personal beliefs that influence the understanding of all these factors. While it is important to understand cultural context in determining how decisions may impact a behavior analyst's clients or the clinical relationship, the behavior analyst's background, history, and past experience of reinforcing and punitive consequences under similar conditions may impact their acknowledgement of challenging situations and determination for appropriate courses of action, as well as their overall comprehension of the ethics code itself. As a result, a behavior analyst's ethical decision-making ability may be dependent not only on their skills and clinical experience but also on their ability to identify when their own cultural foundations and beliefs may influence, supersede, hinder, or encourage the most advantageous course of action (Brodhead, 2019; Rosenberg & Schwartz, 2018).

Ethical Delivery of ABA Services

While ethics has been a timeless topic discussed at length by philosophers such as Kant, J.S. Mill, and Aristotle, from a behavioral perspective, Skinner's work has rarely commented on which behavior would be considered ethical or moral. Rather, he focused on the contingencies that influence the display and maintenance of behavior. As such, behavior analysts are often tasked with understanding what is known as normative ethics**.** ***Normative ethics*** is the study of ethical behavior which investigates how one ought to act during certain scenarios or ethical decision-making (Brodhead et al., 2018).

Behavior analysis is a discipline with three distinct branches: (1) behaviorism, which focuses on the philosophy of behavior analysis, (2) experimental analysis of behavior, which concentrates on analyzing the basic principles of behavior, and (3) applied behavior analysis (ABA), which centers on solving socially significant problems using the principles of behavior analysis. Applied Behavior Analysis and behavior analytic principles and strategies have been applied toward a number of different areas and subjects. Of the different subspecialties, ABA is best known for its effectiveness in treating autism spectrum disorder (ASD). In fact, at the time of this writing, approximately 73% of all certified practitioners work with individuals with autism spectrum disorder (BACB, n.d.). As such, we will focus on this population when discussing ethical and legal issues within the subsequent section.

Most ABA services are delivered in a tiered model in which a behavior analyst provides clinical oversight to either an assistant behavior analyst or a behavior technician (BACB, 2014). This tiered model operates under the umbrella of a legal entity referred to as an ABA therapy organization (Gershfeld Litvak & Rue, 2020).

While a behavior analyst may only reasonably be responsible for maintaining their own ethical behavior, in an ABA therapy organization, most professionals practicing within the field will find themselves in a position to interact with members of other disciplines. Working within an interdisciplinary team provides the opportunity to support potential clients and provide quality care from multiple vantage points, while also allowing behavior analysts to effectively disseminate and share the value of behavior analytic services across fields. (Brodhead, 2015).

Challenges may arise when the behavior of collaborative members is questionable, as well as when strategies are proposed that are not compatible with behavior analytic principles or are not grounded in research. Though not responsible to the code of ethics for behavior analysts, many professionals who will work with similar populations do follow their own ethical framework. As a result, when cooperating with other disciplines it may be beneficial for the behavior analyst to be conscious of not only their own interaction and representation but also the ethical expectations of other members (Newhouse-Oisten et al., 2017). Similarly, familiarizing themselves with the strategies and interventions commonly utilized by other professionals with whom behavior analysts frequently interact will allow the behavior analyst to more effectively identify and differentiate harmful practices from those that may be appropriately integrated within a behavioral context (Brodhead, 2015). Finally, though common for behavior analysts to work as part of a group, receiving training, supervision, and mentorship should not be overlooked as a strategy to increase competence and teamwork (Luiselli, 2015).

Ethics and Cultural Considerations

Inherent in our work is that behavior analysts must function in accordance with the values, ethics, and standards that govern our field (Litvak & Rue, 2020). Cultural competence is critical to providing ethical service delivery (Fong & Tanaka, 2013). Within the behavior analytic community, some organizations have provided a framework for behavior analysts to consider regarding ethics as it relates to diversity and cultural competence and provide resources and guidance on how to integrate these concepts into practice.

Cultural Considerations from Association for Behavior Analysis International

Per their website, “ABAI seeks to be an organization comprised of people of different ages, races, nationalities, ethnic groups, sexual orientations, genders, classes, religions, abilities, and educational levels. ABAI opposes unfair discrimination." (Fong & Tanaka, 2013) To further this mission, ABAI has created a Culture and Diversity Special Interest Group (SIG). The goal of the SIG at ABAI is to "create a network of behavior analysts who speak a language or have a skill set relevant to a given population with people who need those services, as well as to connect behavior analysts with others who share common interests." (Culture and Diversity SIG, 2019). The SIG publishes and presents on topics related to cultural competence and understanding, as well as mentors students, supports professional advancement, and improves service delivery. The SIG also advocates that diversity enhances our profession, benefits our community, and that culture is an important topic of research. Some efforts made by the SIG include creating awareness around the need to recruit more diverse, global professionals into the field, remove barriers to their education, success, and advancement, and encourage diversity of thought, interdisciplinary expertise, and experience.

Cultural Considerations from Behavior Analyst Certification Board (BACB)

As referenced earlier, the BACB serves as the primary regulatory body for behavior analysts and provides several areas that behavior analysts should be attuned to related to cultural competence cited within the BACB's Ethic's Code for Behavior Analysts (BACB, 2020). A few of these areas are noted in Table 2.1.

Both code items refer to an individual behavior analyst's responsibility to ensure that they have received adequate training with the population they serve. When creating a culturally competent clinical practice, clinical leadership should ensure that their supervisory and clinical staff receive regular training regarding cultural differences and ensure that staff are matched appropriately based on competence.

Table 2.1 BACB's ethic's code for behavior analysts items for cultural competence

1.07	Cultural responsiveness and diversity
4.07	Incorporating and addressing diversity

Cultural Considerations from Behavioral Health Center of Excellence (BHCOE)

BHCOE provides diversity standards to ensure organizations are creating cultural informed practices (BHCOE, 2021). A few of these areas are noted in Table 2.2.

Table 2.2 BHCOE standards for diversity, equity, and inclusion

B.01	B.01 The organization has a diversity statement
B.02	B.02 The organization has access to and when necessary utilizes translation services for oral and written communication and communicates availability of translation services to patients
B.03	B.03 The organization has representation of diverse individuals at a minimum including age, gender, race/ethnicity, and disability. Instructional, training, and marketing materials include diverse images and narratives
B.04	B.04 The organization makes closed captioning available for its videos. This item is not applicable for organization does not have video content
B.05	B.05 The organization provides cultural humility training and competency checks to all employees upon hire, annually, and as required by state and federal guidelines
B.06	B.06 The organization actively recruits and engages in retention strategies to promote a diverse workforce
B.07	B.07 The organization demonstrates engagement in fair hiring practices, as regulated by Equal Employment Opportunity Commission (EEOC)
B.08	B.08 The organization engages in self-assessment of diversity efforts at least annually
B.09	B.09 The organization's physical location is compliant with the Americans with Disabilities Act
B.10	B.10 The organization has a means to and actively allows qualified low-income patients access to services
B.11	The organization assures that leadership have completed conflict resolution training and has process(s) for responding to bias incidents

All items relate to an organization's responsibility to showcase their commitment to creating an environment that promotes equity and inclusion. The standards indicate that the organization should have access to, and when necessary, utilize translation services for oral and written communication and communicate availability of translation services to parents (Fong & Tanaka, 2013; Cheng, Chen, & Cunningham, 2007). The standards also request that organizations provide cultural humility training and competency checks to all employees upon hire, annually, and as required by state and federal guidelines. Along this path, an organization should make reasonable efforts to involve parents/guardians in treatment planning, which relates to an organization's responsibility to consider patient cultural preferences into their treatment program and planning.

It is also required through the BHCOE standards that the organization demonstrates engagement in fair hiring practices, as regulated by United States Equal Employment Opportunity Commission (EEOC). The EEOC is responsible for enforcing federal laws that make it illegal to discriminate against a job applicant or an employee because of the person's race, color, religion, sex (including pregnancy, gender identity, and sexual orientation), national origin, age (40 or older), disability, or genetic information. Organizations must be aware that it is also illegal to discriminate against a person because the person complained about discrimination, filed a charge of discrimination, or participated in an employment discrimination investigation or lawsuit. Lastly, organizations are required to engage in the self-assessment of diversity efforts at least annually.

Legal Considerations in Applied Behavior Analysis

Though laws and ethics codes may be similar in that both maintain a set of rules that must be followed, there are significant differences in the applications, expectations, and ramifications related to each standard. In consideration of the similarities, and despite the contrasts, there are substantial legal implications that span throughout and beyond the clinical work of Applied Behavior Analysis. As ABA has evolved into a medical service, the concepts of waste, fraud, and abuse have arisen as common challenges in delivering care. Fraud typically includes knowingly submitting, or causing to be submitted, false claims or making misrepresentations of fact to obtain a federal health care payment for which no entitlement would otherwise exist or knowingly soliciting, receiving, offering, or paying to induce or reward referrals for items or services reimbursed by health care programs. Anyone can commit healthcare fraud, and while the definition includes the term "knowingly," intent is often challenging to prove. Remember, *ignorantia legis neminem excusat,* or, "ignorance of law excuses no one." Below, we review a few case scenarios of how these could manifest in clinical practice.

Fraud

Knowingly Billing at a Service Level Higher Than Actually Provided

Case Scenario: Johnny is a technician working with a 4-year-old boy. Johnny's supervisor, Keanna, regularly oversees his session. Johnny is unable to join for session one day, so Keanna decides to cover Johnny's session that day. If Keanna billed for this session as if it were a supervisory session, which would be billed at a higher rate, rather than a direct care session, this would be considered billing fraud.

Knowingly Billing for Services That Were Not Furnished, Including Falsifying Records

Case Scenario: Johanna shows up to her regularly scheduled session which typically lasts between 9:00 AM and 11:00 AM and finds that the family is not home. Upon calling the family, her client's parent says that they will be home at 9:30 AM, but tells Johanna she can just "make up the extra 30 minutes" by adding 10 extra minutes to the next few sessions. Johanna decides to bill for the time from 9 AM to 11 AM knowing that she will make up the session later. While seemingly innocuous, by billing for time in which she did not provide services, Johanna is engaging in billing fraud.

Knowingly Ordering Medically Unnecessary Items or Services for Patients

Case Scenario: Ahmed conducts an evaluation on a patient who is moderately impaired. In his professional clinical opinion, he believes the patient would benefit from 20 hours per week of ABA therapy. However, his supervisor lets him know that they would prefer he recommends 30 hours per week as it would be easier to staff a technician on the case if the patient received more hours. The supervisor also told Ahmed "more hours can't hurt." If Ahmed were to alter his prescription recommendation, not only would this violate the ethics code, but he would be engaging in billing fraud.

Billing for Appointments Patients Fail to Keep

Case Scenario: Tunde regularly does not show up for his regularly scheduled ABA therapy sessions because of scheduling miscommunications between his divorced parents. When Tunde doesn't show, Jamie, the direct technician, will not get paid for the hours she was supposed to work with Tunde. Sometimes, when Tunde does not show up to session, Jamie does not mention this to her supervisor so that she can get paid for the scheduled session. This is considered billing fraud.

Defrauding the federal government or a commercial insurance plan is illegal and the consequences can be detrimental to an individual's livelihood and ability to practice within healthcare in the future. In worst case scenarios, committing fraud could lead to imprisonment, fines, and penalties.

Abuse

Abuse refers to practices that may directly or indirectly result in unnecessary cost to the health plan. Abuse refers specifically to a practice that does not provide the patients with the medically necessary services for which they have been authorized. The nuance between fraud and abuse can depend on circumstances, intent, and knowledge. Along with identifying risk of fraud waste and abuse in day to day practice, it is important those practicing ABA familiarize themselves with laws governing fraud, waste, and abuse as summarized below:

False Claims Act (FCA)

The False Claims Act (31 U.S.C. Sections 3729 through 3733), also known as the "Lincoln Law," protects the Federal Government from being overcharged or oversold goods of services. The legal community has cited the False Claims Act to be the most effective antifraud law in the United States. Under the False Claims Act, a person with evidence of fraud against federal programs can sue the alleged on behalf of the United States Government. The government may then intervene and join the litigation.

If the government has already filed a False Claims Act lawsuit against the entity, a new suit cannot be pursued. Violators of the False Claims Act are liable for three times the dollar amount that the government was defrauded and between $10,000 and $20,000 for each false claim. In addition, the plaintiff can receive 15–30% of the recovery from the defendant. The whistleblower only receives the reward if the government recovers money from the defendant as a result of the suit. The financial incentive captured in the False Claims Act has been cited as a key component of bringing to light information about fraud and has been a controversial component of the False Claims Act (Rapp, 2007).

Anti-Kickback Statute (AKS) and Stark Law

The Anti-Kickback Statute, 42 U.S.C. § 1320a-7b(b), is a law that prohibits the knowing and willful payment to induce referrals or generate business. Payment can include anything of value, not just cash, such as gift cards, tickets to an amusement park, or paying for travel. While in many industries, it may be acceptable to reward those who refer business to you, in most healthcare programs, paying for referrals is a crime. Penalties for violating the anti-kickback statute includes fines, imprisonment, exclusion from participating in healthcare programs, or penalties of up to $50,000 per referral and three times the amount of payment received per referral.

Legal Relevance of Clinical Documentation

Clear medical record documentation can play a critical role in providing patients with quality care, ensuring timely and accurate payment, and mitigating risk of malpractice (Pine & Bossen, 2020). It also helps organizations plan for patient treatment and maintain continuity of care (BHCOE, 2020). Clinical documentation not only supports appropriate reimbursement and billing practices, but also increases quality of care provided to patients. Individuals documenting services should also be aware of best practice related to general management of clinical records and ensure they have clear understanding of which documents may be considered part of the medical record. For more information, review the BHCOE Standard for the Documentation of Clinical Records for Applied Behavior Analysis Services (BHCOE, 2020).

HIPAA & Privacy Laws

The Health Insurance Portability and Accountability Act ("HIPAA") is a federal law that protects the privacy of protected health information ("PHI"). PHI is any individually identifiable information pertaining to your patients, including nonclinical records, such as an admission agreement. HIPAA applies to Business Associates who are persons or entities that maintain, transmit, disclose, or use PHI on behalf of a Covered Entity. Business Associates must have a Business Associate Agreement (BAA) with their related Covered Entity. If the Business Associate subcontracts work that would involve the exchange of PHI, the Subcontractor must enter into an Agreement with the Business Associate that meets the same standards as the BAA between the Covered Entity and Business Associate. All staff and volunteers must receive HIPAA training on an annual basis consistent with their job responsibilities.

The Privacy Rule protects all "individually identifiable health information" maintained or transmitted by a Covered Entity or its Business Associate, in any form or media, whether electronic, paper, or oral. The Privacy Rule calls this information protected health information (PHI). "Individually identifiable health information" is information, including demographic data, that relates to: the individual's past, present, or future physical or mental health or condition; or the provision of health care to the individual; or the past, present, or future payment for the provision of health care to the individual; and contains enough information for which there is a reasonable basis to believe it can be used to identify the individual. Individually identifiable health information includes many common identifiers (e.g., name, address, birth date, Social Security Number). Practitioners should be especially mindful about The Privacy Rule in their social media usage and other public communication in which patient communication could be inadvertently shared with those outside of their organization.

A breach is the acquisition, access, use, or disclosure of PHI in a manner that is not permitted by the Privacy Rule and compromises the security of privacy on the PHI. A suspected breach is presumed to be a breach unless the Business Associate demonstrates that there is a low probability that the PHI has been comprised by conducting a Breach Risk Assessment. A Breach Risk Assessments must be documented and assess the following:

- Was the PHI accessible?
- What type of information was included in the PHI?
- What actions can be taken to mitigate the improper disclosure?
  - Mitigating factors include having the information returned or destroyed, obtaining an attestation from the receiving party that the information has not been copied or further disclosed, remotely wiping a lost device, etc.

If it is determined that a breach has occurred, the Business Associate must notify:

- The Covered Entity and, in possible conjunction with the Covered Entity:
- Affected Individuals
- Office for Civil Rights
- Some state licensing agencies also require notification

After a breach, the individual or organization responsible for the breach should perform root cause analysis to determine appropriate actions for preventing a similar breach in the future.

Criminal penalties range from $50,000 and/or imprisonment for one year, to $250,000 and/or imprisonment for up to 10 years. In addition, state attorneys general have authority to bring civil actions on behalf of residents of the state.

Conclusions and Ethical Decision-Making

Ethical behavior, and the decisions guiding ethical behavior, should be held to the same standard of evaluation, analysis, and understanding as all other behavior subject to behavior analytic interpretation (Brodhead, 2019). While an ethics code may provide a set of rules for the practice of behavior analysis, centralizing agreement upon the determination of ethically acceptable representation, individual values continue to influence the interpretation of the code. In a broad sense, ethics codes provide an operational definition of those behaviors that best represent the field; however, without context, such as the situation in which the code is meant to apply, the circumstance requiring analysis and the cultural and personal factors of all parties involved (including the behavior analyst), even the most clear and concise definition, may be rendered inadequate and impractical (Sellers et al., 2020).

Ethical decision-making has evolved and progressed as the complexity of ethical behavior has grown. As behavior analysts come to understand ethical decision-making outside of the determination of what is simply "wrong" or "right," but more so of how decisions may be influenced not only by the standards of the field, but also by the environmental factors surrounding the opportunity to "behave ethically," behavior analytic, ethical decision-making has expanded to include a clearer understanding and thorough review of the antecedent and consequent variables related to the choices and options that have or will occur (Sush & Nadjowski, 2019).

Simply relying on the code as guidance cannot and should not be sufficient when determining and interpreting ethics within behavior analysis. First, it is not possible to include code elements that will apply directly to each and every circumstance and situation encountered. Further, even when clearly addressed within the code, there is a likelihood that elements of the ethics code will not fit the exact mold of the circumstances faced by the behavior analyst. As a result, though the code does provide clear and concise rules from which all those practicing behavior analysis may follow, a degree of interpretation is not only understandable, but necessary and encouraged.

The code was developed as a tool for ethical guidance, as well as in response to previous ethical issues and identified transgressions. Though each circumstance in which the potential for ethical decision-making may be unique, behavior analysts will likely be best served by first identifying the similarities between their clinical practice, the potential challenging circumstance and the relevant areas already identified within the ethics code. The majority of ethical challenges and dilemmas will likely be best served by review of the ethics code and direct application of code elements. Even when there is no exact correspondence between the situation inspiring the ethical review and the code itself, there is likely significant parallels that can be inferred and employed from which to initiate and continue to assess ethical decision-making opportunities that may best serve the situation and those involved. In other words, it would not be appropriate, nor advisable to chart a path in response to an ethically challenging event without reference or guidance from aspects already included within the ethics code, simply because a specific code element does not precisely relate to the issue at hand. Instead, though there might be limitations for each standard as written or described, the general application of the code will provide useful recommendations for preventing or managing most dilemmas.

As with most demonstrations and applications of behavior analysis, following a systematic method in avoidance, anticipation, identification, management, reduction, and reflection of ethical issues and concerns may provide those practicing within the field a conscientious and poised approach that will be of most benefit to the identified client, the field of behavior analysis, and the practitioner.

Though there are multiple suggested approaches in standardizing ethical decision-making, most recommendations focus on first identifying that the incident does in fact pose an ethical concern, and if so, addressing any risk or harm to those impacted by the situation. Recognizing all relevant parties, applicable code elements, contextual factors, and personal values that may impact how one addresses the dilemma and resolves the concern is also of utmost importance, as well as consulting with supportive resources in identifying potential solutions. Finally, continuous data collection and further analysis are generally recommended to not only ensure that challenge does not progress or escalate but also to apply lessons learned in the future (BACB, 2020; Brodhead et al., 2018; Rosenberg & Schwartz, 2019; Sush & Nadjowski, 2019).

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3 Social Reinforcers

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Introduction to Social Reinforcers

Social reinforcers are among the most commonly used reinforcers in applied behavior analysis (Vollmer & Hackenberg, 2001). Social positive reinforcement involves the contingent delivery of a stimulus by another person that results in an increase in the probability of future behavior (Lovaas et al., 1966; Miltenberger, 2016). A common form of social positive reinforcement is the delivery of attention, which may be delivered in various forms. Attention may include vocal-verbal interactions (e.g., praise, conversations, reprimands), physical attention (e.g., hugs, pats on the back), proximity (e.g., approaching a person, sitting beside a person), and facial expressions (e.g., smiles, winks, frowns). Previous research has shown the reinforcing effects of attention for increasing desirable behavior (e.g., Gable & Shores, 1980; McLaughlin, 1982; Neimy et al., 2020), as well as undesirable behavior (e.g., Lovaas & Simmons, 1969; Iwata et al., 1994) in various populations across various contexts and settings. However, less is known about the conditions under which attention functions as a reinforcer (i.e., the variables that may influence the efficacy of attention as a reinforcer; Vollmer & Hackenberg, 2001).

Importance of Attention in Human Interaction

From birth, infants depend on others caring for them for survival. That is, an important role of the parent is to provide positive and negative reinforcers (Bijou & Baer, 1965), and a major determinant in the development of social and intellectual behavior in young children involves parent responses to child behavior (Hart & Risley, 1995; Horowitz, 1963; Lovaas et al., 1966). Later on, our behavior is affected by attention from others (e.g., peers and teachers) in our daily interactions. Whether attention is an unconditioned or conditioned reinforcer is something that is up for debate. An unconditioned reinforcer is a stimulus that works to increase behavior without a learning history with the stimulus. For example, food, water, oxygen, and sexual stimulation are known unconditioned reinforcers. Some researchers suggest that some forms of human interaction can be added to that list (e.g., Gewirtz & Pelaez-Nogueras, 2000; Vollmer & Hackenberg, 2001).

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_3

A conditioned reinforcer is a previously neutral stimulus that comes to serve as a reinforcer because it has been paired with one or more unconditioned or conditioned reinforcers. Many behavior analysts have suggested that reinforcers linked to our social behavior are conditioned reinforcers (Axe & Laprime, 2017; Bijou, 1995; Bijou & Baer, 1961, 1965; Dozier et al., 2012; Lovaas et al., 1966; Skinner, 1953). In fact, many forms of attention are often described as generalized conditioned reinforcers (Bijou, 1995; Dudley et al., 2019; Skinner, 1957). A generalized conditioned reinforcer is a conditioned reinforcer that has been paired with so many other reinforcers that it serves as a reinforcer for behavior under various establishing operations. Bijou (1995) suggested that forms of attention can become generalized reinforcers such that they are effective when delivered by various individuals and under various establishing operations. Many forms of attention (e.g., verbal, physical, facial expressions, proximity) have been paired with so many other reinforcers that they come to serve as reinforcers under a variety of antecedent situations. For example, praise may be a generalized conditioned reinforcer for the behavior of many people because praise is often paired with other reinforcers (e.g., edible reinforcers, tangible reinforcers, activity reinforcers) and may serve as a reinforcer for behavior under a variety of antecedent conditions.

Strengths and Limitations of Social Reinforcers

Strengths of Social Reinforcers

There are several advantages to using attention to increase behavior. When a therapist is starting a reinforcement-based program, it's important that they use reinforcers that are easy to administer and that can be delivered immediately following a behavior (Mallott & Shane, 2014). Attention meets both of these criteria and it occurs naturally in the environment. Therefore, attention is almost always used as part of behavior-intervention plans. For example, praise is used as part of most, if not all, skill acquisition programs. Another advantage of using attention as a social reinforcer is that it is a low-to-no-cost approach to increasing behavior (Mathews et al., 1980). Edible and tangible reinforcers can cost money, but it doesn't cost anything to deliver praise, a kind gesture, or a smile. An additional advantage of social reinforcers is that they can be delivered without interrupting behavior (Helton & Ivy, 2016). For example, a teacher can give a pat on the back or a thumbs up while an individual is engaged in the target behavior, such as completing an assignment with a peer. When behavior analysts teach educators and caregivers to implement reinforcement-based procedures, they often teach them to gradually move from delivering contrived reinforcers to delivering naturally occurring reinforcers (Cooper et al., 2020). For example, an educator or caregiver may be instructed to fade the use of a token economy over time. One advantage of attention is that many forms should already be naturally occurring in the environment. Therefore, educators and caregivers can be taught to deliver praise along with other forms of contrived reinforcers (e.g., tokens), and eventually the contrived reinforcers can be faded out and praise may continue to reinforce the behavior. Because praise remains a part of the natural environment, it might also help to maintain the behavior over long periods of time. If attention is a generalized conditioned reinforcer, then attention might also be more resistant to satiation and may be preferred over other types of reinforcers. In addition, it might be easier to individualize social reinforcers compared to other types of reinforcers. For example, if a child prefers high-fives over praise, then it's simple enough to provide their preferred form of attention. However, if a child prefers M&Ms over Skittles, but you're out of M&Ms, then it might take some time to obtain the preferred reinforcer.

Limitations of Social Reinforcers

The use of attention may not serve as a reinforcer for the behavior of all individuals (Dozier et al., 2012). For some individuals, social reinforcers in the form of attention may even be aversive

(Hagopian et al., 2001; Taylor & Carr, 1992). Bijou and Baer (1961) suggested that when behavior is not sensitive to attention as a reinforcer, the individual may exhibit deficits in intellectual and social development. When this occurs, it may be necessary to establish attention as a reinforcer. Despite the fact that individuals frequently experience attention in conjunction with other forms of reinforcers, this natural pairing may not be enough to condition many forms of attention as a reinforcer. Therefore, systematic conditioning procedures may be needed to condition attention as a reinforcer. Researchers have used various methods to try and establish social stimuli as reinforcers including stimulus pairing procedures (see Chap. 10), observation procedures (Leaf et al., 2015), and establishing social stimuli as discriminative stimuli (Lovaas et al., 1966; Rodriguez & Gutierrez, 2017).

Although attention is ubiquitous in everyday life, training is often needed on delivering attention effectively (Hall et al., 1968). It's easy to deliver tangible reinforcers in a standardized way. However, attention is not always delivered in the same standardized manner across individuals. It's not uncommon for individuals to use different facial expressions, verbal expressions, or physical contact to express approval. There are also different factors that may influence the use of attention as a reinforcer (e.g., immediacy, magnitude, schedule, motivating operations, content, quality), and individuals may need to be trained to account for these factors. In addition, researchers have found that attention is often delivered following inappropriate behavior (e.g., McKerchar & Thompson, 2004). Telling an educator or caregiver to deliver more attention for appropriate behavior and less attention for inappropriate behavior sounds easy enough. However, merely telling an individual to do something is not likely to result in a change in their behavior for very long. Several researchers have shown that teachers are likely to deliver more disapproving remarks for inappropriate behavior as compared to approving remarks for appropriate behavior (Nafpaktitis et al., 1985; Strain et al., 1983; Thomas et al., 1978; White, 1975). Therefore, teachers and other professionals will likely need to be trained (e.g., instructions, modeling, rehearsal, feedback) on how to deliver attention for appropriate behavior, and they may need to see and experience the success of contingent attention for increasing appropriate behavior.

Social Reinforcers for Appropriate Adaptive Behavior

Since the conception of the field, applied behavior analysis has addressed the influence of social reinforcers, such as attention, within motivational and instructional domains with respect to critical skills across the lifespan. Social reinforcers can play a vital role in the development and maintenance of appropriate adaptive behavior across populations and environments. Verbal and nonverbal forms of attention have been used to increase a wide variety of adaptive behavior within a variety of skill domains such as on-task behavior (e.g., Allday & Pakurar, 2007), self-help skills (e.g., Poche et al., 1982), communication (e.g., Novak & Pelaez, 2004), contextually appropriate vocalizations (e.g., Wilder et al., 2001), early motor skills (e.g., Correa et al., 1984), outdoor play skills (e.g., Johnston et al., 1966), peer interaction (e.g., Allen et al., 1964), physical activity (e.g., Zerger et al., 2016), and many others.

The Use of Social Reinforcers to Facilitate Critical Skills

In a series of papers on social positive reinforcement, researchers at the University of Washington, led by Montrose Wolf, demonstrated that positive reinforcement, in the form of attention, plays a prominent role in early childhood development (e.g., Allen et al., 1964; Harris et al., 1964; Hart et al., 1964; Johnston et al., 1966). These researchers showed that adult attention could be used to increase verbal skills (Hart et al., 1964), social skills (Allen et al., 1964), and gross motor skills (Harris et al., 1964; Johnston et al., 1966) in young children. The findings of these seminal studies showing the reinforcing efficacy of adult attention for increasing the behavior of young children are thought to be influential in common caregiver and teacher training procedures on how to interact with young children (Risley, 2005). Adult attention is used to help children learn what behaviors are deemed socially appropriate or socially inappropriate and to shape a wide range of appropriate behaviors in early childhood (e.g., verbal behavior, social behavior, leisure skills, and academic and classroom behavior). As we age, attention remains a primary component in most environments that may help to shape new behaviors, refine old behaviors, and maintain adaptive behaviors across our lifespan.

Vocalizations and Verbal Behavior One type of behavior that is uniquely human and, perhaps, particularly sensitive to social reinforcers is complex verbal behavior. Skinner (1957) defined verbal behavior as "behavior reinforced through the mediations of other persons" (p. 2). That is, the behavior of the speaker is effective through the mediation of the listener. From infancy, approximations to verbal behavior are followed by attention. For example, caregivers often deliver vocal attention following infant babbling (e.g., mama, dada), which may shape and reinforce the behavior over time (e.g., Spitz, 1949). Numerous studies have demonstrated that early vocal-verbal behavior can be shaped and reinforced by attention (e.g., Neimy et al., 2020; Pelaez et al., 2011; Pelaez et al., 2018; Poulson, 1983; Reynolds & Risley, 1968; Rheingold, 1956; Rheingold et al., 1959; Routh, 1969; Thompson et al., 2007; Weisberg, 1963).

In addition to shaping verbal behavior, receiving high-quality verbal attention starting in infancy has been correlated with increased verbal repertoires (Hart & Risley, 1995). Hart and Risley (1995) conducted one of the first longitudinal studies examining language development in young children. The study included 42 young children from three different socioeconomic statuses ([SES] i.e., high SES, middle SES, and low SES). The children were observed, and a one-hour audiotape recording was collected once per month for 2.5 years. The authors found that adult verbal attention was provided to the children when they were in their infancy an average of 28 min per hour sample. However, the number of words spoken by the parents to the children differed based on socioeconomic backgrounds. The children in families with a high SES received higher quality attention (larger vocabulary and more affirmations), followed by the children in the families with a middle SES, and then the children from families with a low SES. In the end, the children from the families with a high SES exhibited a much larger number of words in their vocabulary as compared to the other two groups, and the children from families with a low SES exhibited the smallest vocabulary. As children age, more complex verbal behavior is shaped by the attention they receive in their environment. Skinner (1957) suggested that attention helps to establish basic verbal operants, which are classes of verbal behavior that have the same effect on the listener (e.g., echoics, tacts, intraverbals), and several studies have shown that the delivery of attention in combination with various prompting procedures is effective for increasing echoics (Poulson et al., 1991), tacts (Braam & Sundberg, 1991; Partington & Bailey, 1993; Sigafoos et al., 1990), and intraverbals (Sundberg et al., 1990).

For example, Poulson et al. (1991) evaluated the use of parental modeling and praise on increasing the echoic behavior of three infants aged 9–13 months. The parents were told to present a vocal model of the desired word during all conditions. During the model-alone condition, the parents did not deliver praise following infant vocalizations. During the model-and-praise condition, the parents provided praise when the infants imitated their vocal model on training trials. All of the infants increased their echoic behavior when praise was provided for imitating the model.

It is clear that attention is important for the acquisition of vocal-verbal behavior such that we can be effective speakers and others can be effective listeners. However, it remains unclear what the necessary and sufficient conditions are for the acquisition of verbal operants with delivery of attention. Research involving naturalistic observations might be able to provide some information regarding these conditions. For example, researchers might conduct naturalistic observations to determine (a) the correlation between the type of attention (e.g., content of attention and quality of attention) and the occurrence and acquisition of particular verbal operants, (b) the contingency and contiguity between the delivery of attention and the occurrence of verbal operants, and (c) the schedules of reinforcement that are associated with increased acquisition and maintenance of verbal operants. Outcomes of these naturalistic observations could provide information regarding the variables to empirically evaluate in more controlled studies to determine the optimal aspects of attention for increasing and maintaining verbal operants. In addition, most researchers use attention in combination with other social reinforcers (delivery of edible and tangible items) and with prompting procedures when teaching verbal behavior. When the delivery of attention is combined with other procedures, the reinforcing efficacy of attention alone is unknown. To determine the role of attention alone in the acquisition of verbal behavior, attention would need to be evaluated as a stand-alone treatment.

Social Behavior Skinner (1953) defined social behavior as "the behavior of two or more people with respect to one another or in concert with respect to a common environment" (p. 297). Social behavior is behavior that is strengthened or weakened by the behavior of others (Novak & Pelaez, 2004). Social behaviors that are prominent in early development include, but are not limited to, initiating and terminating interactions, taking turns, making eye contact, sharing, playing with others, cooperating with others, and displaying social safety skills (e.g., not interacting with strangers, seeking help, reporting problems to adults). Attention plays a role in the development of early social behavior (Novak & Pelaez, 2004), and attention continues to play a role in our social behavior throughout our lifetime. Attention has been shown to play a role in verbal interaction (Emshoff et al., 1976; Milby, 1970), peer interaction (Allen et al., 1964; Barton & Ascione, 1979; Pinkston et al., 1973; Strain & Timm, 1974), and even facial expressions (Brackbill, 1958; Cooke & Apolloni, 1976).

For example, Pinkston et al. (1973) increased peer interaction and decreased aggression for a 3.5-year-old boy through the use of contingent teacher attention and extinction in a preschool classroom. During the intervention, teachers were instructed to deliver attention to the student when he engaged in appropriate behavior and not to respond to aggression except to physically separate the participant from his peer and console the peer. This intervention was effective for increasing appropriate social behavior and decreasing aggression with this participant. However, it is unclear which component (i.e., attention or extinction) of the intervention made it effective. To determine the effectiveness of attention for the acquisition of social behavior in young children, attention would need to be evaluated as a stand-alone treatment. In some instances, it might be the case that attention is not an effective reinforcer for increasing appropriate social behavior.

Insensitivity to social cues and social reinforcers can have detrimental effects on the development of social behavior (Bijou & Baer, 1961). This situation is often reported with children diagnosed with autism spectrum disorders (ASD) who often show both social deficits and behavioral insensitivity to attention (Dawson et al., 2012). One of the defining characteristics of ASD is impaired social skills, which can include failure to make eye contact, failure to initiate conversations, failure to respond to bids for social interaction, and failure to maintain social interactions (Hyman & Towbin, 2007). When the attention that occurs in the natural environment is ineffective in the shaping and maintenance of social skills, then other forms of reinforcement will be required to teach these important skills.

Leisure Skills and Activities Acquiring leisure skills and the ability to appropriately engage in activities is important for improving quality of life throughout our lifetime. In addition, with the acquisition of these skills, there is potential for increased social interaction. Several studies have used attention alone or in conjunction with other reinforcers or instructional procedures (e.g., prompting and modeling) to increase appropriate leisure skills such as activity engagement (e.g., DiCarlo & Reid, 2004; Duffy & Nietupski, 1985; Whitman et al., 1970), motor play on outside play equipment (Buell et al., 1968; Hardiman et al., 1975; Harris et al., 1964; Johnston et al., 1966), physical activity (Anderson & Kirkpatrick, 2002; Larson et al., 2014; Vintere et al., 2004; Zerger et al., 2016), pretend toy play (DiCarlo & Reid, 2004), and solitary play (Shafto & Sulzbacher, 1977).

Relatively few studies have shown the isolated effects of attention for increasing leisure skills. In an early study, Johnston et al. (1966) showed that the contingent delivery of attention (i.e., proximity; speaking to, smiling at, and touching the child) resulted in an increase in levels of appropriate motor activity on outside play equipment. More recently, Larson et al. (2014) and Zerger et al. (2016) showed that physical activity could be increased through the use of adult attention and interactive play. However, most studies have shown that the delivery of attention in conjunction with other intervention procedures resulted in an increase in leisure activities.

DiCarlo and Reid (2004) showed that pretend toy play increased for five toddlers, who were diagnosed with various disabilities, when praise, choice of classroom center, and prompting were implemented. In another study, Whitman et al. (1970) increased social play (i.e., ball-rolling and a block-placement response) when praise and edibles were delivered on increasing fixed-ratio (FR) schedules. In addition, Buell et al. (1968) increased play on outside motor equipment using the delivery of teacher attention and a priming procedure. Priming included telling the participant to engage in the activity (e.g., “Show me how you play on the ___”). Similarly, Hardiman et al. (1975) evaluated the effects of praise, priming, and training sessions to increase outside motor play skills. Results indicated that all three components together were necessary for appropriately engaging in the motor response for each different activity.

In addition to appropriate motor and social play, several studies have involved increasing interesting leisure skills. Anderson and Kirkpatrick (2002) used a treatment package that included contingent praise, visual feedback of performance, and instructions for improving performance of inline roller speed skaters. The experimenters found that the treatment package was effective at increasing the percentage of correct responses during skating practice. Duffy and Nietupski (1985) showed that a young adult diagnosed with Down syndrome could be taught to initiate, sustain, and terminate video game play. Effective procedures used in this study were a combination of praise, modeling task analysis steps, and physical prompting. Finally, Shafto and Sulzbacher (1977) showed that praise and edibles were effective at reducing activity changes (i.e., short durations spent with a single activity and rapid switching among many different activities) and increasing engagement in a single activity.

Academic and Classroom Behavior Teachers and other professionals are trained to use various social reinforcers to increase appropriate classroom behavior. Many teacher-delivered social reinforcers involve the delivery of different forms of attention and several studies have focused on increasing academic behavior by delivering contingent attention and antecedent attention. Researchers have shown that attention alone is effective for increasing preacademic behavior, academic behavior, and appropriate classroom behavior (e.g., Allday & Pakurar, 2007; Baer & Sherman, 1964; Broden et al., 1970; Hancock, 2002; Schutte & Hopkins, 1970).

For example, Schutte and Hopkins (1970) showed that praise and physical attention could be used to increase the preacademic behavior of instruction following with five girls in a kindergarten classroom. During the baseline conditions, all of the girls were observed to follow teacher instruction approximately 60–69% of the time. When the teachers were taught to deliver praise and physical attention contingent on instruction following, then instruction following increased to approximately 78–84% of the time during the treatment conditions.

Allday and Pakurar (2007) demonstrated that something as simple as teacher greetings could be used to increase the on-task behavior of three middle-school students who engaged in maladaptive behavior. In this study, the researchers instructed the students' teachers to greet the students upon their arrival by saying the student's name and a positive statement (e.g., Kay, you look nice today!). During the baseline condition, the students were observed to start the day on-task during a mean of 37–52% of intervals. When the teachers were taught to greet the students upon their arrival, the students began to start the day on-task during a mean of 66–87% of the intervals. This simple antecedent attention procedure produced an increase in on-task behavior for all three students.

Given that it is commonplace to train teachers and other professionals to use various forms of attention for increasing appropriate classroom behavior, it is important to mention the research on the influence of approval and disapproval rates in classrooms. Several early evaluations on the occurrence of teacher delivery of approval and disapproval have found that there was more disapproval delivered by teachers for inappropriate behavior as compared to approval for appropriate behavior (e.g., Nafpaktitis et al., 1985; Rutter et al., 1979; Strain et al., 1983; Thomas et al., 1978; White, 1975). For example, Thomas et al. (1978) showed that seven out of 10 teachers displayed disapproval rates at least three times greater than their approval rates. In addition, some studies have investigated the effect of approval and disapproval on the classroom behavior of children. Thomas et al. (1968) evaluated the effects of approval and disapproval in varying amounts to demonstrate how these rates influenced child behavior. The experimenters showed that when the delivery of approval for appropriate behaviors was removed (i.e., only disapproval was used), students engaged in significantly lower levels of appropriate behavior and higher levels of disruptive behavior. Moreover, when teachers provided frequent disapproval (twice as much disapproval as compared to previous disapproval phases), similar results were found. In another study, Cossairt et al. (1973) provided instructions, feedback, and feedback plus praise to increase teacher praise for student attending behavior. In all phases of the intervention, when the percentage of intervals with teacher praise increased, the percentage of student attending increased. Overall, these data suggest that increases in approval and a decrease in disapproval in the classroom may result in an increase in appropriate behaviors and a decrease in inappropriate behaviors in the classroom; however, it is unknown what about approval is necessary and sufficient to change important behavior.

In summary, the research on the effects of attention for increasing appropriate behavior suggests several important things. First, most of this research was conducted over 40 years ago, and less research has been recently conducted on the utility of attention for increasing appropriate behavior. Second, the majority of studies on attention for increasing appropriate behavior involve several topographies of attention (e.g., praise, conversation, and physical contact) or the delivery of attention as part of a treatment package. Therefore, it is difficult to determine the effects of single forms of attention and the efficacy of attention alone for behavior change. As suggested by Wacker et al. (1988), this lack of knowledge is likely to interfere with the effectiveness with which we can use attention in acquisition and maintenance programs. Third, the small number of studies that involve determining the effects of attention alone raises questions regarding the utility of attention as a reinforcer for increasing and maintaining appropriate behavior.

There are several possible reasons why fewer studies have been conducted recently on the efficacy of attention and why few researchers have isolated the effects of attention for increasing and maintaining appropriate behavior. First, attention alone may not be an effective reinforcer for the population of individuals for whom behavioral research is mostly published (i.e., individuals with intellectual and developmental disabilities).

Second, attention may be an important component of a treatment package, but may not be a potent reinforcer in isolation. Third, it is possible that attention is already widely assumed to be a reinforcer, and therefore, little research has been conducted to validate this assumption.

Social Reinforcers for Maladaptive Behavior

Most recent research on attention as a reinforcer is in assessment and treatment of behavior disorders, particularly with individuals with intellectual and developmental disabilities. In several large-scale studies, outcomes of indirect assessments (e.g., Maurice & Trudel, 1982) and descriptive assessments (e.g., Lerman & Iwata, 1993; McKerchar & Thompson, 2004; Thompson & Iwata, 2001) have suggested that attention is a common consequence following the occurrence of maladaptive behavior. Furthermore, functional analysis research has suggested that a relatively high percentage of published functional analyses have shown some form of attention as the maintaining variable (Beavers et al., 2013; Hanley et al., 2003; Kurtz et al., 2003). Beavers et al. (2013) compiled data from functional analysis outcomes across all functional analysis cases that were published in behavioral journals through the year 2012. Results showed that social positive reinforcement was the function of problem behavior for 29.2% of the published cases with 17.2% showing maintenance by access to attention only. Overall, functional analysis research has shown that various maladaptive behavior may be maintained by contingent attention including self-injurious behavior (SIB; Lovaas & Simmons, 1969; Iwata et al., 1982/1994), physical aggression (Roscoe et al., 2010), and bizarre vocalizations (DeLeon et al., 2003; Wilder et al., 2001).

If functional analysis results suggest that problem behavior is maintained by social positive reinforcement in the form of attention, various function-based interventions may be developed, which include (a) eliminating access to attention (i.e., extinction), (b) providing access to attention on a time-based schedule (i.e., noncontingent reinforcement [NCR]), (c) providing attention contingent upon an alternative behavior (differential reinforcement of alternative behavior [DRA]), or (d) implementing negative punishment procedures (e.g., time-out) to decrease the occurrence of the maladaptive behavior (Greer & Fisher, 2017; Hagopian et al., 2013b; Iwata et al., 1993). It is important to note that extinction is often used in combination with reinforcement-based procedures such as NCR and DRA for treating attention-maintained maladaptive behavior because (a) it often increases the efficacy of those interventions (Greer & Fisher, 2017; Hagopian et al., 1998; Hagopian et al., 2013a, b) when combined with reinforcement-based procedures, it is less likely to be associated with various side effects (e.g., response bursts, emotional responding, extinction-induced aggression; Lerman et al., 1999).

One type of DRA procedure, functional communication training (FCT), is a highly effective procedure for decreasing maladaptive behavior maintained by attention (Greer & Fisher, 2017; Tiger et al., 2008). FCT involves teaching a form of communication (vocal, sign, picture card) to recruit attention from others and, as mentioned, is often more effective when implemented in combination with extinction or time-out for maladaptive behavior. Furthermore, FCT is often the treatment of choice for attention-maintained maladaptive behavior because the individual (a) is taught a behavior for which they can prompt others to deliver attention, (b) can control when and how much attention they receive, and (c) it is often preferred by the individual over other interventions (Greer & Fisher, 2017; Hanley et al., 1997).

In summary, functional analysis methodology and function-based interventions have been effective in reducing the occurrence of maladaptive behavior maintained by attention, and some common interventions (e.g., FCT) also involve procedures to increase the occurrence of appropriate behavior to access attention. These function-based interventions have resulted in an increase in the efficacy of behavioral interventions to address attention-maintained maladaptive behavior and resulted in a reduction of reliance of intrusive punishment procedures for behavior change. Furthermore, recent research has suggested functional analyses are useful in isolating the specific aspects or parameters of attention (e.g., form, magnitude, and schedule of attention) on the occurrence of maladaptive behavior, which provides us some insight on how these variables influence the efficacy of attention.

Form of Social Reinforcers

Although various studies, review papers, and position papers suggest the utility of attention in the modification of human behavior, we know little about the conditions under which it functions as a reinforcer. Thus, a more in-depth study is needed on the various characteristics of and factors influencing the efficacy of attention. The largest area of research on characteristics of attention that influence its efficacy as a reinforcer is the form (i.e., type, content, and quality) of attention delivery. That is, because of different individuals' conditioning history, it is highly unlikely that all behavior for an individual occurs to access all forms of attention (Brophy, 1981; Fisher et al., 1996a; Harper et al., 2021). For example, a nod may function as a reinforcer for some behavior displayed by one individual, and only vocal-verbal attention that involves a certain quality may function as a reinforcer for another behavior displayed by another individual. Thus, it is important to determine the influence of the form of attention for particular individuals and behaviors in various contexts. Research in this area has included determination of forms of attention for increasing various behavior, as well as research in functional assessment and function-based treatment of maladaptive behavior. Both areas of research provide pertinent information for increasing our knowledge of ways to determine specific forms of attention that may influence behavior.

Type of Attention

Most research on the use of attention as a reinforcer has involved a combination of several types of attention including vocal-verbal attention (e.g., praise, conversation), physical attention (e.g., hugs and high fives), and facial expressions (e.g., smiles and winks). Until recently, little was known about the reinforcing efficacy of specific types of attention. A few exceptions include earlier studies such as Kazdin and Klock (1973) who showed that an increase in delivery of nonvocal attention (i.e., smiling, patting, touching) by a classroom teacher resulted in an increase in student attentive behavior for 11 out of 12 students with IDD. In addition, multiple studies have shown that various forms of physical attention (e.g., pats on the back and hand holding) used in isolation may function as a reinforcer, and a combination of physical (e.g., pats on the back and hand holding) and vocal-verbal attention may be more powerful than either type of attention alone (e.g., Clements & Tracy, 1977; Wheldall et al., 1986).

Recently, researchers have focused on the use of systematic preference and reinforcer assessment methodology to determine preferred types of attention, particularly for children with ASD and individuals with IDD (e.g., Clay et al., 2013; Clay et al., 2018; Kelly et al., 2014; Lang et al., 2014; Morris & Vollmer, 2019, 2020; Nuernberger et al., 2012; Smaby et al., 2007). For example, Kelly et al. (2014) conducted a paired stimulus preference assessment with different picture cards depicting seven different types of attention (e.g., singing, hugs, high-fives, praise) to determine high and low preferred types of attention for five children with ASD. Next, they validated the preference assessment by showing that participants engaged in higher levels of mands to access high preferred types of attention as compared to low preferred types of attention. In a series of studies, Morris & Vollmer (2019, 2020) showed the efficacy of the Social Interaction Preference Assessment (SIPA) for determining preferred types of attention that function as reinforcers. The SIPA is similar to a multiple stimulus without replacement preference assessment

(MSWO; DeLeon & Iwata, 1996) in which pictures that represent the different types of attention are presented in an array from which the participant chooses. However, to allow for determination of a hierarchy of preference, the SIPA involves restriction of access to high preferred types of attention in subsequent MSWO trials. Results of these studies showed the SIPA is a valid procedure for determining individual attention reinforcers for children with ASD. Specifically, reinforcer assessments suggested that high preferred types of attention generally resulted in higher levels of responding as compared to low preferred types of attention. Furthermore, the researchers showed that attention alone can function as reinforcement for increasing behavior in children with ASD.

Although researchers have shown the utility of various preference assessment methods for determining preferred types of attention that function as reinforcers for children with ASD and IDD, little research has been conducted with other populations (e.g., typically developing children, adults with IDD). Furthermore, reinforcer assessments that have validated the outcomes of preference assessments have involved low schedule requirements and simple tasks. Harper et al. (2021) showed that a concurrent-operant preference assessment was effective for determining high preferred types of attention for a large number of typically developing preschool children. The types of attention included were common types of attention delivered in preschool classrooms (i.e., praise, physical attention, conversation). Specific results suggested that either conversation or physical attention was most preferred for most children; few children allocated responding for praise in the preference assessment. Results of a single-operant reinforcer assessment validated the outcomes of their preference assessment (i.e., most participants responding at high levels for at least one type of attention that was preferred in the preference assessment) when the response requirement was an FR 1 schedule. Next, when they increased the response requirement in the reinforcer assessment by using a progressive-ratio (PR) schedule, similar but less robust results were found.

Functional analysis research has also suggested that different types of attention may differentially influence the occurrence of maladaptive behavior (e.g., Britton et al., 2000; Kodak et al., 2007; LeBlanc et al., 2001; Piazza et al., 1999; Richman & Hagopian, 1999; Roscoe et al., 2010). For example, Richman and Hagopian (1999) conducted a functional analysis in which inconclusive results were found. Because destructive behavior was suspected to be maintained by other forms of attention (i.e., physical assistance, picking up, and holding), physical attention was included in the attention condition of the functional analysis, resulting in higher levels of destructive behavior. A treatment package in which physical attention was delivered on a noncontingent schedule and destructive behavior was placed on extinction was effective at reducing destructive behavior.

Kodak et al. (2007) evaluated the effects of different types of attention on the attention-maintained maladaptive behavior of two children (one participant was diagnosed with ADHD and the other with PDD-NOS). Initial functional analysis results showed that problem behavior of the participants was maintained by attention. Next, an attention assessment was conducted to determine the influence of several common types of attention (i.e., reprimands, unrelated comments, tickles, eye contact, praise, and hands-down procedure) on levels of problem behavior. The researchers showed that one participant engaged in higher levels of problem behavior to access reprimands and tickles, whereas the other participant engaged in higher levels of problem behavior when reprimands and unrelated comments were delivered. Thus, results demonstrated that different forms of attention differentially affected problem behavior for particular individuals.

Content of Vocal-Verbal Attention

The content of vocal-verbal attention (i.e., what is said) has been shown to influence both the occurrence of appropriate behavior and maladaptive behavior. For example, recommendations for the use of descriptive praise (i.e., praise that specifies the behavior being praised) over general praise have prompted researchers to compare the two praise types (Chalk & Bizo, 2004; Polick et al., 2012; Senn et al., 2020). Authors of these studies have suggested negligible differences between these two types of praise; however, Senn et al. (2020) suggested descriptive praise may be more preferred by some individuals. In a recent study, Clay et al. (2020) evaluated preference for and reinforcer efficacy of praise delivered in English versus Spanish for bilingual students. Although the researchers suggested no differential preference or reinforcing efficacy for the language in which praise was delivered, this methodology might be useful in working with English Language Learners (ELL) and bilingual students.

Several studies have shown that content of vocal-verbal attention may influence the efficacy of attention for maintaining maladaptive behavior (e.g., DeLeon et al., 2003; Fisher et al., 1996a; Hagopian et al., 2000; Roscoe et al., 2010). For example, Fisher et al. (1996a) compared the effects of a verbal reprimand related to maladaptive behavior (e.g., "don't hit me") versus a statement unrelated to the maladaptive behavior (e.g., "it's sunny today") for occurrence of maladaptive behavior of a 4-year-old boy. Other characteristics of attention such as facial expression and voice intonation were the same across conditions. The researchers showed that maladaptive behavior occurred at higher levels in the verbal reprimand condition. Similarly, Roscoe et al. (2010) showed that shorter latencies to physical aggression were displayed by a 13-year-old girl with ASD when the behavior resulted in high-preferred conversation topics as compared to low-preferred conversation topics. Treatment involved functional communication training (FCT) in which the participant was taught to hand over a card to receive access to high-preferred conversation and physical aggression was on extinction.

Quality of Attention

In addition to type of attention and content of vocal-verbal attention, other qualities of attention (e.g., voice intonation, posture; Blaze et al., 2014; Gardner et al., 2009; Gilboa & Greenbaum, 1978; Richman & Hagopian, 1999; Weyman & Sy, 2018) may influence the efficacy of attention as a reinforcer. For example, Richman and Hagopian (1999) showed voice intonation may influence the degree to which attention functions as a reinforcer for maladaptive behavior. The experimenters included two attention conditions in a functional analysis of maladaptive behavior displayed by a 6-year-old boy. During one attention condition, a reprimand was delivered using a "normal" voice intonation; in the other, a reprimand was delivered using an "exaggerated" voice intonation (i.e., raised voice and physical signs of displeasure). Higher levels of maladaptive behavior occurred in the exaggerated attention condition. Gardner et al. (2009) showed problem behavior by two participants was more likely to occur to escape demands when low-quality attention was provided (i.e., infrequent eye contact, no physical contact, distant physical proximity, negative verbal statements, and a flat monotone voice) as compared to when high-quality attention was provided (i.e., frequent eye contact, physical contact, close proximity, enthusiastic praise). In an additional evaluation, both participants allocated more responding to access play or demand contexts in which the high-quality attention was delivered as compared to the low-quality attention in a concurrent-operants arrangement.

Gilboa and Greenbaum (1978) evaluated the influence of "warm" nonvocal attention and "cold" nonvocal attention on correct responding by a large number of 3rd graders. These different qualities of attention were delivered noncontingently during a session along with vocal-verbal statements (i.e., "correct" or "nice") for correct responding. Aggregate data for all participants showed that higher levels of correct responding occurred when "warm" nonvocal attention was delivered than "cold" nonvocal attention. More recently, Blaze et al. (2014) showed that both loud and quiet praise deliveries were effective for increasing on-task behavior in four high school classrooms. These results suggest that teachers may consider the conditions under which each is most appropriately used.

In summary, recent research has suggested the use of modified functional analysis methodology to determine the influence of specific types of attention on the occurrence of problem behavior. Furthermore, researchers have suggested various options in using preference and reinforcer assessment methodology for determining types of attention that are likely to be most preferred and reinforcing for particular individuals. However, more research is needed on the most efficient and effective methodologies to determine these types of reinforcers. Furthermore, additional research to determine whether these types of attention function as reinforcers under conditions of increased work requirements or acquisition tasks is needed. Finally, additional research on the relation between attention type and other factors discussed below (e.g., duration, schedule) may provide some insight into the conditions under which attention is most likely to be an effective reinforcer. Also, additional research determining the extent to which changing various aspects of the "quality" of attention (or a particular type of attention) may be valuable. For example, if there is a change in voice intonation, nonvocal behavior, or content of what is said, then manipulations can be made to typical types of attention (e.g., praise) such that those types of attention may become more potent reinforcers.

Other Factors that Influence the Effectiveness of Social Reinforcers

In addition to the form of attention, other factors may influence the effectiveness of attention as a reinforcer. However, it is important to note that much of this research has been in the area of assessment and treatment of maladaptive behavior, which is briefly discussed in this section as well as more extensively in various other chapters in this book. In this section, we provide an overview of some of these factors, which include (a) magnitude of attention, (b) immediacy of attention delivery, (c) schedule of attention delivery, (d) motivating operations, and (e) conditioning history.

Magnitude of Attention Delivery

Few applied studies have evaluated the influence of magnitude (duration) on reinforcer efficacy (Lerman et al., 2002), particularly on the efficacy of attention as a reinforcer. Most research on magnitude of reinforcement has been conducted in assessment and treatment of problem behavior, and results of these studies have been conflicting. In studies conducted by Fisher et al. (1996b) and Volkert et al. (2005) on the effects of different reinforcer durations in the context of functional analyses, results of both studies suggested that longer durations of reinforcer access resulted in lower levels of problem behavior as compared to shorter durations of reinforcer access. However, reinforcer access time was not subtracted from overall session time in these studies, which may have influenced the results. Trosclair-Lasserre et al. (2008) evaluated the relation among reinforcer magnitude, preference, and reinforcer efficacy with three children with autism spectrum disorders whose problem behavior was maintained by social positive reinforcement (i.e., tangibles or attention). The experimenters conducted a magnitude preference assessment to determine preference for a large or small magnitude of the reinforcer. Following this assessment, a magnitude reinforcer assessment was conducted to determine the reinforcing efficacy of each magnitude value under progressive-ratio schedules. Overall, results showed that preference for different magnitudes of reinforcers may predict the efficacy of these reinforcers and magnitude effects may be influenced by the schedule requirement.

In summary, researchers suggest that the duration of attention may influence the efficacy of attention as a reinforcer. However, research to date suggests that longer durations of attention may be useful for reduction of maladaptive behavior, whereas shorter durations of attention may be more effective for increasing appropriate behavior. That is, longer durations of attention may result in a satiation effect resulting in a decrease in the occurrence of behavior to access that reinforcer, whereas shorter durations of attention result in the continuation of the relevant establishing operation resulting in a possible increase or continuation of appropriate behavior to access attention. However, it is likely that the degree to which magnitude influences the efficacy of attention is interrelated with other factors such as the quality or form of attention (e.g., conversation may be more reinforcing for longer durations than praise) or the schedule of attention delivery such as shown in Trosclair-Lasserre et al. (2008). In fact, research using other positive reinforcers has suggested that longer durations of access to stimuli such as leisure items or toys may be more preferred and/or effective based on the quality or type of reinforcer (Steinhilber & Johnson, 2007) and the schedule of reinforcement (e.g., DeLeon et al., 2014). Additional research is needed to determine the influence of magnitude on the reinforcing efficacy of attention, particularly with respect to certain forms of attention, various schedules of reinforcement, and the type of task (e.g., acquisition vs. maintenance task).

Immediacy of Attention Delivery

Both basic and applied research studies have suggested that delays to reinforcement can influence responding. Specifically, recommendations suggest reinforcement be provided immediately to increase and maintain responding (Sy & Vollmer, 2013); however, there are various situations that do not allow for immediate reinforcement. Little research has evaluated the influence of delays to reinforcement on skill acquisition (Majdalany et al., 2016; Sy & Vollmer, 2013). Of the studies that have been conducted, most have used stimuli other than attention or a combination of attention and other reinforcers (e.g., edibles, preferred toy). For example, Sy and Vollmer (2013) conducted a multi-experiment study comparing the influence of immediate reinforcement and various delays to reinforcement (praise and small edible or 30-s access to preferred toy; up to 40-s delays) on conditional discrimination skills in children with IDD. Overall, results showed that immediate reinforcement was more effective than delayed reinforcement for some participants; however, for others short delays did not interfere with acquisition. Similar results were found by Majdalany et al. (2016) with short delays (up to 12 s) in teaching tacts to three children with autism spectrum disorders. Finally, only a few studies have focused on immediacy of attention delivery. For example, Ramey and Ourth (1971) and Millar and Watson (1979) investigated the delay in caregiver attention following the occurrence of infant vocalizations. The infant's rate of vocalizations occurred at the highest levels when attention was delivered immediately, whereas lower levels of vocalizations occurred under the 3-s, 6-s, or 10-s delays.

Because delays to delivery of attention may decrease its reinforcing value, it is important to determine procedures that allow for a delay in attention delivery. These procedures might include delay fading and various mediating variables such as rules or instructions, signals, delivery of conditioned reinforcers (e.g., tokens), and the availability of intervening activities. Most research evaluating procedures that allow for delays to attention delivery are in the assessment and treatment of problem behavior (i.e., during fading of reinforcer delivery during FCT interventions). Overall, research has suggested that delay fading (i.e., gradually increasing the period of time between a response and the delivery of attention) alone has not been very effective (e.g., Hagopian et al., 1998; Hanley et al., 2001) for maintaining behavior under delayed reinforcement. However, some studies have shown that providing an activity during the delay with or without delay fading may be effective (Austin & Tiger, 2015; Hagopian et al., 2005). For example, Hagopian et al. (2005) showed that providing access to preferred tangible items during delay fading was effective for maintaining appropriate communication responses to access the functional reinforcer (e.g., attention or tangibles) during FCT. However, the degree to which contingencies for engaging in the intervening task or activity are necessary for efficacy of task/activity provision during delay periods is open to question (see Ghaemmaghami et al., 2016 for preliminary information). A notable limitation of these studies is that delay periods were 5- to 10-min in duration; thus, it is unknown whether similar procedures would be effective during longer delays.

Most research focusing on procedures to maintain responding under delays has been conducted with other reinforcers such as preferred tangibles and edibles. For example, Vollmer et al. (1999) showed that the use of a signal (e.g., countdown timer) was effective for maintaining high levels of appropriate requests and low levels of problem behavior during delays to access edibles. Furthermore, studies have shown that providing access to various activities including work tasks (e.g., Dixon & Cummings, 2001) and high-preferred activities (Newquist et al., 2012) may be an option for maintaining responding to access delayed attention. Finally, it is possible that providing a rule or instruction regarding the delay may be effective for some individuals. For example, Hanley et al. (2007) showed that teaching young children to repeat a rule (i.e., "When I wait, I get what I want") was effective for maintaining appropriate requests and decreasing problem behavior associated with accessing preferred items and activities. Additional research evaluating the procedures that are most effective for increasing delays to the delivery of attention for maintenance and acquisition of appropriate behavior is needed. Furthermore, determining procedures for teaching individuals to seek out other reinforcers or preferred activities during delays to reinforcement might be particularly useful for delay to attention periods in various contexts and environments such as during times when caregivers are busy at home or in preschool classrooms when the teacher is busy interacting with other children or engaged in other tasks.

Schedule of Attention Delivery

Basic and applied research has shown that responding may maintain under both dense and lean schedules of reinforcement; however, few studies have evaluated the influence of the schedule of reinforcement on the efficacy of attention for increasing and maintaining appropriate behavior. One exception is a study by Gable and Shores (1980) showing the rate of oral reading was higher under intermittent as compared to continuous attention schedules. Specifically, the researchers showed that praise delivered on escalating variable-ratio (VR) schedules (i.e., escalating from VR5 to VR15) in which response requirements were increased within or across sessions was more effective at increasing oral reading rates than a VR5 schedule. Furthermore, Brackbill (1958) showed the schedule of attention delivery affected patterns of responding under later conditions of extinction or deprivation from attention. Overall, results showed that infants who were previously exposed to an intermittent schedule of attention smiled at higher rates under extinction as compared to infants who were exposed to a continuous reinforcement schedule of attention. These outcomes are in line with research showing that behavior is more likely to be resistant to extinction when it has been intermittently reinforced (Kazdin & Polster, 1973).

Given that higher levels of appropriate behavior may be maintained under intermittent reinforcement schedules and the fact that it is often difficult to deliver reinforcement on dense schedules in the everyday environment, it is important to determine ways in which the schedule of attention delivery can be thinned while maintaining the occurrence of appropriate behavior. Determining effective schedule thinning procedures has been a focus of research on assessment and treatment of maladaptive behavior, particularly in the application of FCT (Greer et al., 2016; Hagopian et al., 2011) given that schedule thinning is associated with weakening in the contingency between the appropriate communication response and the functional reinforcer. This contingency weakening may result in the reemergence of the maladaptive behavior and a decrease in the occurrence of the functional communication response.

A common schedule thinning procedure for FCT involves the use of a multiple schedule in which distinctive stimuli (e.g., colored cards, different color leis) signal the availability and unavailability of attention for engaging in an appropriate response (e.g., asking for attention; Hanley et al., 2001; Tiger & Hanley, 2004; Tiger et al., 2013). For example, Tiger and Hanley (2004) used different colored floral leis to signal (a) the availability of attention delivery by the teacher for the target child, (b) the unavailability of attention for the target child but the availability of attention for another child, and (c) the unavailability of attention for either child. All three children displayed high levels of requesting attention when the signal was present for availability of attention for that child and low levels of requesting when the other signals were present. In a later study, Tiger et al. (2013) showed that a distinctive stimulus for extinction periods may not be necessary for discriminated responding under reinforcement and extinction periods. Furthermore, research has suggested that discriminated responding based on periods of attention availability and unavailability may be established under more naturalistic conditions (e.g., availability denoted by caregiver writing or talking on phone vs. unavailability denoted by caregiver sitting alone without any activity) rather than having to program colored stimuli such as cards and leis (e.g., Balka et al., 2016; Kuhn et al., 2010; Leon et al., 2010). Overall, researchers suggest that multiple schedules for schedule thinning during FCT are highly effective and preferred procedure for maintaining a functional communication response (Greer et al., 2016; Luczynski & Hanley, 2014; Rooker et al., 2013), particularly if longer periods of reinforcer unavailability are necessary; however, for some individuals, it may be necessary to incorporate additional interventions such as access to alternative activities during reinforcer unavailability periods (Fuhrman et al., 2018).

Future research is needed on the conditions under which continuous and intermittent attention delivery is necessary and sufficient for acquisition and maintenance of appropriate behavior and important skills. Furthermore, research is needed to determine the conditions under which appropriate behavior and relevant skills can be maintained under relatively thinner schedules of attention delivery (e.g., those that involve periods of reinforcer unavailability for periods more than 4 to 8 min). Finally, further research is needed to determine the most efficient and effective way for thinning attention delivery for appropriate behaviors such as academic and social behaviors.

Motivating Operations

Researchers have suggested the reinforcing efficacy of attention is influenced by a recent history of reinforcer availability (i.e., motivating operations). That is, exposure to or restriction from access to attention has been shown to affect subsequent responding to access attention in reinforcer assessments (e.g., Gewirtz & Baer, 1958a, b; Vollmer & Iwata, 1991), tact and intraverbal training (Cengher et al., 2014; Cengher & Fienup, 2020), and functional analyses (e.g., Berg et al., 2000; Iwata et al., 1994; McComas et al., 2003; O'Reilly, 1999; O'Reilly et al., 2006).

Most studies on the effects of immediate histories of reinforcement have evaluated the effects of prior restricted access (no access) or continuous access to attention on subsequent responding for attention. For example, in two early studies, Gewirtz and Baer (1958a, b) found that (a) no access (deprivation period) to attention resulted in an increase in subsequent responding for attention and (b) continuous access (a satiation period) to attention resulted in a decrease in subsequent responding for that stimulus. That is, in the social-deprivation condition, the participant was told that the experimenter needed to go find something and was left alone in a room with access to toys for 20 min. After the 20-min period, the experimenter returned and conducted a 10-min session in which praise was delivered for placing a marble in a prespecified hole. In the social-satiation condition, the experimenter brought the participant to the room and provided continuous social interaction for 20 min. After this 20-min period, the 10-min session in which praise was delivered for correct responding on the marble-dropping task was conducted. Results showed that higher levels of responding occurred to access attention on the task after periods of social deprivation as compared to periods of social satiation. Vollmer and Iwata (1991) evaluated the effects of satiation and deprivation on the reinforcer efficacy of various stimuli including social interaction for two individuals with intellectual and developmental disabilities. Prior to each session, participants were either provided with continuous (satiation) or no access (deprivation) to social interaction. After each of these sessions, praise was delivered for engaging in a block-placement task. Results showed that responding on the task for contingent praise was higher after deprivation presession periods as compared to satiation presession periods and a no reinforcement baseline. Overall, these studies suggest prior exposure to attention influences the levels of responding to access attention.

Research on the assessment and treatment of problem behavior has also shown the influence of access to and restriction from attention on levels of responding to access attention. As mentioned above, NCR is a common treatment for decreasing the occurrence of problem behavior maintained by attention, which may be effective due to altering the establishing operation for attention. This is particularly the case if attention is delivered continuously or on a dense schedule of reinforcement during NCR (Goh et al., 2000). For example, a young child might engage in tantrum behavior to gain access to teacher attention. If NCR in which continuous teacher attention is implemented reduces the occurrence of the tantrum behavior, then this is likely due to an abolishing operation (i.e., free and frequent access to attention reduces the value of attention and results in a reduction in tantrum behavior to access attention). In addition, researchers have shown that access periods and restricted access periods to attention affect subsequent levels of problem behavior (e.g., Berg et al., 2000; O'Reilly, 1999; O'Reilly et al., 2006; O'Reilly et al., 2007). For example, O'Reilly (1999) determined that both yelling and head hitting were maintained by access to attention for a 20-year-old man with IDD. Prior to functional analysis sessions, the participant was exposed to deprivation from attention (no social interaction for one hour) or a high level of attention (attention on an FT 30-s schedule for one hour). Results showed that higher levels of head hitting occurred in sessions that were preceded by deprivation from attention as compared to sessions in which there was a high level of attention. Similarly, Berg et al. (2000) conducted a three-experiment study showing that prior continuous access to attention resulted in lower levels of problem behavior in subsequent attention-contingent conditions as compared to prior no access to attention conditions. McGinnis et al. (2010) evaluated the effects of longer durations (45 min) of presession access and no access to attention on subsequent levels of problem behavior to access attention during 15-min sessions. In addition, the experimenters evaluated the effects of two different presession access conditions involving the fixed-time delivery of attention; one condition involved the delivery of attention on an FT 15-s schedule (denser), whereas the other condition involved the delivery of attention on an FT 120-s schedule (leaner). Overall, results showed lower levels of problem behavior after presession FT schedules as compared to presession no access conditions. Furthermore, somewhat lower levels of problem behavior occurred during subsequent attention-contingent conditions after the denser FT schedule of attention as compared to the thinner FT schedule of attention for two participants.

Overall, researchers suggest prior access to or deprivation from attention is likely to influence the reinforcer efficacy of attention for both appropriate behavior and problem behavior. The implications of these results are that if attention is to be used as a reinforcer for increasing appropriate behavior, then it might be beneficial to provide a period of deprivation prior to teaching or training situations. For example, teachers may find it useful to program periods of individual work time or quiet reading time in which attention is not provided prior to teaching periods in which attention will be delivered for correct responding on acquisition tasks.

There are several areas for future research on motivating operations and the effectiveness of attention as a reinforcer. Future researchers might conduct a parametric evaluation to determine the influence of varying lengths of reinforcer access and no access on subsequent responding for attention as well as a determination of the effects of noncontingent delivery of attention (rather than continuous access to attention) on subsequent appropriate responding for attention or the efficacy of attention for subsequent teaching or training procedures. In addition, it might be interesting to determine whether satiation or deprivation from one form of attention (e.g., praise) influences the efficacy of other forms of attention (e.g., physical attention). Finally, it might be interesting to compare the effects of satiation and deprivation periods on responding for biological versus social reinforcers such as various forms of attention.

Conditioning History

Another factor that may influence the efficacy of attention as a reinforcer is an individual's conditioning history (e.g., Baer & Goldfarb, 1962; Bijou & Baer, 1965; Piazza et al., 1999). Bijou and Baer (1965) suggested that the type of attention provided in an infant or child's environment may affect the degree to which their behavior is later affected by certain forms of attention. For example, some individuals may be more influenced by high-fives and smiles, whereas others may be more influenced by hugs. Similarly, some individuals may be more influenced by attention that involves a certain voice tone, voice level, and body movement. Research on conditioning attention as a reinforcer (e.g., Axe & Laprime, 2017; Dozier et al., 2012; Dudley et al., 2019; Greer et al., 2008; Holth et al., 2009) likely supports this notion. For example, Dozier et al. (2012) showed that response contingent pairing in which praise and edibles were delivered contingent upon a simple operant response resulted in praise becoming a reinforcer for 4 out of 8 participants with IDD. Furthermore, praise functioned as a reinforcer for two additional behaviors that were not included in the pairing procedures. Procedures that allow for conditioning of certain forms or aspects of attention may provide insight into how forms or aspects of attention become reinforcers throughout a person's lifetime.

Another variable that may influence the efficacy of attention as a reinforcer is the individual who is delivering attention, which is likely related to an individual's conditioning history. That is, certain individuals may signal the delivery of attention or certain forms of attention. For example, certain behaviors may be maintained by attention from peers but not adults or by attention delivered by one parent but not the other. Multiple studies have shown that peer attention may function as a reinforcer for maladaptive behavior (e.g., Ervin et al., 1998; Grauvogel-MacAleese & Wallace, 2010; Jones et al., 2000; Lewis & Sugai, 1996) and may be a more potent reinforcer than teacher attention (e.g., Broussard & Northup, 1995; Flood et al., 2002; Northup et al., 1995). For example, Jones et al. (2000) modified traditional functional analysis conditions (Iwata et al., 1982/1994) by evaluating the effects of peer attention, teacher attention, and escape on the percent of disruptive behavior in a functional analysis. Peer attention was found to maintain high levels of disruptive behavior as compared to the other conditions. Treatment results showed that noncontingent peer attention was somewhat successful in reducing disruptive behavior. In a similar study, Northup et al. (1995) showed that peer attention maintained problem behavior of three students with attention deficit hyperactivity disorder (ADHD), and DRO in which access to the peer of choice was provided contingent upon a period of time without problem behavior was successful for reducing disruptive behavior.

Similarly, conditioning history likely plays an important role in research on determining preference for staff in individuals with IDD (e.g., Jerome & Sturmey, 2008, 2014). Jerome and Sturmey (2008) conducted a preference assessment to determine relative preference of staff (i.e., preferred and non-preferred staff) and then evaluated the reinforcing effects of attention delivered by preferred and non-preferred staff. Next, a progressive-ratio (PR) schedule was implemented to determine the amount of work completed for preferred and non-preferred staff attention. For all three participants, access to attention from highly preferred staff (as determined by the preference assessment) resulted in a higher PR break point than for lower preferred staff. Jerome and Sturmey (2014) replicated these results and extended this study by showing that conducting stimulus pairing procedures in which non-preferred staff delivered high preferred items in conjunction with greeting the participant (e.g., smiled and said, "how are you doing?") on a variable time (VT) 1 min schedule resulted in an increase in PR break points and an increase in approach responses toward non-preferred staff during conditions in which participants engaged in a work task for non-preferred staff attention.

In summary, research suggests that conditioning histories likely influence the efficacy of attention and the degree to which attention delivered by certain individuals is reinforcing. However, it remains unclear (a) how attention might be conditioned as a reinforcer during our lifetime and (b) what procedures are the most efficient and effective to condition attention as a reinforcer. Furthermore, little research has determined the influence of conditioning history on different forms and components of attention. Future research might involve programming attention-based conditioning histories and subsequently determining the effects of that conditioning history on behavior to access particular forms or characteristics of attention. For example, one form or characteristic of attention could be conditioned as a reinforcer (e.g., paired with an already established reinforcer using a response-contingent pairing procedure) and another form of attention not conditioned, then a test could be conducted to compare the efficacy of each form of attention in the acquisition and maintenance of responding for a particular individual.

General Conclusions and Recommendations

Attention plays a big part in the acquisition and maintenance of critical behaviors. Attention is an important component in the development of verbal behavior, social behavior, leisure skills, and academic behavior. However, there is still more to learn about what makes social consequences (e.g., attention) effective reinforcers, and research is still needed to identify the types and features of social reinforcement that make it effective (Vollmer & Hackenberg, 2001).

To date, researchers have suggested that attention is most effective in the acquisition and maintenance of appropriate behavior when it (a) involves both nonverbal and verbal forms of attention, (b) involves high-quality verbal attention, (c) is combined with instructional procedures (e.g., prompting and modeling) and other social reinforcers, (d) is delivered close in time to the behavior, (e) is delivered after periods of deprivation, and (f) is short in duration. Researchers should continue to assess (a) the reinforcing effectiveness of attention as a stand-alone intervention, (b) the factors that influence the effectiveness of attention as a reinforcer, and (c) the reinforcing effectiveness of different types of attention across different populations and environments. It is important to also remember that the behavior of some individuals will not be sensitive to attention as a reinforcer, and attention may need to be conditioned as a reinforcer. More research is needed to determine the best methods for conditioning attention as a reinforcer and the generality of the effects.

Descriptive analysis and functional analysis research has shown that attention is a common consequence following problematic behavior in the natural environment and that some form of attention maintains a high percentage of problematic behavior. Research suggests that various forms of attention may reinforce maladaptive behavior and that preference assessments can be used to determine an individual's preferred types of attention. Research also suggests that attention is likely to maintain maladaptive behavior when (a) the verbal attention is related to the maladaptive behavior, (b) the attention is exaggerated (vocal and physical forms of displeasure), (c) the attention is delivered after a period of deprivation, and (d) the attention is longer in duration. Various function-based interventions (e.g., extinction, NCR, DRA) have been suggested for the treatment of problem behavior maintained by attention.

Social reinforcers, such as attention, will likely continue to be a primary component of behavior intervention plans for increasing appropriate behavior and decreasing inappropriate behavior. Given the widely recommended use of social reinforcers, it's important to continue to evaluate the effectiveness of attention as a reinforcer for each of the individuals with whom we work. Practitioners should do all they can to establish attention as a reinforcer and to deliver it effectively. Pairing should be a primary part of working with clients. Pairing should include making sure that the practitioner's attention is paired with known reinforcers for the client. Practitioners should ensure that they deliver attention contingent on appropriate behavior and that high-quality attention is being delivered. Practitioners should vary the forms of attention that they use, and they should realize that not all forms of attention will serve as a reinforcer for the behavior of all individuals. As long as the data do not suggest that attention is aversive, contingent attention should continue to be incorporated in behavior-intervention plans.

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4 Tangible Reinforcers: Conceptual Overview and Considerations for Practice

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Behavior analysts are responsible for implementing behavior-change strategies that are conceptually consistent with behavioral principles and consider relevant factors (e.g., risks, benefits, side effects, implementation efficiency, cost effectiveness) on their way to producing outcomes likely to maintain under naturalistic conditions (Code 2.14; Behavior Analyst Certification Board [BACB], 2020). Tangible reinforcers (TRs) are among the most common stimuli that are delivered as consequences for individuals with intellectual and developmental disabilities (Graff & Karsten, 2012). Specifically, behavior analysts indicate that they deliver tokens or points (67% of respondents), edible items (50% of respondents), and toys (49% of respondents) regularly in practice.

Given the ubiquity of TR delivery in practice, it is a behavior analyst's responsibility to understand how tangible stimuli come to function as reinforcers in the first place and it is imperative for them to be familiar with their associated effects. For instance, TRs can either function as unconditioned or conditioned reinforcers and certain stimuli can become generalized conditioned reinforcers. Further, there are variables associated with each type of tangible stimulus that will alter its momentary reinforcing effectiveness including: (a) deprivation and satiation, (b) schedules of reinforcement, (c) immediacy of reinforcement delivery, (d) duration of reinforcement delivery, and (e) preference for reinforcers. Behavior analysts should consider all of these variables when incorporating the delivery of TRs into practice. In addition, there are ethical considerations related specifically to the use of TRs that behavior analysts should also be familiar with.

The purpose of this chapter is to provide a conceptual overview of TRs and offer considerations for incorporating TRs into practice. Our goal is for the content of this chapter to serve as a useful resource for practicing behavior analysts. Given the breadth of the content reviewed within this chapter, sometimes we are unable to offer a thorough discussion of certain procedures or topics. Where appropriate, we direct the reader to other chapters within this handbook that offer further depth into these topics (e.g., pairing procedures, reinforcer thinning, token economy).

Overview of Tangible Reinforcers

Prior to describing the conditions under which one might consider programming TRs and suggesting recommendations for incorporating them into one's practice, it is important to understand how tangible stimuli come to function as rein-

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_4

forcers in the first place. Below we discuss how TRs can be either unconditioned or conditioned and describe how certain stimuli can become generalized conditioned reinforcers. Although these processes and procedures are not unique to TRs, we will discuss them within the context of these particular stimuli. Our aim is to link our discussion of TRs to our field's conceptual systems, so the reader understands how these stimuli acquire their reinforcing properties and can proceed to accomplish this within their applied clinical practice.

Unconditioned Tangible Reinforcers

An unconditioned tangible reinforcer (UTR), also known as a primary or unlearned reinforcer, is a stimulus that functions as a reinforcer because of its biological importance in the organism's survival (Catania, 2013). For instance, food, water, and oxygen are tangible stimuli that function as reinforcers without a prior learning history (Cooper et al., 2020). Behavior analysts often use access to preferred food, snacks, beverages, or candy as reinforcers because they can be easily delivered, consumed quickly, and serve as potent reinforcers across a variety of skill acquisition (Paden & Kodak, 2015) and behavior reduction programs (Slocum & Vollmer, 2015).

Although use of UTRs is often desirable given their potency and overall effectiveness, reliance on them over time can result in satiation effects or consumption of an unhealthy amount of food (Rincover & Newsom, 1985). In turn, these undesirable side effects can render TRs ineffective or may interfere with establishing a healthy diet. In addition, consistent, high-rate usage of edible reinforcers may become expensive over time, can have harmful health effects on individuals with preexisting health conditions (e.g., diabetes, allergies), and may not be feasible for caregivers to deliver reliably in the home setting. For these reasons, use of UTRs may not be a long-term solution within behavior-change programming and other forms of TRs will need to be considered or even established.

Conditioned Tangible Reinforcers

A conditioned tangible reinforcer (CTR), also known as a secondary or learned reinforcer, is a previously neutral stimulus that comes to function as a reinforcer because of prior pairing with a primary or already established conditioned reinforcer (Skinner, 1953). CTRs play an important role in the development and maintenance of many socially important behaviors. In fact, common CTRs, such as various electronic devices and entertainment media, influence most of our daily activities (Bell & McDevitt, 2014). In some cases, researchers have shown that CTRs may be more preferred by an individual when compared to UTRs depending on age (Ortega et al., 2012), magnitude of reinforcer delivery (e.g., Clark et al., 2020), or the individual's ability to manipulate and contact the item's reinforcing qualities (Hanley et al., 2006). Using a wide variety of CTRs reduces a behavior analyst's reliance on unhealthy edible reinforcers and helps to mitigate satiation effects. Therefore, behavior analysts should be fluent in procedures for establishing CTRs.

Procedurally, establishing CTRs is often akin to respondent conditioning in which previously neutral stimuli acquire response-eliciting properties via repeated associations with an unconditioned stimulus (Williams, 1994). Similarly, CTRs acquire their reinforcing properties via repeated associations with an existing reinforcer (i.e., stimulus-stimulus pairing; e.g., Dozier et al., 2012; see Chap. 10 within this handbook for further discussion of stimulus pairing). Because just about any neutral stimulus can be conditioned as a CTR, behavior analysts may select stimuli that are accessible and easy to deliver to ensure that a variety of effective reinforcers are available across numerous settings.

Despite there being a number of advantages for applying CTRs in behavior change programs, behavior analysts should also be aware of some of their limitations. First, after the CTR has been conditioned, there may be a decrease in responding as a result of the removal of the primary reinforcer (Dozier et al., 2012). Second, CTRs will only maintain their reinforcing properties if they continue to be paired (at least intermittently) with other reinforcers, unless other naturally occurring reinforcers are contacted (Miltenberger, 2016). Otherwise, continuing to provide these stimuli after they have lost their reinforcing properties may result in extinction and its associated undesirable effects. For these reasons, behavior analysts should also consider using generalized CTRs.

Generalized Conditioned Tangible Reinforcers

Generalized conditioned tangible reinforcers (GCTRs) are the result of having been paired with *multiple* unconditioned and conditioned reinforcers (i.e., backup reinforcers; Hackenberg, 2009, 2018). GCTRs include items such as money (Koffarnus et al., 2013), tokens (Ayllon & Azrin, 1965), and vouchers (Meredith et al., 2014). Compared to CTRs, GCTRs are oftentimes more preferred by the individual (Sran & Borrero, 2010) because they can be exchanged for a nearly limitless range of backup reinforcers (Ivy et al., 2017). Given this, GCTRs are typically less susceptible to satiation effects because their effectiveness does not depend on a single type of deprivation. Thus, GCTRs maintain their effectiveness despite changing establishing operations or shifts in individual preference for backup reinforcers (Moher et al., 2008). Primary limitations of this approach are related to the effort and potential complexity associated with operating a token economy due to its dynamic nature (Ivy et al., 2017) and the resources required to maintain a stockpile of putative backup reinforcers (see Chap. 32 within this handbook for further discussion of token economies).

Summary

This section provided a conceptual overview on how TRs acquire their reinforcing properties and provided examples for how behavior analysts can proceed to accomplish this within their applied clinical practice. We briefly described the classification of TRs, as they may be UTRs (e.g., edibles), CTRs (e.g., toys), or GCTRs (e.g., tokens). It is important for behavior analysts to know these classifications and understand how the conceptualization of each is associated with different strengths and limitations which may be important to consider when designing programming to fit the unique needs of the individual or their environment.

Considerations for Incorporating the Delivery of Tangible Reinforcers into Practice

Reinforcement effects of a given stimulus are idiosyncratic, with effects varying across and within individuals (Vollmer & Iwata, 1991). Apart from individual differences, several other variables alter the momentary effectiveness of a stimulus that functions as reinforcement. These variables include (a) deprivation and satiation, (b) schedules of reinforcement, (c) immediacy of TR delivery, (d) duration of TR delivery, and (e) individual preference. The following section will discuss these variables and their effects on TRs. Behavior analysts should consider all of these variables when incorporating the delivery of TRs into practice.

Deprivation and Satiation

The effects of motivating variables such as deprivation and satiation offer a clear example of how the effectiveness of a tangible stimulus can be altered (e.g., DeLeon et al., 2000). Deprivation refers to the reduction in the availability of a reinforcer, resulting in an increase in reinforcer effectiveness (Catania, 2013). For example, if you only eat pumpkin pie once a year on Thanksgiving, it may be a more powerful reinforcer if you have gone without it for some time (e.g., since last Thanksgiving). Conversely, satiation refers to the continued presentation or availability of a reinforcer, resulting in a decrease in reinforcer effectiveness (Catania, 2013). For example, after you consume a large traditional Thanksgiving meal (and several days of leftovers!), you may no longer be motivated to seek out and consume these items for some time (at least until next year). Therefore, it is important for behavior analysts to keep the influence of motivational variables in mind when arranging therapeutic environments.

Considerations and Recommendations

Programming Periods of Deprivation When targeting a behavior to increase, creating an intentional state of deprivation is recommended to increase the likelihood that the learner will be motivated to engage in that behavior to contact the contingencies of reinforcement (e.g., North & Iwata, 2005; Sy & Borrero, 2009). TRs are particularly useful for contriving states of deprivation as they are easily manipulated and controlled. One way to program for periods of deprivation for a TR is to withhold access and make it only available contingent on the occurrence of the target behavior (Gottschalk et al., 2000). By making the item less available, its reinforcing effectiveness is expected to increase. If using edible reinforcers, one can contrive a state of deprivation by implementing the intervention or teaching trials during naturally occurring periods of deprivation (e.g., prior to meal times) when the individual may be more motivated to access the reinforcer (Vollmer & Iwata, 1991). To demonstrate these two strategies, consider the following example: A parent reinforces a child's homework completion by giving the child a snack if they complete their homework after school. To increase the effectiveness of the snack as a reinforcer, the parent can create a state of deprivation by (a) making the snack available contingent on homework completion only (i.e., snacks are unavailable during all other times of the day) and/or (b) requiring the child to complete their homework and receive the snack before dinner when they are more likely to be hungry.

Controlling for Satiation Satiation is likely to occur eventually with *any* type of reinforcer, especially if the reinforcer is repeatedly presented or continuously available (North & Iwata, 2005). This is a particularly important consideration for behavior analysts when designing skill acquisition programming because satiation effects could negatively impact the effectiveness of the intervention. To manage the effects of satiation of TRs, we suggest a few recommendations. First, we recommend that behavior analysts conduct ongoing, systematic assessment of reinforcer effectiveness and replace reinforcers before satiation occurs (DeLeon et al., 2001). Second, we recommend varying the reinforcers used for a single target behavior or using different reinforcers for different target behaviors (Keyl-Austin et al., 2012). This can be done by creating a pool or "menu" of available reinforcers and allowing the individual to choose his or her reinforcement regularly (e.g., prior to each work session or teaching trial; Egel, 1981). Rotating toy sets or providing access to multiple toys has also been demonstrated to be effective at reducing satiation and maintaining intervention effects over time (DeLeon et al., 2000). Third, we recommend that behavior analysts monitor the amount of the reinforcer delivered and only use what is necessary to maintain the target behavior (Zirpoli & Melloy, 1997). It is also important to consider satiation levels on an individual basis. That is, behavior analysts should know how much food the individual is likely to consume or how much time the individual is likely to spend consuming or engaging with an item or activity before experiencing satiation. Finally, tangible items can be paired with "complementary" items (i.e., consumption of one tends to vary positively with consumption of the other) to enhance their effectiveness and reduce satiation effects. For example, a child might play with a toy train when a train track is available but not when the train track is unavailable.

Schedules of Reinforcement

Schedules of reinforcement are rules that describe how often the occurrence of behavior will be followed by a reinforcer (Miltenberger, 2016). In general, these rules may specify whether reinforcement is delivered on a continuous or intermittent reinforcement schedule. Typically, behavior analysts use continuous reinforcement (CRF) schedules when teaching new behavior and intermittent schedules of reinforcement (i.e., fixed or variable) to maintain the behavior after it has already been established. For example, one may use a CRF schedule when initially teaching a child to raise their hand in class; however, after the child starts to reliably engage in this response, performance can be maintained on an intermittent schedule. In addition, these rules can describe whether reinforcement is delivered on a response- or time-based schedule (i.e., ratio or interval, respectively). That is, reinforcement may follow either (a) a prespecified number of responses (i.e., ratio schedule) or (b) the first response following a prespecified amount of time (i.e., interval schedule). Behavior analysts should be familiar with these schedule components and understand the patterns of responding that each combination is associated with so that they may harness their effects when programming TR delivery in practice.

Considerations and Recommendations

Feasibility of Reinforcement Schedules Depending on the type of TR, certain reinforcement schedules may be more feasible than others to implement. For instance, large or bulky leisure items or activities that cannot be immediately presented might be more easily delivered on an intermittent schedule of reinforcement. Conversely, edible items or tokens are usually more feasible to deliver on a CRF schedule because of their small size. However, there are some important considerations when delivering edible reinforcers on a CRF schedule. First, edible items delivered on a CRF schedule are more susceptible to satiation effects and reduced reinforcer effectiveness (North & Iwata, 2005). For these reasons, tokens are preferred over edible items if using a CRF schedule (BACB, 2020). Alternatively (or in addition to), programming intermittent schedules of reinforcement are recommended eventually in order to arrange a schedule of reinforcement that is more feasible to maintain over time. Second, implementing a ratio schedule with high integrity requires consistent monitoring which may be challenging for behavior analysts to adhere to. Therefore, it may be more feasible for behavior analysts to manage an interval schedule of reinforcement given the observation periods are intermittent and the programmed contingency is delivered following the first instance of the target behavior.

Deprivation and Satiation Effects Schedules of reinforcement have a direct impact on states of deprivation and satiation. Tangible items delivered on a continuous schedule of reinforcement are more prone to satiation effects, while tangible items delivered on an intermittent schedule of reinforcement may be less susceptible to satiation. While a CRF schedule is common initially in a teaching procedure, we recommend transitioning from a continuous to an intermittent schedule as soon as possible to prevent satiation (Zirpoli & Melloy, 1997). By shifting to a leaner schedule of reinforcement and reducing how often a TR is delivered, periods of deprivation are introduced for the individual, thus increasing their motivation as well as the effectiveness of the reinforcer. See Chap. 6 within this handbook for further discussion of reinforcer thinning.

While behavior analysts often take steps to prevent satiation, satiation of TRs may be desired if problem behavior is maintained by their access. That is, behavior analysts can use noncontingent reinforcement (NCR) to create an enriched environment and reduce the individual's motivation to engage in problem behavior (e.g., Kahng et al., 2000; Vollmer et al., 1993). By providing the TR that maintains the individual's problem behavior for free (i.e., noncontingently; time-based) and on a dense schedule (e.g., continuously), a temporary state of satiation is created, and problem behavior is expected to decrease (Slocum et al., 2018). Overall, NCR is an effective treatment for problem behavior maintained by various functions, including TR (Hagopian et al., 2001; Wallace et al., 2012). Despite its effectiveness, NCR does not strengthen an adaptive alternative response (e.g., requesting for access; Vollmer et al., 1993) and dense schedules of reinforcement can interfere with other skill acquisition programming (Wallace et al., 2012). Therefore, behavior analysts should consider combining NCR with contingent reinforcement for socially appropriate behavior (e.g., Fritz et al., 2017) and thinning the NCR schedule systematically so that satiation effects do not interfere with the acquisition of the alternative response (Goh et al., 2000).

Immediacy of Reinforcement Delivery

Immediacy of reinforcement delivery is another important consideration that can impact the effectiveness of the TR. Delays to TRs may be problematic because they can result in inadvertently reinforcing a nontarget or disruptive behavior that most immediately preceded TR delivery (Catania et al., 2015; Sidman, 1960) or may disproportionately diminish the value of the TR, thus rendering it a less effective consequence (Blackburn & El-Deredy, 2013). In addition, delays to TRs can result in extinction-induced response variability or resurgence of a previously extinguished response (Briggs et al., 2018b).

That said, there are situations in which immediate TR delivery is not possible and the individual must learn to tolerate delays to the TR. In addition, because delayed TR delivery reduces an individual's ability to clearly discriminate the active contingency, it is desirable to teach delay tolerance to promote generalization and maintenance of the desired response within the natural environment, which is unlikely to provide immediate reinforcement regularly (Hagopian et al., 2011; Stokes & Baer, 1977).

Considerations and Recommendations

Ensuring Immediacy It is necessary to consider ways to decrease the delay to TR delivery, especially during initial skill acquisition programming. For example, TRs should be within arm's reach of the behavior analyst prior to beginning the task. Edible items should be prepared in bite-sized pieces in an easily accessible container, toys should contain working batteries, and videos, music, and games should be preloaded and ready to play. In addition, TR delivery should immediately follow the occurrence of the target behavior, before the behavior analyst begins to conduct other tasks (e.g., clearing session stimuli, collecting data, preparing for the next trial). Ensuring immediacy of TR delivery will result in reinforcement contingencies that effectively strengthen the target behavior.

Maintaining Effectiveness of Delayed Reinforcement Of course, there are times in which immediate TR delivery is not feasible or might even be impossible. For example, riding a bike outside cannot practically be delivered following every instance of target behavior or after every teaching trial. In addition, the skill of delaying gratification and tolerating delays to TR is a valuable intervention in-and-of itself (Hagopian et al., 2011). If this skill is left unaddressed, delays to TRs can result in extinction-induced behavior. Thus, it is important to anticipate and plan for the unwanted effects of delay to TR by teaching tolerance to delayed TRs, while also maintaining the target response.

Delay-tolerance procedures typically include systematically increasing the delay between the response and reinforcer delivery (Fisher et al., 2000). One such strategy for signaling the delay between behavior and reinforcement is to enhance delay tolerance through verbal behavior such as instructional control and rule following (Skinner, 1984). For instance, "first/then" language or other verbal stimuli can be used to inform the individual of the contingency and increase the likelihood of them associating the delayed TR with the correct behavior. There is also evidence that providing intervening activities during the delay, combined with language stating the contingency, may increase tolerance and effectiveness of delayed reinforcement (Ghaemmaghami et al., 2016). However, the efficacy of this strategy may depend on the individual's receptive language abilities and history of receiving reinforcement for following instructions and rules (i.e., rule-governed repertoire; Tarbox et al., 2011). Alternatively, programming salient visual aids (e.g., colored floral leis; Tiger & Hanley, 2004) or signaled schedules of reinforcement (e.g., multiple schedule; Saini et al., 2016) that remain present throughout the delay interval and signal the forthcoming delivery of reinforcement can be used when the transient nature of vocal stimuli or one's rule-following repertoire is weak or ineffective. Similarly, CTRs or GCTRs (e.g., tokens; Scheithauer et al., 2016) may also exert discriminative control over one's behavior by signaling the schedule requirement for accessing the TR, thus serving to bridge the delay to TR delivery. See Chap. 6 within this handbook to review evidence-based strategies for accomplishing delay fading or denial tolerance training while maintaining the target response and mitigating extinction-induced phenomenon.

Duration of Reinforcement Delivery

Optimal duration of TR delivery varies and is dependent upon a variety of factors related to the individual receiving TRs and the type of TR delivered. For instance, some TRs require longer periods of access time to extract their reinforcing value (e.g., a puzzle) compared to other tangible stimuli that require less time (e.g., a skittle). Given these various factors, the following section will review considerations and recommendations related to reinforcement duration.

Considerations and Recommendations

Ensuring Sufficient Reinforcement Duration When considering TR duration for appropriate behaviors, the individual must access the TR for a sufficient duration for the reinforcing qualities of the item or activity to be extracted, otherwise the potency of the TR is likely to be diminished. It is important for the behavior analyst to consider that the required duration likely varies as a function of the item, its value, the response requirement for accessing it, and other individual characteristics. For instance, a child can extract the reinforcing properties of candy within seconds, while reinforcement for playing a video game might not be accessed until a within-game milestone is reached or the game is completed. If the video game is taken away before a milestone is reached, its reinforcing qualities are likely to be diminished and its withdrawal may serve as the antecedent for other problematic behaviors. If access to the TR is not effectively reinforcing (i.e., maintaining) the target behavior, or is occasioning problem behavior, consider evaluating whether increasing the duration of TR delivery results in increased effectiveness or decreased problem behavior. In addition, using a stimulus, such as a timer or verbal statement (e.g., "one more minute"), that signals the duration of TR delivery may help reduce negative behavior associated with the withdrawal of reinforcement (Mace et al., 1998).

Identifying Preference for Work-to-Reinforcement Ratios The required duration of TR access to maximize effectiveness is likely idiosyncratic across individuals. Therefore, behavior analysts should assess the optimal duration of TR delivery, for each individual, while also mitigating effects related to too little or too much TR access. For instance, some individuals prefer delayed, but accumulated and prolonged access to TRs rather than receiving immediate, but brief access following each target response (DeLeon et al., 2014; Fulton et al., 2020). Subjects in a study conducted by Fulton et al. (2020) preferred receiving access to an electronic device for 7.5 min after 15 task trials rather than receiving 30 s access following each trial. Accumulated and delayed TR access may be beneficial for activities that require a longer duration for the individual to extract the reinforcing properties from it, provided the individual is able to effectively delay gratification and understand this contingency. Behavior analysts should also monitor the ratio of work-to-reinforcement duration when programming TR access, as this ratio can impact the effectiveness of the TR (Briggs et al., 2018a). Given that the preference for larger and longer duration of access to TR varies by individual, behavior analysts should assess and compare the individual's preference and performance under contingencies that utilize small, immediate reinforcement and accumulated reinforcement.

Assessing Preference

Preference assessment methodologies include indirect assessments of preferred stimuli (e.g., structured interviews, checklists, survey; Fisher et al., 1996) and direct assessment technologies referred to as stimulus preference assessments (SPAs; Piazza et al., 2011). SPAs involve the systematic and direct assessment of an individual's preference by measuring their differential responses to brief and repeated presentations of various stimuli (Fisher et al., 1992). Tangible items such as food, toys, and leisure activities are commonly used in preference assessment procedures to identify putative TRs for individuals across various populations, including children and adults with developmental disabilities (e.g., Conine & Vollmer, 2019; Hanley et al., 1999), typically developing adults in the workforce (e.g., Wine et al., 2014), and older adults with dementia (e.g., Raetz et al., 2013). In fact, current preference assessment literature more often describes procedures for assessing tangible items as compared to non-tangible items such as praise (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992; Pace et al., 1985). SPA technologies are useful for determining a hierarchical preference value of various stimuli that may serve as effective reinforcers (Horrocks & Higbee, 2008). The following section will review SPAs in the context of TRs as well as considerations and recommendations for conducting them (see Chap. 21 within this handbook for further discussion on SPAs).

Considerations and Recommendation

Presentation Modality Presentation modality is an important consideration when assessing preference of putative TRs. Putative TRs can be assessed by presenting (a) verbal choice of items (e.g., "do you want the car or the ball?"), (b) pictures of the items, or (c) the actual items. Research suggests presentation of items in a tangible format (i.e., presenting the actual item) may result in more accurate identification of preference and better prediction of reinforcer effects for individuals with developmental disabilities (e.g., Conyers et al., 2002; Higbee et al., 1999). Furthermore, Conyers et al. (2002) found that the ability to choose high preference food and non-food items using object, picture, and spoken presentation modalities was predicted by participants' basic discrimination skills. Therefore, it is recommended that choice opportunities be provided in a functional way, such that they match the individual's discrimination skills. For example, if an individual has poor auditory discrimination skills, then you would not provide verbal choice opportunities. Provided the individual has the appropriate discrimination skills, verbal or pictorial choice presentations may be more practical for tangible items that are big in size and difficult to manipulate (e.g., a bicycle) or for events or activities that cannot be immediately presented and involve many stimuli and behaviors (e.g., going to one's favorite restaurant; Conyers et al., 2002).

SPA Methodology Type of SPA methodology is also an important consideration when assessing preference of putative TRs. If using a tangible presentation format to offer choice of items that are large or bulky (e.g., a trampoline or bicycle), SPAs such as free operant observation, single-stimulus, or paired-stimulus presentation may be more appropriate as they can accommodate larger-sized items (Cooper et al., 2020). Furthermore, for individuals who engage in problem behavior maintained by access to TR, a free operant SPA may be preferred when assessing for preference of putative TRs as it may result in lower rates of problem behavior, especially compared to paired-stimulus and multiple-stimulus presentations which involve the removal of items following participant selection (Kang et al., 2010).

It is important to note that SPAs and putative TRs used in these assessments will likely vary based on an individual's age and level of functioning. Behavior analysts should continually run SPAs to account for contextual, temporal, and environmental variables that may influence the individual's preference. Behavior analysts should also account for appropriateness of items used in preference assessments to the individual's environment. For example, a behavior analyst may choose cash, gift cards, lottery tickets, or office supplies as items in an SPA when assessing preference of an adult employed in an integrated workplace setting (Wine et al., 2014).

Displacement of Tangible Items from Different Stimulus Classes Another important consideration when assessing preference of putative TRs is whether to include both leisure items/toys and edible items within a single preference assessment. Several studies have evaluated combined presentation of leisure and edible items in SPAs and have found mixed results in terms of displacement of selection across populations (e.g., Bojak & Carr, 1999; Carter & Zonneveld, 2020; Conine & Vollmer, 2019; DeLeon et al., 1997; Fahmie et al., 2015). Overall, research suggests that there is a tendency for edible items to displace leisure items in combined preference hierarchies, regardless of preference assessment methodology (Bojak & Carr, 1999; Clark et al., 2020; DeLeon et al., 1997).

There are several possible explanations offered for the displacement of leisure items by food in combined-class preference assessments. According to DeLeon et al. (1997), displacement may be due to (a) shifts in establishing operations (i.e., deprivation of edible items may result in greater preference for these items) or (b) differences in response effort (i.e., it may be easier to extract reinforcement from edible items compared to leisure items). Another explanation may be due to the unequal magnitudes of reinforcement used in combined preference assessments (e.g., one small portion of an edible item vs. 30 s access to a leisure item). Clark et al. (2020) found that displacement of leisure items may be due to relatively brief periods of access to leisure items typically used during preference assessments and as the duration of access to leisure items increased, their displacement by edible items decreased. These findings have important implications for behavior analysts who prefer to use leisure items for reinforcement, as leisure items of sufficient magnitude (i.e., a long enough duration of access) may be just as preferred as edible items. Lastly, it may be that individual participant characteristics (e.g., lack of appropriate play skills) are another important factor that may influence preference and displacement in a combined-class SPA (Carter & Zonneveld, 2020).

Some concerns with combined presentation of edible and leisure items are that displacement of one class of stimuli (e.g., toys) for another (e.g., edibles) may mask the identification of putative reinforcing stimuli and lead to false negative outcomes (e.g., DeLeon et al., 1997, Fahmie et al., 2015; Roscoe et al., 1999). For example, Fahmie et al. (2015) found that despite initial differences in relative preference for leisure and edible items (i.e., most subjects showed an exclusive preference for edible items), both classes of stimuli were similarly effective when used as reinforcers for individuals with developmental disabilities, such that they resulted in similar rates of skill acquisition. This finding has important implications given that leisure items are recommended over edible items when used as reinforcers during skills training as they are more natural, less harmful to one's health, and may reduce the likelihood of satiation effects (BACB, 2020).

More recently, research has evaluated the extent to which the inclusion of screen-based devices (e.g., iPads, tablets) in SPAs influences (a) the displacement of edible items in a combined assessment and (b) the displacement of other leisure items or toys within the same stimulus class (e.g., Carter & Zonneveld, 2020; Conine & Vollmer, 2019). Conine and Vollmer (2019) found that screen-based devices were the top-ranked item on a leisure-only assessment for 58% of participants. Furthermore, a screen-based device was the top-ranked item for 89% of participants who had a leisure item as their top-ranked item in a combined preference assessment. The authors also found that other leisure items also outranked edible items for these participants, suggesting that the inclusion of a screen-based device may contribute to a relatively higher selection of leisure items over food. Carter and Zonneveld (2020) demonstrated similar findings with respect to the leisure-only preference assessment, with approximately half of their participants (47%) ranking screen-based devices as their most preferred leisure stimulus. However, their findings were more discrepant when considering the ranking of screen-based devices among other leisure items in a combined preference assessment. That is, among those participants who ranked leisure items over food, only 38% ranked a screen-based device as their highest preferred item. Overall, more research is needed to evaluate preference for screen-based devices and the extent to which these devices displace other items within the same stimulus class as well as items in a different stimulus class (e.g., food); however, behavior analysts should consider the influence of screen-based devices on the displacement of both food and leisure items when conducting preference assessments.

Ethical Considerations When Programming Tangible Reinforcers

Despite TRs offering many benefits in the development and maintenance of behavior, there are several negative aspects of TRs worth reviewing. These ethical considerations are based on the Ethics Code for Behavior Analysts (BACB, 2020; hereafter referred to as the Code). Behavior analysts have the ethical responsibility to adhere to the Code when delivering TRs to individuals. There are several unique ethical considerations that should be monitored prior to and throughout the planning and delivery of TRs. The remainder of this section will review and suggest ways to mitigate ethical dilemmas related to the Code.

Reinforcement Versus Bribery

Teachers, caregivers, and the public can misconstrue TRs as bribes; therefore, TRs are sometimes met with divergent reactions (O'Leary et al., 1972). Merriam-Webster (n.d.) defines the verb "bribe" as "to influence the judgment or conduct of (someone) with or as if with offers of money or favor." In the eyes of the layman, the use of TRs could easily be misconstrued, as the TR itself could be viewed as a bribe, as it is influencing the individual's behavior. Acknowledging this common misconception, behavior analysts must be prepared to defend and educate others on the use of TRs for positive behavior change. The crucial differentiator between bribes and TRs (and most reinforcers in general) is that bribes are generally considered coercive, whereas use of TRs are neutral. Bribes, in a corruption context, are used to benefit the influencer, not the individual behaving. Alternatively, TRs are used in behavior-analytic services to motivate and strengthen behavior to meet the diverse needs of the individual (Codes 2.13 and 2.14; BACB, 2020), such as increasing self-help skills (e.g., toothbrushing, cleaning, cooking, etc.) and social skills. This behavior change is neither illegal nor unethical in nature. Rather, the consequence of TR delivery is often designed to be ethically sound, benefitting the individual behaving rather than the influencer. For example, if the planned consequence of time spent on an iPad for the adaptive living skill of brushing one's teeth helps only to motivate and strengthen the individual's toothbrushing behavior, then there would be no benefit to the influencer (the behavior analyst).

Choice

In their thoughtful article, Bannerman et al. (1990) examined individuals with developmental disabilities' right to "eat too many doughnuts and take a nap." It is essential that behavior analysts respect the personal liberties and rights of individuals with intellectual and developmental disabilities across ages during service delivery (Code 3.01; BACB, 2020). Part of respecting their rights includes giving them the simple freedom to make their own choices. These opportunities for choice can be embedded into programming to ensure the individuals' rights are respected (Bannerman et al., 1990). As such, we recommend that behavior analysts give the individual opportunities for choice, and if the individual does not have the ability to make a choice in their repertoire, the behavior analyst should teach the individual how to do so. When providing an opportunity for choice of TRs (in which the individual has an opportunity to choose from two or more tangible items; Martin et al., 2006, as cited in Howell et al., 2019), behavior analysts should continually run SPAs to assess the individual's preferred choice of TRs (see prior section on SPAs for more information).

Changes in Ethicality of Tangible Reinforcers Over Time

Code 2.15 explains that behavior analysts must minimize the risk of harm for individuals (BACB, 2020), including minimizing the use of harmful reinforcers. More blatant examples of harmful TRs in today's society include, but are not limited to, nicotine products or weapons such as knives and guns. Although these may act to increase behavior, they can be harmful to the individual and those in the environment; therefore, they are generally regarded as dangerous and inappropriate. Despite these items being universally regarded as harmful today, it is important to note that the ethical use of TRs changes over time. For example, when smoking was more socially acceptable, tobacco was used in residential facilities as reinforcers (Bailey & Burch, 2013). Consequently, behavior analysts must be aware of the fluid nature of TRs and how ethical they are in relation to cultural and societal standards. This will require behavior analysts to stay in contact with the scholarly literature in order to monitor best practice recommendations as they evolve over time (Briggs & Mitteer, 2021; Carr & Briggs, 2010).

Quantity and Quality of Tangible Reinforcers Delivered

Edible Reinforcers

In order to minimize risk of harm to individuals (Code 2.15), behavior analysts should avoid using reinforcers that require excessive restriction to establish the necessary motivating operations (BACB, 2020). It might be tempting for behavior analysts to set aside an individual's water or lunch for an extended period of time to create a state of deprivation (as to increase the reinforcing effectiveness of water or food). Although it has been shown that programming periods of deprivation for a reinforcer prior to delivering it increases the effectiveness of a reinforcer (see Michael, 1993; Vollmer & Iwata, 1991), the appropriateness of this practice is largely based on the context and reinforcers involved. For example, a situation in which it would be appropriate to program periods of deprivation for a specific TR (or combination of TRs) could be during intensive toilet training given the importance of effectively teaching this skill in an efficient manner. For instance, a behavior analyst might withhold a piece of the individual's favorite candy (preferred reinforcer) during programming that occurs outside of a bathroom context, using the candy as a reinforcer only when the individual successfully voids in the toilet.

Behavior analysts, however, may cross ethical boundaries when they deprive individuals of food or water just to make the food or water more reinforcing as a TR (Bailey & Burch, 2013). On a larger scale, the deprivation of food and water can break the basic human, civil, and legal rights guaranteed to individuals with intellectual and developmental disabilities in the United States (Code 3.01; BACB, 2020; see The Arc, 2020; U.S. Equal Employment Opportunity Commission, n.d. for more information on basic human, civil, and legal rights of individuals with intellectual and developmental disabilities). Behavior analysts must carefully analyze the function of programming for deprivation of edible reinforcers. In certain circumstances, such as the treatment of severe instances of self-injurious behavior, programming deprivation of edible reinforcers (outside of regularly scheduled meals) may be an appropriate intervention given limited reinforcers and an urgent need to motivate positive behavior change. In other circumstances, deprivation of edible reinforcers for treatment of minor, non-severe behaviors (e.g., programming for deprivation in order to increase letter identification) may not be as appropriate and could cross the ethical boundary if the individual is deprived of their basic, civil, and legal rights to consuming edibles.

Opposite of deprivation, Code 2.15 can be debated in the context of overconsumption of healthy and unhealthy foods. Common foods that are more readily regarded as unhealthy (and thus more readily regarded as harmful reinforcers) include candy, chips, fast food, and desserts. To mitigate the unhealthiness of these reinforcers, behavior analysts often allot a small amount to the individual (e.g., one mini chocolate chip, one small potato chip, one skittle, one bite of a dessert, etc.). Conversely, this mitigation might not be as readily practiced when edibles are considered healthier for the individual, such as fruits, vegetables, or nuts. Regardless of the type of edible, we believe it essential for behavior analysts to take data on how much of each edible is delivered as any edible in excess can cause harmful side effects for the individual. As discussed previously, if an excess of edibles (especially those that are unhealthy) are provided to the individual as reinforcers, potential harmful health effects can occur. Further, overconsumption of foods that function as reinforcers may interfere with structured mealtimes or limit the opportunity for healthier foods to be introduced (and accepted) if the individual feels sufficiently sated.

Other strategies can be used to alleviate the harmful effects of negative reinforcers. When unhealthy foods are preferred by the individual, behavior analysts must attempt to thin the schedule of reinforcement for the unhealthy edible reinforcers. In general, this may consist of delivering a small amount of an edible reinforcer (e.g., one piece of chocolate candy) following every 10 task completions instead of every five (see Chap. 6 within this handbook for further discussion of reinforcer thinning). An alternative method that behavior analysts may consider is to transition to nonedible reinforcers through reinforcement thinning or a pairing procedure. Lastly, if the thinning of potentially harmful edible reinforcers is not feasible, one might consider introducing a healthy alternative to replace the unhealthy edible. This introduction can take multiple forms, including gradual exposure plus escape extinction procedures or simply finding and introducing a healthy alternative to the preferred edible, such as natural fruit chews instead of artificially flavored fruit gummies (see Chawner et al., 2019; Tanner & Andreone, 2015).

Screen Time

Devices with screens, such as iPads, tablets, televisions, or video game devices, are often utilized in ABA treatment as TRs. Devices that utilize screen time often act as potent TRs. By this, we mean that these devices can be used to access a variety of reinforcing activities and applications (from watching videos to playing games) that all may act as reinforcers to the individual. Due to the immense number of reinforcing activities available on these devices, individuals are likely to access high-quality reinforcement continuously (e.g., through the completion of a level of a game, listening to a song, watching a video/show, reading a story, etc.) and easily without satiation occurring within this one stimulus (Hoffman et al., 2019). Given that individuals display a strong preference for these highly valued items, attempting to remove them following a reinforcement interval oftentimes evokes problem behavior. Although this indicates the need to teach delay and denial tolerance training, caregivers may just avoid using these very potent reinforcers altogether in order to prevent instances of problem behavior.

Devices that utilize screens are potent TRs and have been associated with potential harmful effects to the development of young children with and without intellectual and developmental disabilities (such as cognitive, expressive language, receptive language, and social/communication delays; American Academy of Pediatrics [AAP] Council on Communications and Media, 2016; Canadian Paediatric Society, 2017; Hill et al., 2020). Researchers have postulated that these harmful effects could be caused in part by screen time replacing time spent in developmentally enriching activities and tasks, thus interfering with opportunities for learning and growth related to behavioral, cognitive, and motor development (Madigan et al., 2019; Pagani et al., 2010). Behavior analysts must be aware of the harmful effects and know where the line is for the amount of screen time that is ethical under Code 2.15 (BACB, 2020). The AAP recommends the following screen times based on age: (a) no screen time other than video conferencing for children less than 18 months; (b) only high-quality programming (such as slow-paced television shows or media like those found on PBS or Common Sense Media) for a limited amount of time per day (e.g., less than 1 hour), under parental supervision for children aged 18–24 months (as children in this age range require parental reteaching of media content to facilitate learning); (c) 1 hour of high-quality programs (no use of media) for children ages 2–5 years; (d) and limited time spent on media so that it does not interfere with children's sleep, physical activity, or healthy behaviors for children over the age of 6 (AAP, 2016; AAP Council on Communications and Media, 2016).

To help mitigate the harmful reinforcer effects, especially for individuals younger than 5 years old, we recommend that behavior analysts limit screen time (e.g., make other reinforcers available) as much as possible and attempt to follow the recommendations from the AAP (see Trinh et al., 2020 for more information). With this, it is necessary for behavior analysts to coordinate with the individual's caregivers to determine their preferences for the child's screen time during service delivery. For example, if caregivers rely on screen time during certain times of the day (e.g., while they are making a meal) and the child meets the recommended screen time duration from the AAP during these activities, the behavior analyst may need to have an important conversation with the caregiver about where and when the duration of screen time can be reduced across the day and during therapy so that it can be ethically utilized as a potent reinforcer during teaching sessions. However, if there are barriers to limiting screen time outside of sessions, we suggest behavior analysts follow the recommendations found in AAP Council for Communications and Media (2016), including making sure that content consists of high-quality programming and ensuring opportunities to socially interact (co-view; Mendelsohn et al., 2010) with the child to help them apply what they are seeing to their environments.

Concluding Remarks

We suspect behavior analysts will continue to rely on the use of TRs as consequences in skill acquisition and behavior reduction programming for the foreseeable future. Therefore, we hope that the conceptual overview and practical and ethical considerations for incorporating TRs into practice presented within this chapter serve as a useful resource for current and future behavior analysts in training. Finally, because most TRs are extrinsic in nature (O'Leary et al., 1972), behavior analysts should avoid overdependence on TRs during skill acquisition and behavior reduction programming, especially for individuals with restricted interests. As such, behavior analysts should plan to thin reinforcement as soon as possible in programming (see Chap. 6 within this handbook for further discussion of reinforcer thinning) in order to promote generalization and maintenance of behavior change outcomes.

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5 Automatic Reinforcement

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Introduction and Support for Automatic Reinforcement

The role of the environment in shaping behavior has been well described and supported by behavior analytic research (e.g., Skinner, 1938, 1957). Specifically, direct reinforcement has been found to maintain both appropriate (e.g., Falcomata et al., 2013) and inappropriate behaviors (e.g., Iwata et al., 1982/1994). Automatic contingencies have been inferred when an immediate external consequence, typically mediated by another person, is not readily apparent (Vollmer, 1994). For instance, it is often presumed by applied behavior analysts that problem behavior not sensitive to social consequences is likely maintained by the "natural" or intrinsic products of that behavior. That is, behavior is maintained by the sensory consequences engaging in the response produces. Previous research has identified many topographies of presumably automatically reinforced problem behavior including stereotypy (e.g., Rapp & Vollmer, 2005), self-injury (e.g., Iwata et al., 1982/1994), and aggression (Thompson et al., 1998). In the case of self-injury, the hypothesized automatic reinforcer has included auditory (Rincover & Devany, 1982), oral (Favell et al., 1982), and tactile (Goh et al., 1995) stimulation. However, because these plausible reinforcers are not accessible to an observer, the operant mechanism maintaining these responses is often unclear.

Automatic contingencies (see Fig. 5.1) include both positive and negative reinforcement and punishment (Vaughan & Michael, 1982). In automatic positive reinforcement, the behavior produces a reinforcing stimulus such as in problem-solving (e.g., engaging in the necessary chain of covert responses is reinforced by "the solution"; Skinner, 1953). In automatic negative reinforcement, behavior is reinforced by the removal or reduction of aversive stimulation, such as in problem behavior that results in pain attenuation (e.g., scratching a bug bite relieves the itching) or in verbal behavior that has been shaped by conditioned aversive properties (e.g., saying "um" while formulating an appropriate response to avoid aversive stimulation of silence). Lastly, in the case of automatic positive or negative punishment, the behavior itself results in

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_5

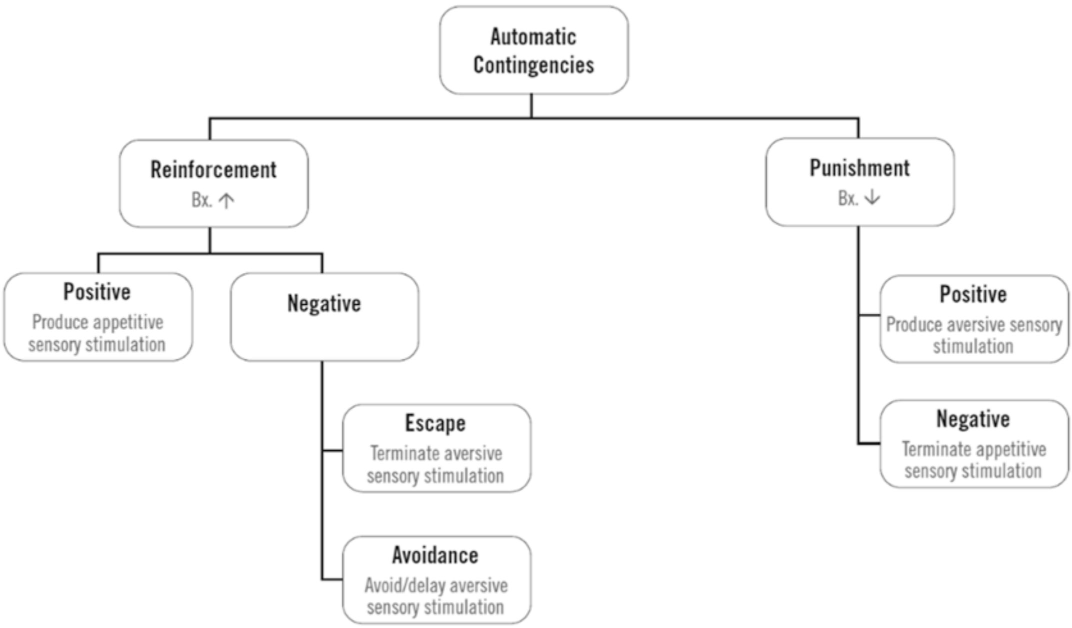

Fig. 5.1 Automatic Contingencies

aversive stimulation (i.e., automatic positive punishment) or in the removal or reduction of appetitive stimulation (i.e., automatic negative punishment), thus decreasing the probability of that response being emitted in the future. The concept of automatic contingencies was also widely used by Skinner in his writings, such as in *Science and Human Behavior* (1953) and in *Verbal Behavior* (1957), to allow for an operant analysis of responses lacking observable sources of reinforcement, such as babbling, problem-solving, and thinking.

Support for the existence of automatic contingencies is available for both research on acquisition of verbal behavior and on the assessment and treatment of disruptive behavior. For instance, findings of previous research suggest that verbal stimuli may be naturally reinforcing (e.g., Matasaka, 1999), reinforcing due to prenatal (e.g., Mampe et al., 2009) or postnatal (e.g., Sundberg et al., 1996) conditioning, or due to achieving parity (e.g., Ostvik et al., 2012). For instance, Matasaka (1999) assessed preference for infant-directed singing (i.e., slower tempo and higher pitch) in 2-day-old hearing infants of deaf families whose primary language was Japanese Sign Language. In this study, newborns preferred infant-directed singing independent of whether the song was in Japanese or English, suggesting that this preference is innate. Mampe and colleagues evaluated the melody in newborns' cry (2–5 days old) from either French or German monolingual families. This study found that melody and intensity differed across the two groups and that it matched the intonation patterns observed in the German and French languages. A plausible interpretation of these findings is that aspects of French and German language were conditioned as reinforcing during prenatal development and that newborns' vocalizations conformed to the vocalizations of their verbal community. A stimulus-stimulus pairing (SSP) procedure was employed by Sundberg et al. to attempt to condition verbal stimuli as a reinforcer and increase vocalizations of five children. In this study, the target vocal stimulus was paired with a reinforcer and no consequences were provided contingent on vocalizations emitted by the participants. In this study frequency of vocalizations increased, although at varying degrees, for all participants (see Shillingsburg et al., 2015 for a literature review on the SSP procedure). Finally, in regard to automatic reinforcement from achieving parity, Ostvik and colleagues evaluated the impact of modeling on the acquisition of the passive voice with Norwegian-speaking children. In this study, modeling alone led to the use of passive construction by 5 out of the 6 participants.

In regard to problem behavior, results of functional analyses and research on sensory extinction, environmental enrichment, contingent access to automatically reinforced behavior, and behavior momentum corroborate the existence of automatic contingencies. For example, in cases where problem behavior persists in the absence of social contingencies (e.g., alone or no interaction session of a functional analysis), it is presumed that the behavior produces its own reinforcer. However, Vollmer (1994) noted that other mechanisms, such as elicitation, or a history of lean reinforcement in the natural environment, may lead behavior to persist in the absence of social consequences. In sensory extinction, the contingency between the target behavior and its sensory product (its presumed reinforcer) is disrupted in some fashion (e.g., Rincover et al., 1979), typically by blocking the behavior or masking its sensory consequences. For instance, Rapp et al. (2000) decreased hair manipulation by requiring the participant to wear gloves that minimized the sensory products (likely tactile) resulting from engaging in the target behavior. Results of this study suggest that sensory consequences are likely the reinforcers (automatically produced) of certain problem behavior. In the case of environmental enrichment, a plausible inference is that manipulation of items and engagement in the target behavior produce sensory consequences, and that in some cases, these responses are members of the same operant class because they result in similar (i.e., matched) consequences (Rapp & Vollmer, 2005). For instance, research suggests that noncontingent access to matched stimulation (e.g., Piazza et al., 2000) and preferred competing items (e.g., Ahearn et al., 2005) suppresses problem behavior. These findings indicate that, at least in some cases, problem behavior and item manipulation result in similar appetitive consequences (i.e., are members of the same response class) that are not socially mediated.

Another source of evidence relative to automatic contingencies comes from studies that have used contingent access to automatically reinforced disruptive behavior to increase other responses (e.g., Charlop et al., 1990; Potter et al., 2013). For instance, Potter et al. increased leisure engagement and decreased stereotypy using a combination of prompts, response blocking, and differential reinforcement. Moreover, intervention components were introduced successively, starting with access to leisure items, prompts to engage with these items, blocking of stereotypy, and then reinforcement of item engagement with access to stereotypy. Results indicated that although leisure engagement increased during the previous phases, stereotypy decreased only when access to stereotypy was contingent on item engagement. As noted by the authors, results suggested that the reinforcement produced by leisure engagement did not compete with reinforcement resulting from stereotypy. In addition, as discussed by Rapp and Vollmer (2005), according to the response deprivation hypothesis (Timberlake & Allison, 1974), withholding access to an automatically reinforced behavior, such as stereotypy, results in a period of deprivation (EO manipulation) and thus should increase the future reinforcing value of the sensory products of that response. The inverse should then occur when prior access to stereotypy (AO manipulation) is in effect. This hypothesis has been evaluated with both socially reinforced behavior (e.g., McComas et al., 2003) and presumably automatically reinforced stereotypy (e.g., Rapp et al., 2004), and the results of these studies were consistent with the response deprivation hypothesis. The results of the aforementioned studies lend additional indirect support for the existence of automatic contingencies by demonstrating that the products of these responses have reinforcing effects (e.g., stereotypy; Charlop et al., 1990) and that this effect is sensitive to motivating operations just as is the case with other operant behavior (Rapp et al., 2004).

Lastly, research informed by the behavior momentum metaphor provides strong, if not definitive, support that automatic contingencies are responsible for the acquisition and/or maintenance of some problem behavior. Nevin's behavioral momentum theory (1984, 1988, 1992) asserts that environmental variables such as contextual stimuli and reinforcer delivery can be used to describe and predict the persistence of operant behavior. A number of investigations (e.g., Dube & McIlvane, 2001; Mace et al., 1990; Sweeney et al., 2014) have shown that when response-independent reinforcers are added to an already existing contingency, behavior was more likely to persist when the contingency was disrupted (e.g., extinction was implemented). Specifically, Sweeney et al. conducted two experiments, one with pigeons and another with children with disabilities, evaluating the impact of analog sensory reinforcers (e.g., animated fireworks display paired with a chime in the experiment with children) on behavior persistence when extinction was implemented following differential reinforcement of alternative behavior (DRA) and noncontingent reinforcement (NCR) conditions. In this study, resistance to extinction was greater when sensory reinforcers were available relative to the absence of sensory reinforcers. The results of these studies support the behavior momentum assertion that behavior, that is discriminated operant responding, is more resistant to change when reinforcement is dense relative to when a lean schedule of reinforcement is in effect.

Results of previous research have also shown that automatically reinforced stereotypy conformed to the prediction of the momentum metaphor (e.g., Ahearn et al., 2003). In this study, stereotypy was higher (more resistant to change) in the test conditions that were preceded by the free reinforcer (VT) condition. This effect was likely due to a history with added reinforcers in that context (a stimulus-reinforcer relation). These results suggest that the stereotypy, presumably maintained by automatic reinforcement, was likely discriminated operant responding. Similarly, in the study by Sweeney et al. socially reinforced responses (i.e., key pecking for pigeons; touching a screen for children) were more resistant to extinction following a condition in which sensory stimulation (e.g., animated fireworks) was available and this effect was independent of the contingency for socially mediated reinforcers (i.e., DRA or NCR). These results indicate that automatic reinforcers play a role in the maintenance of operant responses and that the addition of sensory reinforcers impacted socially mediated responses in a manner consistent with the momentum metaphor.

In summary, applied studies on verbal behavior and the assessment and treatment of problem behavior provide some evidence for automatic contingencies. However, as Rapp and Vollmer (2005) proposed, sensory extinction and environment enrichment provide only indirect support for the existence of automatic contingencies by showing that these behaviors are likely maintained by an unobservable reinforcer (sensory input). Research on the contingent access to these responses and on whether presumably automatically reinforced behavior conforms to the response restriction hypothesis provides further indirect evidence that the product of these responses is reinforcers. In these cases, data are interpreted based on the available information, and a plausible explanation is inferred (i.e., a post hoc analysis). Simply demonstrating that contingent access to a response in which sensory consequences are likely putative increases another response, however, is not sufficient evidence that the response is operant in nature because similar effects have been shown when the contingency involved a reflex. For instance, López et al. (1999) found that running time was shorter when it resulted in ejaculation compared to when it resulted in either intromission or no sexual contact. However, research on behavior momentum has provided a tool to demonstrate some functional control over these presumably automatically reinforced responses.

As noted above, results of functional analyses alone do not provide definitive proof for the existence of automatic contingencies (Vollmer, 1994). Nevertheless, because topographically similar and different responses may belong to the same or different response classes (e.g., head-directed SIB with social and automatic function; Hagopian et al., 2017), functional assessments are warranted to determine the variables responsible for the maintenance of disruptive behavior. Furthermore, functional assessments have allowed for the identification, and subsequent treatment, of various topographies of problem behavior presumably to be automatically reinforced (e.g., Berg et al., 2016). Thus, given the current technology available to behavior analysts, the first step in the intervention planning for problem behavior in which the source of reinforcement is not conspicuous must be a functional assessment.

Common Topographies of Automatically Reinforced Problem Behavior

Although various topographies of disruptive behavior have been shown to be maintained by automatic reinforcement, self-injurious behavior (SIB), stereotypy, higher-order restricted and repetitive behavior (HRRB), and inappropriate sexual behavior (ISB) are common in people with autism spectrum disorder (ASD) and related disabilities. Therefore, in describing assessments and interventions for automatically reinforced behavior, this chapter will focus on examples that relate to these topographies of disruptive behavior.

SIB is a class of behaviors resulting in physical harm to the individual emitting the behavior (Tate & Baroff, 1966). Common topographies of SIB include, but are not limited to, bruxism, head-banging/hitting, self-biting, hand mouthing, body hitting, pica, rumination, self-scratching, hair pulling, eye-poking, skin picking, pinching, and kicking (Shawler et al., 2019). Moreover, the prevalence of SIB among individuals with intellectual or developmental disabilities is 5–41% (Cooper et al., 2009). Rumination, the voluntary regurgitation, chewing, swallowing, or expulsion of stomach contents (Lang et al., 2011), and pica, the consumption of non-nutritive, nonfood substances (Moline et al., 2020), are two topographies of SIB that can result in severe medical problems (Fields, 2019; Wilder & Lipschultz, 2016) and, in the case of pica, even death (Williams & McAdams, 2012) and thus warrant particular attention by clinicians.

Stereotypy consists of repetitive, persistent, and invariant responses that are not contextually appropriate (e.g., Hagopian & Toole, 2009; Rapp & Vollmer, 2005) and can include motor or vocal topographies (i.e., motor (MS) and vocal stereotypy (VS)). Stereotypy is often present during an early age; however, for typically developing children, these behaviors often diminish without requiring intervention; for children with ASD who do not receive treatment, these behaviors tend to persist and increase in severity (Digennaro Reed et al., 2012; MacDonald et al., 2007). ASD is associated with the highest prevalence rate (88%) of stereotypy compared to other diagnoses (Chebli et al., 2016), and on average, 51.8% and 54% of individuals with ASD engage in motor stereotypies (Melo et al., 2020) and in vocal stereotypies (Chebli et al., 2016), respectively. Although repetitive behaviors do not often result in injury, both MS and VS have been found to emerge into more severe forms of stereotypy that persist into adulthood and can impact an individual's adaptive, social, and academic functioning (Crutchfield et al., 2015; Lanovaz, et al., 2013; Akers et al., 2020).

Higher-order restricted and repetitive behaviors (HRRB) are a type of complex stereotypy that can encompass various behavioral topographies. Specifically, these behaviors can be characterized as an individual's rigid adherence to a rule or mental set that can present as compound chains of behavior. Behaviors might include repetitively acting out scenarios in certain environments, insisting parents drive the same route home each day, or consistently straightening, hoarding, or organizing objects (Boyd et al., 2012). RRBs can be broken down into ritualistic behavior and compulsions, which can be found in both ASD and obsessive-compulsive disorder (OCD) diagnoses. However, given that restricted and repetitive behavior (RRB) and interests are a core diagnostic feature of ASD, all children with ASD engage in some form of this behavior. Moreover, in children with ASD, lower-order RRB remain relatively high and stable over time, whereas insistence on sameness, or HRRBs, starts low in prevalence and severity but increases and worsens over time (Richler et al., 2010). Given the overlapping symptomology of ASD and OCD, it is estimated that 17–37% of young people with ASD also experience OCD symptoms (Leyfer et al., 2006). Moreover, a recent study by Martin et al. (2020) found that 25% of youth with OCD also had a diagnosis of ASD, while 5% of those with ASD had a diagnosis of OCD. Thus, it is important to discuss each type of HRRB in regard to the distinguishing factors of each.

Although ritualistic behaviors and compulsions may share the same topography, it is suggested that repetitive behavior in children with ASD may provide a source of pleasure (i.e., automatic positive reinforcement), whereas compulsions are emitted to relieve anxiety (i.e., automatic negative reinforcement; Zandt et al., 2007). Specifically, compulsions are unique in that the individual experiences a type of urge that builds in intensity and can cause significant stress and discomfort when the behavior cannot be carried out (American Psychological Association, n.d.). These urges are a key diagnostic criterion for OCD. However, if the individual also presents with cognitive or language impairments similar to ASD, a comorbid diagnosis of ASD and OCD is not uncommon (Martin et al., 2020; Zandt et al., 2007). These higher-order behaviors are of concern because interruption or prevention of these behaviors often evokes challenging behavior such as tantrums or aggression (Sigafoos et al., 2009).

No consensus exists on what constitutes ISB. For instance, Brown and Barrett (1994) defined inappropriate sexual behavior as sexual offenses or abuse, whereas Tarren-Sweeney (2008) classified sexual behavior that was developmentally and socially inappropriate as ISB. Furthermore, sexual behavior which could result in injury or distress of others (Tarren-Sweeney) or sexual behavior (e.g., public masturbation) that occurs at high levels and thus impedes completions of other activities also constitutes ISB (Hingsburger, 1994). Examples of ISB include nonconsensual sexual interaction or contact, public masturbation, disrobing in public, sexual behavior with inappropriate objects, looking down others' shirts or up others' skirts, and sexually explicit talk (Clay et al., 2018; Tarren-Sweeney, 2008). It is estimated that as many as 6–28% of individuals with intellectual or developmental disabilities (IDDs) engage in ISB (Ruble & Dalrymple, 1993, as cited in Falligant & Pence, 2020) and that sex offenses are the causes of 14–26% of criminal convictions of persons with intellectual disabilities (IDs; Day, 1997). In addition, 65% of caregivers of children with ASD indicated in response to a survey that their child had touched their genitals in public (Ruble & Dalrymple, 1993; cited by Davis et al., 2016).

Functional Assessment

According to Hanley (2012), a functional assessment consists of a process to identify the variables responsible for the maintenance of problem behavior. There are three types of functional assessments: indirect (e.g., interview, rating scales), descriptive (e.g., antecedent-behavior-consequence recording), and functional analysis. A functional analysis (FA; Iwata et al., 1982/1994) involves direct observation and measurement of the target problem behavior while systematically manipulating the environment to assess the impact of environmental variables on problem behavior. FA is the only type of functional assessment that allows for an experimental demonstration of a functional relation between a behavior and reinforcer(s). As such, FA is considered the gold standard in functional assessment technology (Hagopian et al., 2013).

Iwata and colleagues were the first to describe the use of FA to identify the functional reinforcer for problem behavior. In this study, FAs were completed in a multielement format and included test conditions for access to attention and escape, automatic reinforcement, and a control condition (i.e., play). Sessions were 15 min in length, and data were recorded on the occurrence of target behavior. Although many refer to the procedures described by Iwata and colleagues as the "standard functional analysis," it is imperative to note that FA conditions should be individualized, based on results of an indirect assessment alone or in combination with a brief descriptive assessment, for each client. Furthermore, since the publication of this study, various studies have demonstrated the utility of iterations of FA procedures in identifying the function of problem behavior (see Beavers et al., 2013 for a review).

The identification of automatically reinforced behavior, however, is often done by reviewing data on the occurrence of the target behavior during alone or no interaction sessions (e.g., Roscoe et al., 2013; Querim et al., 2013). It is presumed that if responding persists during conditions when behavior does not result in a programmed consequence, then its functional reinforcer must be the sensory consequences produced by the behavior itself. In the case of an FA that includes multiple conditions, an automatic function is presumed when responding persists across all conditions (e.g., Roscoe et al. 2013), or all test conditions but not the control (i.e., play) condition (e.g., Iwata et al., 1994). In cases when responding persists across all conditions, a series of alone or no interaction sessions is usually completed to rule out multiple sources of reinforcement and further support an automatic function (e.g., Roscoe et al., 2013; Vollmer et al., 1995).

Modifications to the FA technology have also been made specifically to identify or rule out an automatic function. For instance, after presuming an automatic function, Roscoe et al. (2013) omitted the play condition and conducted more frequent alone or no-interaction sessions (i.e., 2:1 ratio of alone to attention and to demand conditions) to identify the functional reinforcer of hand mouthing. In this study, the initial FA, which omitted the play condition, successfully identified the function of hand mouthing for 72% (46 out 64) of cases suggesting that this design can increase the efficiency of FA in cases where behavior is presumed to be automatically reinforced.

To further increase the efficiency of the functional assessment process, Querim et al. (2013) evaluated correspondence between results of a screening procedure (i.e., automatic screen) and that of FAs, including multiple conditions in identifying problem behavior maintained by automatic reinforcement. The screening procedure consisted of a series of repeated alone or no interaction sessions that were conducted prior to the multi-condition FA (i.e., attention, demand, and play). In this study, results of the initial screening alone were sufficient to determine whether problem behavior was maintained by automatic or social reinforcement for 28 out of the 30 cases. More specifically, in cases where problem behavior did not persist during the automatic screen, subsequent FA results indicated that problem behavior was maintained by either access to attention or escape from demands, whereas when problem behavior persisted in the automatic screen, results of the FA confirmed an automatic function.

As previously discussed, there are multiple automatic contingencies, and although an FA permits the identification of problem behavior maintained by automatic reinforcement, it does not identify the specific automatic contingency responsible for maintenance of the behavior, making decisions about the best treatment difficult. However, recent research by Hagopian et al. (2015) has used results of FAs (i.e., patterns of responding during FA) and the presence of self-restraint to classify automatically reinforced SIB (ASIB) into subtypes which presumably are maintained by different types of automatic contingencies. Accordingly, Subtype 1 consists of ASIB that occurs at high levels in the alone condition and low levels in the play condition; Subtype 2 refers to ASIB that occurs at high, but potentially variable, levels across all conditions; and for individuals who engage in self-restraint, ASIB is classified as Subtype 3. The authors then investigated whether differences existed in response to treatment for the three subtypes of SIB. For individuals with Subtype 1, access to alternative reinforcement (e.g., preferred activities or materials) was more likely to decrease ASIB compared to Subtype 2 and that reinforcement-based interventions alone were effective in reducing ASIB in most of the cases of Subtype 1 but never effective for Subtype 2. Reinforcement alone was not evaluated with Subtype 3, which required restraint during treatment to prevent injury. That is, more intensive treatments (i.e., interventions with more than two components or that included restraints) were needed for Subtypes 2 and 3, whereas less intrusive interventions were effective for individuals with Subtype 1. Similar results were attained by Hagopian et al. (2017). Thus, it is possible that by analyzing FA results in regard to patterns of responding, certain treatments may be more viable than others.

Given the current status of FA technology for automatically reinforced behavior, for topographies of problem behavior with a presumed automatic function other than SIB, our recommendation is to begin with an automatic screen. Although the automatic screen does not permit the identification of problem behavior with multiple functions (e.g., automatic plus a social function) or the identification of the specific social reinforcer responsible for maintenance of problem behavior, results of Querim et al. (2013) suggest that in most cases where an automatic function is presumed, it is possible to implement an intervention following results of automatic screening. However, in the case of rumination, it is important to consider timing of assessment in relation to meals. For instance, in Wilder et al. (2009), rumination occurred across all conditions of the FA completed after a meal but did not occur during sessions conducted before the meal. Additionally, for an FA of pica, clinicians must bait the room with edible and nonedible items that are safe for consumption (e.g., rice, beans, pasta, turnips (e.g., Piazza et al., 2002); rice paper, fondant (Mitteer et al., 2015)) and, whenever possible, resemble items the individuals often consume (e.g., licorice jelly beans for rocks; Wasano et al., 2009), and block attempts to consume non-baited items (Mitteer et al., 2015).

Nevertheless, in the case of SIB, results of an FA with multiple conditions in addition to information on the occurrence of restraint are necessary to identify the subtype of ASIB (Hagopian et al., 2015, 2017). Thus, we suggest a more comprehensive FA that also includes a control condition and tests for social reinforcement. Results of the FA must then be used to guide treatment selection. For instance, reinforcement-based interventions alone do not appear to be appropriate for Subtype 3 ASIB, whereas access to competing items may be a good starting intervention for Subtype 1 ASIB (Hagopian et al., 2015). Berg et al. (2016) also suggest that if an automatic function is presumed from the FA, a pairwise comparison between NCR and an ignore/alone condition can be used to guide treatment selection. Specifically, if differentiated responding is obtained during the pairwise analysis, then a treatment based on NCR should be employed first. However, if no differentiation is observed, then a concurrent operant assessment with blocking should be completed and for participants that engage with alternative stimuli, treatments involving the manipulation of the availability of reinforcers (i.e., differential reinforcement plus response cost) should be evaluated, and for those that continue to engage in problem behavior, response blocking should be employed.

In regard to HRRB, after attaining inconclusive FA results, Roscoe et al. (2015) used results from additional indirect and descriptive assessments to design a pairwise FA in which access to fix items was manipulated. In the control condition, Jim was allowed to fix and rearrange items in the room and no consequences were provided for aggression. Prior to the onset of the test condition, the researcher allowed Jim to briefly arrange placement of the items in the room but then, while Jim was outside, disrupted the arrangement of these items; during the session the researchers blocked Jim's attempts to rearrange items but the participant was given access to "fixing" contingent on aggression. Higher levels of aggression were observed in the test compared to the control condition, indicating that Jim's aggression was maintained by access to fixing items. Similar methodologies have been used to identify the functional reinforcer for unique rituals such as repeatedly opening and closing doors (Hausman et al., 2009), throwing away important items (Kuhn et al., 2009), arranging game pieces in a straight line (Leon et al., 2013), and access to specific routines (e.g., watching certain shows, lining up or stacking foam letters/trains, and rapidly turning book pages; Rispoli et al., 2014). These results suggest that in the case of HRRBs, results of indirect and direct assessments should be used to design individualized test and control conditions for the FA.

Finally, in the case of pica, rumination, and SIB, before conducting any type of assessment, first a medical evaluation to identify or rule out medical causes (e.g., medication side effect causing rumination (Rogers et al., 1992); iron, zinc, or calcium deficiency leading to pica (Edwards, 1960)) for these behaviors is necessary. Furthermore, clinicians should complete a risk assessment (e.g., Deochand et al., 2020) to determine whether it is possible to complete an FA while ensuring the safety of the participant and implementer. To determine a level of risk (slight, moderate, substantial, and high risk) associated with conducting an FA, the risk assessment tool (a downloadable excel® file) provided by Deochand et al. takes into consideration the level of clinical experience of the person considering conducting an FA, the safety of the environment in which the assessment will be conducted, access to support staff such as medical professionals, and the intensity of the target behavior. In addition, if results deem that an FA is associated with substantial or high risk of injury to the participant, the tool describes ways to reduce the risk of conducting the FA (e.g., seeking additional support staff; conducting a latency-based functional analysis; Thomason-Sassi et al., 2011). Furthermore, this tool includes an extensive list of published resources and description of modifications to FA methodology; thus, this tool may be helpful for all clinicians considering conducting an FA.

Interventions for Automatically Reinforced Problem Behavior

Various behavioral interventions alone or as part of a treatment package have been identified as effective in reducing automatically reinforced SIB, stereotypy, HRRB, and ISB. Here we name and describe some of these interventions and divide them into antecedent-based (i.e., environmental manipulations that occur before the target behavior) and consequence-based interventions (i.e., environmental manipulations that occur after appropriate behavior or the target behavior is emitted). Whenever possible, specific information related to intervention for rumination and pica are included. We then conclude this section with suggestions for future research and clinical recommendations. It is important to note that this is not an exhaustive list and that omission of an example for a particular topography of problem does not imply the intervention has not been used for that disruptive behavior. Furthermore, in much of the published studies on ISB, a functional assessment was not included thus the operant reinforcer for ISB was unclear.

Antecedent-Based Procedures

Noncontingent Reinforcement (NCR)

NCR involves delivering preferred or reinforcing stimuli on a response-independent, time-based, or continuous schedule (Cooper et al., 2019) and it is sometimes referred to as environmental enrichment (Watkins & Rapp, 2014). In previous research, NCR procedures have included access to preferred items (e.g., Watkins & Rapp, 2014), competing items (i.e., associated with high levels of engagement and low levels of disruptive behavior; e.g., Lindberg et al., 2003), or matched stimulation (i.e., stimuli that produce sensory stimulation similar to that resulting from the target behavior; e.g., Lanovaz et al., 2009). NCR has been shown to reduce various topographies of automatically reinforced behavior including SIB (e.g., hand-mouthing, head hitting, forcibly rubbing arms; Lindberg et al., 2003), rumination (e.g., Wilder et al., 2009), pica (e.g., Saini et al., 2016), stereotypy (e.g., Lanovaz et al., 2009), HRRB (e.g., Sigafoos et al., 2009), and ISB (e.g., Kelly & Simpson, 2011).

In regard to SIB, Lindberg et al. (2003) decreased SIB by providing access to competing items (e.g., stringing beads, coloring books) during brief (10 min) sessions with access to a single stimulus and extended (120 min) sessions with various stimuli available. Results of the study indicate that NCR reduced SIB for all participants and that during extended periods, the use of varied competing stimuli was beneficial to prevent satiation. Wilder et al. (2009) reduced rumination by providing access to a preferred food spray (i.e., apple pie) on a 2-s fixed-time (FT) schedule. The schedule was then thinned to FT 10 s and the participant was taught to self-administer the spray. For pica, Saini et al. (2016) assessed the effects of access to competing stimuli (e.g., tone pipe, pretzels, vibrating teether, teething keys) and response blocking for two individuals who engaged in automatically reinforced pica. NCR and response blocking successfully decreased pica. Treatment package was more effective compared to NCR alone for the participant with whom NCR alone was also evaluated.

For stereotypy, Watkins and Rapp (2014) used environmental enrichment consisting of free access to preferred stimuli (e.g., moon dough, DVD) in combination with a punishment procedure (e.g., response cost consisting of removal of preferred stimuli) to decrease levels of stereotypy (e.g., finger twisting, non-contextual vocalizations, object stereotypy, ear play). Matched stimulation in the form of noncontingent music (Gibbs et al., 2018; Love et al., 2012) or access to toys that produced auditory stimulation (e.g., musical toys; Lanovaz et al., 2009) has been used to decrease VS. Furthermore, in Lanovaz et al. (2012), access to preferred songs led to greater reduction of VS than songs identified as non-preferred.

In regard to HRRB, Sigafoos et al. (2009) utilized an enriched environment approach to reduce object rearrangement. Specifically, during the intervention phase the participant was offered a choice between two preferred activities (e.g., book or puzzle), the therapist modeled correct use of the materials, provided them to the participant, and then either stepped away and removed attention (choice condition) or remained next to the participant and interacted (e.g., vocalizations and gestures) with them for 60 s (choice plus social interaction condition); neither condition included prompting for leisure engagement or blocking of object rearrangement. Object rearrangement decreased compared to baseline for both treatment conditions, but more robust effects were observed for choice plus social interaction. Lastly, for ISB, Kelly and Simpson (2011) evaluated the impact of redirection and timeout (i.e., standard intervention) alone or in combination with an NCR component (i.e., fixed-time access to a sex worker) and found that although redirection in combination with timeout led to a decrease in ISB, the addition of the NCR component was necessary to decrease ISB to near-zero levels.

Discrimination Training

During discrimination training, also referred to as stimulus control procedures (e.g., Gould et al., 2019) or multiple schedule training (Slaton & Hanley, 2016), visual stimuli (e.g., green and red cards) signal when a reinforcer is available (discriminative stimulus; SD) or unavailable (S-delta). Discrimination training has been used to decrease stereotypy (e.g., Conroy et al., 2005) and ISB (e.g., Walker et al., 2014) during specified contexts. For instance, in Conroy et al. (2005), MS that occurred in the presence of a 3-in white card with a red circle (i.e., SD) produced no consequences; however, if the participant engaged in MS in the presence of a 3-in white card with a red circle and line through it (i.e., S-delta), the researchers reoriented the participant to the visual cue and vocally reminded them that engaging in MS was inappropriate at that time (i.e., reprimand). Lower rates of MS were observed during the S-delta condition in comparison to the SD condition, indicating that stimulus control over stereotypy had been established. In regard to ISB, Walker et al. (2014) used verbal instruction specifying which stimuli the participant should or should not become aroused, to teach one of the participants to suppress his sexual arousal in the presence of children (inappropriate stimuli) but not in the presence of adults (appropriate stimuli).

Increasing Response Effort

Another intervention to decrease automatically reinforced behavior involves increasing the effort associated with emission of the target response. For example, Van Houten (1993) assessed the use of wrist weights for a participant who engaged in self face-slapping maintained by automatic reinforcement. In this study, when the wrist weights were worn for 30 min daily, SIB decreased during all three observation periods. Treatment effects were maintained during a follow-up conducted 5 months after the study had been completed.

Cognitive Behavior Therapy (CBT)

CBT is a psychological treatment that aims at improving functioning and quality of life by changing covert (i.e., thinking; feelings) and overt behavioral patterns (American Psychological Association, 2017). In regard to HRRB, exposure and response prevention (ERP) has been used to treat compulsions and involves intentionally putting the individual in an anxiety provoking situation, having the individual refrain from engaging in the ritualistic or compulsive behavior, while demonstrating the nonoccurrence of the consequence that is feared by the individual. For example, if an individual engages in excessive or compulsive hand washing after using the restroom, the individual would be brought into the restroom, prompted to touch the toilet seat, and experience that they are physically left unharmed (e.g., nonoccurrence of the feared consequence). Additionally, the individual may be prevented from washing their hands more than one time (Abramowitz, 1996). Thus, the compulsive behavior that routinely accompanies the obsessive thought is no longer negatively reinforced (e.g., placed on extinction) which eventually leads to suppression (Boyd et al., 2012). Additional components may be included such as verbalization of coping statements (e.g., "I know nothing bad will happen") during ERP sessions to ameliorate anxiety (Lehmkul et al., 2008) and having individuals take an active role in the treatment process. Moreover, researchers have shown that a combination of imaginal exposure and in vivo exposure is more effective than exposure alone in reducing symptoms of anxiety (Abramowitz, 1996).

For ISB, Withers and Gaskell (1998) employed CBT to decrease the public masturbation (PM) of an 11-year-old child with a learning disability. The CBT intervention included seven sessions during which the participant was taught to suppress the urge to masturbate by engaging in distracting thoughts, encouraged to engage in an alternative behavior (i.e., play with putty) when anxious or bored, received education on appropriate masturbation and the importance of engaging in this response in privacy (e.g., his bedroom), and praised for his progress. The participant's parents were also instructed to prompt him to use a private space to masturbate. Across the seven sessions, which spanned over 3.5 months, CBT decreased the participant's PM to zero.

Exercise

Antecedent exercise involves instructing and providing opportunities for individuals to engage in some form of exercise (e.g., jogging; Baumeister & MacLean, 1984, jumping on a trampoline; Neely et al., 2014) and then measuring rates of the target behavior following intervention (Morrison et al., 2011). In regard to SIB, Baumeister and MacLean evaluated the effects of a jogging program on SIB (e.g., slapping, hitting of the face, head, and shoulders) and stereotypy (e.g., body rocking) for two individuals with developmental disabilities. The jogging program consisted of a 1 mile jog every afternoon which then increased by 1 mile every 2 weeks (terminal distance of 3 miles) over a 6-week period and resulted in decreased levels of stereotypy and SIB for both participants compared to baseline. For stereotypy, Neely et al. evaluated the effects of antecedent physical exercise on MS (e.g., repetitive bouncing, rocking, arm swinging) in two participants. Before instructional time, each participant was allowed exercise via a trampoline with minimal attention from the experimenter until they engaged in three consecutive behavioral indicators that they were satiated (e.g., getting off the trampoline or ceasing jumping for 1 min). The participant was prompted to exercise until three indicators of satiation were observed. Results indicated that stereotypies occurred at lowest levels when the participant had access to antecedent exercise until satiated.

Behavioral Contract

A behavioral contract specifies the conditions under which a specific reinforcer will be delivered. Wesolowski et al. (1993) used a behavioral contract in combination with verbal and written feedback to decrease the ISB of two adults with traumatic brain injury (TBI) (a third participant experienced feedback only). In this study, the behavioral contract consisted of differential reinforcement of low levels (DRL) of ISB. Specifically, a contract was developed by the participant and the clinical team and it specified the reinforcer available at the end of the week (e.g., trip to a shopping mall) contingent on whether or not ISB occurred at or below the specified criterion. During subsequent weeks, the number of instances of ISB that could occur was slowly decreased. Behavioral contracting, paired with feedback, decreased ISB to zero levels.

Instructional Procedures

A variety of instructional procedures (e.g., prompts, discrete trial teaching, video modeling) can be employed to teach an individual to emit a novel response or new information. For instance, Potter et al. (2013) used a variety of prompts to increase item engagement, and indirectly decrease stereotypy, of three individuals with autism. In this study, access to activities, prompting, blocking of stereotypy, in combination with differential reinforcement of engagement in the form of access to stereotypy, was effective in suppressing stereotypy and increasing item engagement for all participants.

For HRRB, visual schedules and video-based technologies may be used to structure an individual's schedule and promote more independent play skills. For example, a student may have a visual activity schedule that displays images of each part of their daily schedule that they use each day. Then, if a novel event (e.g., pep rally, fire drill) is scheduled for a certain day that is atypical from the student's schedule, an image of this event can be added to the schedule and discussed with the student ahead of time to prevent challenging behavior that may arise from the schedule interruption. Banda et al. (2009) provide an overview of important steps for the construction of visual activity schedules to assist students with transitions. Similarly, video-based technologies such as video modeling utilize assistive technology for the individual to rehearse the target behavior or skill based on video observation (Odom et al., 2010). Video models may be used to model appropriate play and demonstrate how to tolerate changes to routines to prevent the emergence of problem behavior associated with HRRB (Boyd et al., 2012).

In the case of ISB, interventions may focus on teaching steps or procedures associated with a particular sexual behavior. For instance, Kaeser and O'Neill (1987) used a task analysis to teach a 29-year-old male described to have profound intellectual disabilities (ID) the proper steps of masturbation. Specifically, during the intervention phase masturbation was divided into six steps that were directly taught to the participant using a combination of prompts (e.g., verbal, gestural, physical assistance).

Diet Manipulation

Diet manipulation has been evaluated as a treatment for rumination and likely applies to rumination only rather than other topographies of automatically reinforced behavior discussed in this chapter. Lang et al. (2011) identified four approaches to diet manipulation that can reduce rumination. One approach is pacing the presentation of food given to participants to ensure slower consumption (e.g., Luiselli et al., 1994). Luiselli et al. (1994) reduced rumination to near-zero levels using a treatment package which included, amongst other interventions, removing foods associated with rumination from the diet, the availability of more portions at mealtimes and snacks throughout the day, pacing (i.e., 5-min interval between consumption of each portion of food), and no programmed consequences for rumination. However, if vomiting occurred, the participant assisted in cleaning the environment. Another approach is to increase the calories and/or quantity of food (e.g., food satiation; Clauser & Scibak, 1990). For example, Clauser and Scibak provided access to triple portions of food and unlimited cereal with milk at mealtimes. For all participants, food satiation resulted in reduced rumination. An additional approach is removing types of food or liquids associated with increases in rumination from a participant's diet (e.g., Heering et al., 2003). Heering et al. (2003) indicated that rumination occurred at the highest rate when the participant had free access to liquids during meals. As a result, liquids were removed from mealtimes. The last approach involves changing the consistency or texture of food items given to the participant. For instance, Greene et al. (1991) evaluated the impact of peanut butter consumption on rumination, prepared in a variety of consistencies, and found that although the consistency of peanut butter had only a minor impact on rumination, rumination decreased as peanut butter consumption increased.

Consequence-Based Procedures

Feedback

Feedback involves the description of a person's behavior with the goal of changing the likelihood of that response occurring again in the future. Wesolowski et al. (1993) decreased ISB of three adults with a TBI using verbal and written feedback. During the intervention phase, staff recorded data on the occurrence of ISB. During the feedback sessions, which occurred every hour (2 participants) or every 30 min (1 participant) between 7:00 am and 11:00 pm, staff reviewed the completed datasheets and vocally described to the participants whether interactions they had with their peers during the preceding interval were appropriate. In this study feedback led to a decrease in ISB for all three participants.

Differential Reinforcement

Differential reinforcement procedures usually involve withholding reinforcer following the occurrence of the target behavior (i.e., extinction) and delivering a reinforcer contingent on an alternative behavior (DRA; e.g., stereotypy; Lang et al., 2014), an incompatible behavior (DRI; e.g., pica; Donnelly & Olczak, 1990), or other behavior (DRO; e.g., head hitting; Patel et al., 2000). Additionally, in a DRO procedure, a reinforcer is delivered following specific intervals during which the participant does not engage in the target behavior (Cooper et al., 2019).

In regard to pica, Donnelly and Olczak (1990) successfully reduced pica in the form of eating cigarettes by reinforcing the incompatible behavior of chewing gum with amounts of instant coffee. DRI resulted in increased latency of pica and rapid reduction of pica to near-zero levels. Donnelly and Olczak concluded that gum chewing can represent an alternative, socially acceptable oral behavior that competes with pica and for these participants, is a response strengthened by edible reinforcement (e.g., coffee).

For stereotypy, Lang et al. (2014) used DRA to decrease MS (e.g., waving toys in front of face) by providing prompts (e.g., gesture, model, verbal, and physical prompts) to engage in appropriate play and differentially reinforcing play with access to edibles and praise. No programmed consequences were provided for MS, unless the participant did not respond to prompts to play, in which they were then physically guided to engage in appropriate play. Reduced rates of MS and increased rates of appropriate play were found. Also related to stereotypy, Gehrman et al. (2017) evaluated the effects of resetting and not-resetting DRO procedures on MS. For both variations, reinforcement in the form of an edible was delivered upon the absence of MS for an entire interval. In the non-resetting condition, if stereotypy occurred during the interval, reinforcement was not available until the remainder of that interval expired. Reinforcement was only delivered following a subsequent interval without stereotypy, whereas in the resetting condition, contingent on MS during an interval, the interval was simply reset. Reinforcement was provided contingent on the absence of MS during the entire interval. Both variations of DRO procedures were effective in reducing MS.

In regard to HRRB, differential reinforcement of variability (DRV) is similar to other differential reinforcement interventions, but reinforcement is provided for varied behavioral responses (Miller & Neuringer, 2000; Neuringer, 2004). Reinforcement is linked to how novel the alternative behavior is and the novel behavior serves as an incompatible response to the ritualistic behavior or engaging in perseverative responding (Neuringer, 2004). For example, Goetz and Baer (1973) increased the variability of building-block constructions for three participants. Participants were instructed to create structures, but reinforcement was only provided if the construction was different from all previous responses within a session. Results demonstrated that each child's repertoire expanded by between nine and 16 novel responses over the course of treatment. Additionally, studies have combined DRV with response interruption, where the individuals target response is interrupted and novel behaviors are reinforced (Boyd et al., 2011). Additionally, functional communication training (FCT), a type of DRA, has been used to treat HRRB and involves the teaching of a functional communication response that results in access to the reinforcer that maintains that target behavior. Several studies have tailored FCT to treat ritualistic behaviors in individuals with ASD. Specifically, a communication response is taught such as, "Is this trash" to replace straightening behavior (Kuhn et al., 2009), "Laura's way" to rearrange the environment (Leon et al., 2013), or "I don't want that" to reinstate a ritual (Rispoli et al., 2014). The target problem behavior is placed on extinction and the communication response results in access to the maintaining reinforcer. This type of FCT can be adapted to serve idiosyncratic functions or topographies of HRRB. Lastly, in regard to ISB, Dufrene et al. (2005) decreased the ISB (i.e., PM involving the use of her hand) of a 7-year-old girl with a TBI by differential reinforcing the incompatible response of writing (i.e., DRI).

Self-Monitoring

During self-monitoring, the individual is responsible for recording (i.e., monitoring) occurrences of their own behavior (Lee et al., 2007). In regard to stereotypy, Crutchfield et al. (2015) evaluated the effects of self-monitoring via a technology-delivered program, I-Connect, on stereotypy for two students with ASD in a school setting. Participants used a handheld device to self-monitor whether or not they had engaged in stereotypy every 30 s. Self-monitoring resulted in decreased levels of stereotypy for both participants.

For HRRB, Lin and Koegel (2018) coached parents to implement pivotal response treatment (PRT) and had children engage in self-management strategies during treatment sessions to promote flexible responses rather than engaging in RRB. Specifically, parents told their children that it was time to practice being flexible in order to earn a reinforcer. Children were provided with a choice of what to earn and a blank self-management point sheet to track when they had demonstrated being flexible. Every time the child demonstrated "flexibility" instead of engaging in problem behavior, the parent prompted the child to mark on their self-management sheet that they had earned a point. Sessions continued until the child earned the expected number of points, which started at two and increased to five by the end of the evaluation. The intervention improved child behavior for all three participants (e.g., increased behavioral flexibility and reduced challenging behavior), increased children's engagement in family activities, and promoted positive parent and child affect and interactions.

In regard to ISB, Zencius et al. (1990) used self-monitoring to decrease the ISB (i.e., exposing himself) of one individual with TBI (other interventions were used with the other participants). During the self-monitoring intervention, the individual was instructed to record in a notebook all of the "urges and feelings" he experienced prior to engaging in ISB. In addition, the participant was instructed to also masturbate to situations presented to him during a dating-skills training class. In this study, self-monitoring in combination with redirection to appropriate sexual behavior decreased ISB to zero levels.

Timeout

Generally speaking, timeout refers to "time away" from reinforcement (Cooper et al., 2019). For pica, Northup et al. (1997) used a combination treatment of a 30-s DRO and 10-s time out from access to mints to reduce pica in an adult participant with developmental disabilities. When DRO was the only intervention in effect, there was a moderate reduction in pica attempts;

however, the combined treatment resulted in near-zero rates of pica attempts. In regard to ISB, Dozier et al. (2011) decreased the automatically reinforced ISB of an adult male with autism spectrum disorders and ID using response interruption in combination with a brief timeout. During the timeout component, contingent on ISB the participant was prompted to remain at the corner of the room for 1 min. The intervention was effective in decreasing ISB. Effects generalized to novel environments and persisted even after the backpack, which was used to help interrupt ISB, was eliminated.

Response Blocking

Response blocking involves physically preventing (i.e., blocking) the occurrence of the target response and thus preventing access to the reinforcer produced by the response itself (Cooper et al., 2019). For example, Lerman and Iwata (1996) decreased automatically reinforced SIB in form of hand mouthing using response blocking delivered across different schedules ranging from blocking every attempt to every fourth attempt. During the intervention, a therapist was seated behind the participant and attempts to put his hand in his mouth were blocked dependent on the schedule in place. Response blocking resulted in near-zero attempts to hand mouth independent to the schedule of consequence delivery.

Response blocking has also been used in combination with other interventions. For instance, Saini et al. (2016) reduced pica using response blocking in combination with NCR in the form of access to competing stimuli (e.g., tone pipe, pretzels, vibrating teether, teething keys). In this study, response blocking for pica consisted of the therapist placing their hand between the participants hand and mouth. Response blocking alone reduced pica to moderate levels; however, the combination of NCR and response blocking resulted in near-zero levels of pica. In regard to stereotypy, Lerman et al. (2003) evaluated the effects of response blocking as a treatment component for MS (e.g., head and tooth tapping). Response blocking consisted of the therapist physically blocking an attempt to engage in MS. In addition, environmental enrichment was evaluated with response blocking and conditional response blocking (i.e., blocked response if individual was not engaging in leisure items). Response blocking decreased levels of MS; however, it also subsequently decreased engagement in leisure activity and an increase in another form of MS (e.g., hand wringing).

Response Interruption (RI)

During RI, each occurrence of the target behavior is verbally or physically interrupted (Sprague & Horner, 1992). For stereotypy and SIB, Sprague et al. (1997) evaluated the impact of contingent sensory reinforcement (i.e., delivery of sensory item contingent on task performance) alone or in combination with RI (i.e., moving participant's hand down while stating "Please don't do that") on SIB and stereotypy of two individuals. In this study, greater suppression of problem behavior was attained when RI was in effect; however, RI was implemented. In regard to ISB, Dozier et al. (2011) used RI to reduce public masturbation for an adult male with autism. Specifically, the participant wore a backpack and PM was interrupted by pulling on the straps of the backpack.

Response Interruption and Redirection (RIRD)

Although many procedural variations exist, RIRD consists of the interruption of inappropriate behavior in combination with redirection to alternative responses (Ahearn et al., 2007), and this procedure has been shown to be effective in reducing a variety of automatically reinforced behavior (see Steinhauser & Ahearn, in press, for a review). RIRD is often employed to decrease stereotypy. For instance, in Ahearn et al. (2007), contingent on VS the implementer gained the individuals attention by initiating eye contact and verbally interrupted the behavior by prompting the individual to answer a social question (e.g., "What's your name?") or engage in vocal imitation ("say ball"), in which the participant was known to engage in reliably in the past. Termination and reinforcement in the form of social praise were delivered contingent on compliance with three consecutive trials with appropriate vocalizations and absence of VS. A significant decrease in VS compared to baseline levels was noted. In regard to ISB, Cividini-Motta et al. (2019) compared the effects of RI (i.e., physical guidance to interrupt PM paired with verbal instruction) and RIRD (i.e., prompt to stand and complete 1-min of physical activity) on the PM of four individuals ages 6–20 years old. Results of this study indicated that RIRD, as well as RI, was effective in reducing PM. See Chap. 16 in this volume for additional information on RIRD.

Response Cost (RC)

During RC, access to a reinforcing stimulus is terminated contingent on occurrence of problem behavior (Cooper et al., 2019). For SIB, Lerman et al. (1997) reduced hand mouthing and head hitting by removing access to a preferred stimulus (i.e., response cost) or manually holding the participant's arm down for a predetermined period of time (i.e., physical restraint) contingent on SIB. Initially, the punishment procedure was implemented continuously (i.e., every occurrence of SIB), but then the authors thinned the schedule of consequence delivery by providing the consequence following first occurrence of SIB after a predetermined amount of time elapsed (e.g., 120 s). RC was effective for all participants; however, SIB remained low across thinning only for a portion of the participants.

To decrease stereotypy, McNamara and Cividini-Motta (2019) compared the effects of RIRD alone, RC alone, and RIRD plus RC on levels of stereotypy. RIRD procedures were the same as those described in Ahearn et al. (2007). During RC alone, the participants had access to a competing item (e.g., Thomas the Tank™, Tigger), and contingent on VS (e.g., humming, repetitive noises), the item was removed for 10 s and was not returned until a full 10-s interval without VS elapsed. During the RIRD plus RC condition, the participant had access to a highly preferred toy that did not suppress levels of VS. Contingent on VS, the highly preferred toy was removed, RIRD procedures were implemented until termination criteria were met, and then the highly preferred toy was returned. RIRD alone and RIRD plus RC resulted in decreased levels of VS for all participants. RC alone was ineffective in reducing levels of VS for one participant.

LeBlanc et al. (2000) implemented RC to decrease the ISB, and other disruptive behaviors, of a 26-year-old male with ID. In this study, token training was completed first and consisted of a verbal description of the contingencies, the delivery of tokens and praise contingent on an arbitrary response (i.e., shake hands), and opportunities to exchange the tokens for back up reinforcers (e.g., preferred foods). During the intervention, at the onset of each session, the participant received five tokens and throughout the session additional tokens were delivered during a DRO procedure contingent on the absence of the target disruptive behaviors (i.e., inappropriate social interaction, ISB, or verbal aggression) during specific intervals of time. In addition, the DRO interval was reset and a token was removed following each occurrence of disruptive behavior. In this study, the RC procedure, combined with a resetting DRO, successfully decreased all three topographies of disruptive behavior, including ISB, to zero levels.

Overcorrection

According to Foxx and Azrin (1973), overcorrection involves restoring the environment to a better state than prior to the emission of problem behavior (i.e., restitutional overcorrection) and practicing appropriate responses related to the target behavior (i.e., positive practice overcorrection (PPOC)). For SIB, in their first experiment, Foxx and Azrin (1973) compared the use of a DRO procedure (edibles and praise for 10 s without hand mouthing), NCR (i.e., candy or cereal with praise delivered on a variable interval 1-min schedule), contingent aversive stimuli (i.e., slap on the thigh contingent on hand mouthing or distasteful solution), and overcorrection (contingent oral hygiene procedure that included brushing teeth and wiping face with a washcloth). Overall, the NCR and DRO procedures were the least effective, while overcorrection was the most effective and reduced hand mouthing to zero instances.

For ISB, Luiselli et al. (1977) assessed the impact of PPOC in combination with reinforcement (i.e., tokens delivered for work completion; praise for on-task behavior) for an 8-years-old boy with ID and psychosis. The PPOC intervention consisted of requiring the participant to complete a series of motor tasks (i.e., raising arms, extending arms in front and to the side of the body, wrapping arms across the chest) four times. During PPOC, physical guidance was employed if the participant did not comply with the task. In this study, ISB occurred at high levels during the reinforcement only phase; PPOC in combination with reinforcement reduced ISB to zero. Similarly, Polvinale and Lutzker (1980) evaluated the impact of social restitution combined with a DRO on the ISB of a 13-years old male with Down Syndrome. In this study the social restitution component consisted of the participant apologizing to six different individuals (e.g., peers, teachers) for the emission of a specified target behavior (e.g., I am sorry [name], I [behavior]). Results of the component analysis completed only for the treatment sessions conducted in the morning indicated that the DRO procedure alone produced only a slight change in ISB, yet the treatment package resulted in a decrease in ISB for zero levels. These data suggest that social restitution was likely the intervention component responsible for the treatment effects.

Other Punishers

Various studies decreased automatically reinforced behavior by delivering an aversive stimulus contingent on the occurrence of the target behavior. Examples of this include tapioca pudding for pica (e.g., Ferreri et al., 2006), lemon juice for PM (e.g., Cook et al., 1978), and electric shock for ISB (e.g., McGuire & Vallence, 1964). However, given that the contingent delivery of aversive stimulation is discouraged by the BACB® ethics code (2014), we are including here just a few examples and recommend that anyone considering decreasing disruptive behavior by presenting an aversive stimulus considers whether such consequences are warranted, whether reinforcement-based and less intrusive interventions (e.g., RC, RB, RIRD) have been exhausted, and ensures that proper consent and assent are attained.

Recommendations for Clinical Practice and Future Research

As noted earlier, in the case of automatic contingencies, the reinforcing stimulus is a product of the behavior itself; thus, withholding reinforcement for these behaviors is not feasible. Despite this challenge, previous research has described a variety of behavioral interventions that can be used to reduce automatically reinforced behaviors. Additionally, previous research has also identified evidence-based practices (EBPs) for some topographies of automatically reinforced behavior (e.g., RIRD and stereotypy; Hume et al., 2021), but for others, previous literature reviews have highlighted the need for more rigorous experimental procedures to improve the quality of research published (e.g., research on ISB; Mann & Travers, 2020) and the lack of evidence-based procedures (e.g., ISB (Clay et al., 2018); RRB (Boyd et al., 2012)).

Given the current studies of research on the assessment and treatment of automatically reinforced behavior, in cases where an automatic function is hypothesized and to increase the probability of the implementation of a function-based treatment, we recommend that clinicians begin by conducting a functional assessment. Given the complex and idiosyncratic nature of the topographies of behavior discussed in this chapter, it is important that the functional assessment be tailored to the individual's target behavior (e.g., Roscoe et al., 2015) and that it includes, minimally, an automatic screen (Querim et al., 2013). However, in the case of SIB, at least a control condition should be included to allow the clinical team to determine if the response meets criterion for Subtype 1 ASIB (Hagopian et al., 2015). If it does not, then further assessments should be conducted to identify the specific subtype of ASIB. In the case of ISB, clinicians must also consider the legality and ethics of evoking and observing sexual behavior. Specifically, Stein and Dillenburger

(2017) note that evoking sexual behavior in a minor is unethical and in the case of a nonconsenting adult, it is illegal. Thus, it is imperative to determine whether the individual has the capability to provide informed consent or at least assent to treatment.

In regard to treatment, in accordance with the BACB® ethical code (2014) and Vollmer et al. (2011), we also recommend that clinicians use the least restrictive yet effective treatment. Thus, we recommend that whenever available clinicians employ a reinforcement-based procedure that has been deemed to meet criteria for an EBP (e.g., DRA and RIRD for stereotypy; Akers et al., 2020; Hume et al., 2021). In cases where EBPs for a particular topography of automatically reinforced behavior have yet to be identified (e.g., ISB), we recommend that clinicians employ an intervention categorized as evidence-based for another topography of automatically reinforced behavior (e.g., DRA, RIRD are EBPs for stereotypy). Moreover, given that reinforcement-based procedures such as NCR, DRO, and DRA are common interventions for automatically maintained behaviors (e.g., ISB; Clay et al., 2018; SIB; Gregori et al., 2018) and are easy to implement, we suggest that clinicians employ NCR procedures initially, followed by the use of a variety of instructional procedures to establish alternative responses in the client's repertoire and then employ DRA procedures to strength and maintain these appropriate responses.

In designing treatment plans, it is also imperative that clinicians consider the topography of automatically reinforced behavior, it's potential for harm, and human's right in determining appropriate target goals. For instance, stereotypic behaviors typically do not cause injury or harm to others; thus, interventions do not need to result in complete elimination of the behavior (Akers et al., 2020), but aim at teaching the individual when and where these responses are acceptable. Similarly, although not all topographies of RRB warrant immediate treatment, research demonstrates that these repetitive behaviors, specifically insistence on sameness, may become more complex over time if not interceded (Richler et al., 2010). However, in the case of certain topographies of SIB such as pica, a single instance of the behavior can result in severe injury, and potentially death. Thus, the goal should be to eliminate these responses from the individual's repertoire. In regard to ISB, people with disabilities have the right to engage in sexual behavior (American Associated on Intellectual and Developmental Disabilities [AAIDD], 2013). Thus, it is imperative that interventions to address ISB do not violate the individual's human rights and instead aim at teaching the individual how and when to engage in sexual responses, safe sex (e.g., use of condoms), and the skills necessary to give and attain consent. Furthermore, in providing sexual education, clinicians should seek assistance from individuals with the appropriate expertise (e.g., sexuality educators certified by the American Association of Sexuality Educators, Counselors and Therapists (AASECT); Stein & Dillenburger, 2017).

Recent studies on treatment of automatically reinforced behavior tended to use punishment procedures less frequently compared to earlier evaluations (e.g., SIB; Gregori et al., 2018); however, punishment-based treatments may sometimes be necessary to reduce problem behavior (DeRosa et al., 2016). Furthermore, previous research has often evaluated the effect of treatment packages on automatically reinforced behaviors (e.g., ISB; Clay et al., 2018). Thus, in clinical settings it is likely that treatment packages are more likely to have a therapeutic effect in automatically reinforced behavior and that, whenever reinforcement-based interventions alone do not reduce or eliminate problem behavior, clinicians will need to introduce more intrusive interventions such as RIRD, RC, and time out, to further reduce problem behavior. Finally, given that HRRB may present symptomology at both the cognitive and behavioral levels (Boyd et al., 2012), the potential of harm resulting from various topographies of automatically reinforced responses, and the fact that various topographies of automatically reinforced behavior may be caused by medical problems (e.g., pica; Edwards, 1960) or a side effect of medication (e.g., rumination; Rogers et al., 1992), we recommend interdisciplinary collaborations in designing treatments for automatically reinforced behaviors.

There are many avenues for future research, some of which are highlighted here. First, results of previous research (e.g., Hagopian et al., 2015) suggest that there are distinct functional classes of ASIB, thus future research should continue to investigate the most efficient and effective interventions for each subtype of ASIB and whether other topographies of automatically reinforced behavior (e.g., stereotypy; HRRBs) also include subtypes of response classes. Additionally, researchers have suggested that in many cases researches have lacked generality and social validity measures (e.g., Akers et al., 2020; Wang et al., 2020) and have not investigated variables that may influence generalization and maintenance of interventions effects (e.g., Gregori et al., 2018). Furthermore, existing research commonly focuses on reducing repetitive or ritualistic behaviors, but few address the underlying cause of the behavior or general construct of behavioral inflexibility (Boyd et al., 2012), and interventions for rumination may lead to a substantial increase in caloric intake (Lang et al., 2011). These topics and issues should be explored in future research. Specifically, literature on automatically reinforced problem behavior would benefit from a further analysis of the lasting effects of various treatments as well as those that are less intrusive and more socially acceptable.

Moreover, the work by Fahmie et al. (2020) indicates that it is possible to identify sensitivity to social reinforcers before severe problem behavior emerges. It would be important to identify, at an early age, individuals for whom social reinforcers are less likely to compete of automatic reinforcement so this information can hopefully lead to the prevention of automatically reinforced severe problem behavior. Furthermore, future research must focus on individual or behavioral characteristics that may be predictive of the development of more persistent or severe topographies of automatically reinforced behaviors and of treatment efficacy. Finally, disruptive behaviors have a negative impact on the individual displaying these responses and also on their caregiver (e.g., HRRB; Boyd et al., 2012). Therefore, future research must investigate ways to support caregivers as well as ways to increase the feasibility (e.g., omitting intervention components; booster sessions by experts; Colón & Ahearn, 2019) of implementation of treatments by individuals with limited to no training in behavioral interventions.

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6 Reinforcer Thinning: General Approaches and Considerations for Maintaining Skills and Mitigating Relapse

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Imagine, if you will, a world in which the best medical care produced only temporary improvements in health and overall functioning. In this world, alleviation of pain associated with mild health problems, like a toothache or a fractured bone, comes only from the frequent application of a numbing cream. Treatment of more serious health problems, like cancer, produces only temporary relief and short stints of being cancer free. The world described above may understandably seem foreign to many reading this chapter—a testament to the omnipresence of modern medicine in advanced societies. We live in a time in which modern medicine produces both short- and long-term health benefits—a result of focusing on symptom management, as well as identification and treatment of the underlying malady.

However, this world of temporary treatment effects is not unlike that of much of applied behavior analysis. Even with the advent of functional analysis methodology (Iwata et al., 1982/1994), lasting treatment of many behavior problems requires the continued implementation of key treatment components with high levels of procedural fidelity. For the utility of much of our practice, treatment adherence is inexorably tied to treatment success. Without it, robust behavioral changes often deteriorate until they regress to pretreatment levels. With it, treatment gains are more likely, but they are never guaranteed. Changes in behavioral function (Lerman et al., 1994), reinforcer potency (e.g., Craig et al., 2017), and the context in which treatment occurs (e.g., Saini et al., 2018) are just a few of the factors that can alter treatment effectiveness in addition to those caused by fluctuations in treatment adherence.

The goal of applied behavior analysis as a discipline is to bring about durable behavior change. A highly efficacious treatment that does not lead to highly effective, long-term behavior change is simply insufficient in modern applied behavior analysis. So, then, what does it take to produce durable behavior change? There are many answers to this question, and they come from a variety of sources (e.g., research on treatment integrity, treatment relapse, and the social acceptability of common treatment procedures). The focus of this chapter discusses two general strategies for improving treatment durability.

One of the simplest means of improving treatment durability is likely to reduce caregiver bur-

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_6

den associated with treatment implementation (Allen & Warzak, 2000; Stocco & Thompson, 2015). Caregiver burden entails all of the facets of treatment on which behavior analysts train caregivers. This may include how and when to reinforce, prompt, display, and change discriminative stimuli, as well as how to block problem behavior. More involved treatments are likely to require more from caregivers, and the overall expectation can amount to a hefty burden on families, many of which are already in need of additional support and other resources. Reducing caregiver burden associated with treatment implementation is important because it helps ensure that treatment adherence is high when and where it is needed most.

Reducing caregiver-delivered reinforcement can be a crucial step for improving the practicality and acceptability of common behavioral treatments (Hagopian et al., 2011). Treatments that require frequent or prolonged caregiver involvement to deliver reinforcement limit the time for other important activities (e.g., preparing dinner, attending to other siblings) and self-care tasks (e.g., getting proper amounts of sleep, spending leisure time with one's partner). When such activities cannot be ignored, adherence to the treatment plan is likely to suffer, and with it, the associated treatment effects. In practice, decreasing caregiver-delivered reinforcement can be achieved in a few different ways. One option is to decrease the amount of time in which reinforcers are available by limiting reinforcer-availability periods. Another possibility is to decrease the overall number of reinforcers delivered (e.g., by requiring the completion of more work before the reinforcer becomes available). We focus on specific tactics for reducing caregiver-delivered reinforcement in the first sections of the chapter.

A second way of improving treatment durability hinges on producing behavior change at a level more fundamental than that of simply thinning a *schedule* of reinforcement. Continuing the discussion above on reducing caregiver burden as a means of improving long-term treatment effectiveness, it stands to reason that treatments requiring little to no caregiver *involvement* are likely to be the most durable. Removal of caregiver involvement here implies that the caregiver's own behavior is no longer responsible for the treatment effect. At this level of behavior change, caregivers no longer serve as intermediaries for treatment efficacy. Behavior change of this sort implies that treatment effectiveness is determined not by how well others adhere to a prescribed treatment plan but by factors that themselves have become automatic (e.g., maintained by natural contingencies; Stokes & Baer, 1977).

The concept of behavior change at such a fundamental level may be illustrated by an example. When toilet training a child, a behavior analyst is likely to arrange potent and extrinsic reinforcers (e.g., preferred foods) to follow each successful void in the toilet. At this early stage of toilet training, slight deviations in the schedule of caregiver-delivered reinforcement are likely to have direct and consequential implications for the efficacy of the toilet-training program. Success or failure at this early stage is dependent on treatment integrity. However, after the child becomes toilet trained, the continued success of the now-trained child depends not on the caregiver's strict adherence to delivering arbitrary reinforcers, but by factors outside the immediate control of the caregiver (e.g., generalized reinforcement). When such a fundamental change occurs to the variables controlling the child's behavior, the caregiver is no longer bound to delivering extrinsic reinforcers and is no longer burdened by the continued implementation of the treatment procedures. At this point, treatment durability is highly likely because caregiver treatment adherence is no longer necessary for continued treatment success.

This type of highly desirable behavior change is a realistic goal for much of applied behavior analysis, yet achieving behavior change of this sort requires tactics that differ in important ways from those mentioned above. In a latter section of this chapter, we discuss procedures for manipulating the reinforcer(s) maintaining behavior and methods for bringing about the type of fundamental behavior change described above. Taken together, these two procedures can be described as *reinforcer thinning* in that they produce a reduction in how often caregivers are responsible for delivering reinforcers while still maintaining treatment effects.

We arranged this chapter with practitioners in mind. Rather than cover each of a large number of methods for thinning reinforcement, we opted for a framework that aimed to be more functional to readers. We hope that by organizing specific tactics by the goals of each that practitioners will learn as much about the procedure as they will conceptually about the conditions under which one approach may be advantageous over another.

Reducing Functional Reinforcers in Behavior Reduction Procedures

Thinning reinforcement after teaching an appropriate response like a novel mand (e.g., requesting access to an electronic tablet) can be challenging. Thinning reinforcement for that response *while also* minimizing the occurrence of problem behavior previously evoked by that reinforcer's restriction can be a Herculean task. This is often a goal of functional communication training (FCT; Carr & Durand, 1985), which is the most commonly prescribed function-based intervention for socially reinforced problem behavior (Tiger et al., 2008).

FCT involves teaching and differentially reinforcing a mand known as a functional communication response (FCR; e.g., a card exchange or vocal mand), which produces the functional reinforcer that previously maintained problem behavior. During the initial stages of FCT, FCRs are reinforced continuously. Additionally, FCT often involves an extinction contingency for problem behavior. FCT with extinction is an empirically supported treatment for socially reinforced problem behavior (Kurtz et al., 2011) and results in rapid and clinically significant reductions in problem behavior (Greer et al., 2016); however, it can be challenging to thin reinforcement for the FCR to a practical schedule while simultaneously maintaining near-zero levels of problem behavior (Briggs et al., 2018b). In the sections below we will discuss several strategies for accomplishing this by teaching the individual to (a) understand when their FCRs will and will not result in the functional reinforcer or (b) tolerate delays or denied access to the reinforcer following the FCR. For each approach, we will provide an overview, discuss an ideal response pattern, review the thinning progression, highlight several considerations, and discuss some strengths and limitations.

Using Compound Schedules with Discriminative Stimuli

Behavior analysts have used compound schedules (i.e., a schedule that combines two or more component schedules; Catania, 2013), like multiple and chained schedules of reinforcement, to signal the availability of reinforcement for the FCR during FCT. During FCT with multiple and chained schedules, at least two schedules (e.g., most often fixed-ratio 1 [FR1] and extinction for the FCR; Saini et al., 2016) alternate and each schedule is correlated with a different stimulus (e.g., a green wristband for the FR1 and red wristband for extinction). Most often, extinction is always programmed for problem behavior regardless of the schedules for the FCR. Behavior analysts can alternate these schedules simply or randomly (Ferster & Skinner, 1957; e.g., FR1/extinction/FR1/extinction or FR1/extinction/extinction/FR1). In practice, behavior analysts may consider alternating the components quasi-randomly according to a preset rule (e.g., no more than two successive presentations of the same component), but one component or the other is always in effect (Mitteer et al., 2020). In the sections below, we provide an overview of FCT with multiple and chained schedules along with the conditions under which behavior analysts might use them to thin reinforcement for alternative behavior like FCRs.

Overview

When using discriminative stimuli, behavior analysts tend to use FCT with multiple schedules (mult FCT) to thin reinforcement for social-positive reinforcers (e.g., caregiver attention or access to preferred items) and chained schedules (chained FCT) to thin reinforcement for social-negative reinforcers (e.g., escape from academic demands; Saini et al., 2016). As described above, behavior analysts typically implement mult and chained FCT by alternating an FR1 component and extinction component for FCRs that are each correlated with a specific stimulus. The stimuli associated with the reinforcement and extinction contingencies are known as the discriminative stimulus (S^D) and stimulus delta (S^Δ), respectively. Researchers have used a variety of stimuli for these purposes, including arbitrary stimuli (e.g., colored cards or wristbands, Greer et al., 2016) or stimuli that might occur naturally in the target individual's life (e.g., variations in caregiver behavior like talking on the phone or reading a magazine; Kuhn et al., 2010; Shamlian et al., 2016). Both the S^D and S^Δ components switch based upon the passage of time in mult FCT, whereas chained FCT's S^Δ component duration varies and terminates following a response requirement (e.g., compliance). Regardless of the arranged stimuli and contingencies affecting component switches, the therapeutic goal is to make the treatment more practical by reducing the number of FCRs and reinforcer deliveries through the caregiver honoring FCRs only during the S^D component.

Desired Response Pattern

As described by Ferster and Skinner (1957), these compound schedules involve the process of discrimination between the stimuli and the simplest way of determining whether responding discriminates between schedule components is to compare the response rates during each component (*rate of correct and incorrect FCRs*) or evaluate the percentage of responses made in the presence of each stimulus relative to the total number of responses (*percentage of correct FCRs)*, where FCRs during the S^D and S^Δ are labeled "correct" and "incorrect," respectively. Both measures have been used to interpret discriminative control of FCRs in mult-FCT research (e.g., Greer et al., 2016; Hanley et al., 2001) and one or the other may be more helpful at various points in the schedule-thinning progression. For example, the percentage measure could be useful early during schedule thinning because a single FCR during a brief 2-s S^Δ component may produce high rates of incorrect FCRs that do not accurately portray the level of FCR discrimination. Conversely, a percentage measure might be less appropriate during terminal mult-FCT schedules (e.g., 2-min S^D and 10-min S^Δ) because a single FCR in both components would yield a correct-FCR calculation of 50%, which does not account for the considerably longer duration of time spent in the S^Δ component. Thus, behavior analysts might oscillate between discrimination measures over the course of schedule thinning. Because behavior analysts arrange response requirements (e.g., completion of two academic worksheets) during chained FCT, a percentage of compliance or rate of completion measure would be considered alongside FCR discrimination.

Thinning Progression

Behavior analysts tend to begin schedule thinning during mult and chained FCT with a long S^D component (e.g., 1 min) and a brief S^Δ component (e.g., 2 s, 1 response requirement) before gradually increasing the latter component duration or response requirement relative to the former (Mitteer et al., 2020). Progression is often dependent upon the levels of problem behavior and FCR discrimination as well as compliance in chained FCT (see the sections below for how to enhance this progression's pace). For example, Hanley et al. (2001) thinned mult-FCT components from a 45-s S^D and 15-s S^Δ to a 1-min S^D and 4-min S^Δ in approximately eight steps based upon prespecified progression criteria. Further, Fisher et al. (1993) used demand fading to increase the response requirement during chained-FCT components from a 30-s S^D and FR2 response requirement during the S^Δ to a 30-s S^D and FR26 response requirement during the S^Δ in approximately 13 steps based upon prespecified progression criteria of FR2 following two sessions with near-zero levels of problem behavior and high levels of compliance. Terminal schedules have varied widely across the literature, such as the range of 1.5-min to 9-min S^Δ components presented in Greer et al.'s (2016) consecutive-case series of FCT with mult FCT. Further, when using demand fading during chained FCT, the terminal schedule can remain as a chained schedule during the S^{Δ} component (e.g., FR40; Briggs et al., 2018a) or the chained schedule can be converted to a multiple schedule in which the child would continue to work for 240 s for a 60-s break; however, the break would become available regardless of compliance (i.e., on a time-based schedule; Greer et al., 2016). Nevertheless, it is likely that the terminal schedule will be dependent upon stakeholder (e.g., caregiver, teacher) input and the characteristics of the target individual (Saini et al., 2016).

Considerations

Enhancing schedule thinning If the behavior analyst establishes discriminative control over FCRs and maintains low levels of problem behavior, it may be possible to thin rapidly from the initial schedule (e.g., 60-s S^D and 30-s S^{Δ}) to the terminal schedule without degrading treatment effects (e.g., 60-s S^D and 240-s S^{Δ}; Betz et al., 2013; Fisher et al., 2015, Fuhrman et al., 2016). However, it sometimes can be challenging to obtain FCR discrimination even with extended exposure to these compound schedules (e.g., Fisher et al., 2014) or to maintain low levels of problem behavior during schedule thinning (e.g., Briggs et al., 2018b). Although a comprehensive list of mult- and chained-FCT teaching procedures is beyond the scope of this chapter, behavior analysts have used the following strategies to improve performance during schedule thinning: (a) adding contingency-specifying rules (e.g., Fuhrman et al., 2016), (b) embedding prompting and response blocking of FCRs during the S^D and S^{Δ}, respectively (Akers et al., 2018), (c) including alternative activities during the S^{Δ} during mult FCT (Fuhrman et al., 2018), (c) allowing multiple FCRs to occur during the S^D component to increase opportunities for learning (e.g., Fuhrman et al., 2016), and (d) using response restriction and stimulus fading of the FCR during the S^{Δ} to reduce incorrect FCRs (Akers et al., 2018).

Multiple reinforcers When a functional analysis demonstrates that problem behavior is multiply controlled (e.g., by escape and access to preferred activities), behavior analysts might not reduce problem behavior to acceptable levels until they address all relevant establishing operations (Bachmeyer et al., 2009; Ghaemmaghami et al., 2016b). Behavior analysts can accomplish this by teaching FCRs for each reinforcer in separate treatment sessions (individual FCRs; e.g., Borrero & Vollmer, 2006) or a single FCR for all reinforcers in a treatment session (an omnibus FCR; e.g., Mitteer et al., 2019). Just as behavior analysts might teach FCRs under individual or combined establishing operations, they might incorporate FCT with discriminative stimuli for each function and FCR separately using unique pairs of discriminative stimuli (e.g., Greer et al., 2019) or together using more than two schedule components for individual FCRs (e.g., Akers et al., 2018) or an omnibus FCR (Mitteer et al., 2019). For example, Akers et al. taught a four-component schedule to signal the availability of (a) food, (b) beverages, (c) food or beverages, and (d) neither reinforcer using yellow, green, blue, and brown posters, respectively, with multiple FCRs. Mitteer et al. described using a similar four-component schedule, but with an omnibus FCR that produced different numbers of reinforcers for a single FCR depending on the component. Additional research is likely needed to elucidate the efficacy of and individual/caregiver preference for these complex arrangements with multiple stimuli relative to a single pair of discriminative stimuli used across FCRs (e.g., moving FCRs or images of the reinforcers between "Available" and "Unavailable" columns on a visual board).

Mult FCT beyond social-positive reinforcement Although we have focused on mult FCT to reduce the rate of social-positive reinforcement, multiple schedules might also be used to decrease the rate of automatic reinforcement (as inferred by a collateral decrease in the rate of automatically reinforced target behavior). As an example, Doughty et al. (2007) arranged two schedules with three adults with intellectual and developmental disabilities who engaged in automatically reinforced stereotypy. Doughty et al. correlated reinforcement-only and reinforcement-plus-punishment components with separate stimuli (e.g., presence/absence of music, green/red cards) by allowing stereotypy to occur and then contact a punisher (e.g., reprimand and hands-down procedure) in the presence of the respective stimuli. This resulted in near-exclusive stereotypy in the reinforcement-only component. Because stereotypy maintained at similar levels in the reinforcement-only component and decreased to near-zero levels in the other component, this presumably led to overall lower rates of automatic reinforcement produced by the stereotypy. Further, while most behavior analysts have used chained FCT to thin reinforcement for social-negative reinforcement when incorporating discriminative stimuli (Saini et al., 2016), there have been some applications of mult FCT with social-negative reinforcement. For example, for an individual with multiply controlled problem behavior, Álvarez et al. (2014) used mult FCT to thin reinforcement for FCRs to access food while programming various nonpreferred stimuli (e.g., instructions to complete academic work) that had previously evoked escape-maintained problem behavior during the extinction component. This may be effective for individuals whose compliance remains high during the extinction component of mult FCT without making the switch to the reinforcement component contingent upon compliance. Even if behavior analysts have conducted the majority of schedule thinning with chained FCT by incorporating a response requirement during the S^{Δ}, they might switch to a time-based schedule for practicality (e.g., such that a school teacher can deliver reinforcement at the end of a class period rather than tracking each instance of compliance; Greer et al., 2016).

Some Strengths and Limitations of FCT with Discriminative Stimuli

These interventions are highly effective at thinning reinforcement for FCRs while maintaining efficient FCRs within the S^{D} component when used with individuals with various functions and topographies of problem behavior and diagnoses (Greer et al., 2016). And, as noted above, establishing discriminative control over FCRs has allowed for rapid schedule thinning (e.g., Betz et al., 2013). Researchers have demonstrated that using discriminative stimuli can mitigate later treatment relapse produced by extended periods of extinction for FCRs (Fisher et al., 2020; Fuhrman et al., 2016) or contextual changes like implementation by caregivers or in new settings (Fisher et al., 2015; Greer et al., 2019). Additionally, studies have demonstrated high levels of caregiver treatment integrity with these interventions during and after caregiver training, despite the complexity of the interventions (Campos et al., 2020; Greer et al., 2019).

Despite these strong effects, perhaps the looming limitation when using these interventions is their practicality without direct programming for generalization. The vast majority of studies using discriminative stimuli during FCT have incorporated arbitrary stimuli like colored index cards and posters or items worn by caregivers like colored wristbands and Hawaiian leis (Saini et al., 2016). Although a recent study by Campos et al. (2020) obtained high social-validity ratings across three caregivers who implemented mult FCT for up to 3 weeks, one can imagine that arbitrary stimuli might be cumbersome to use and easy to misplace when working with an individual or particularly challenging to manage if working with multiple individuals simultaneously (e.g., in a classroom). The likelihood of a busy caregiver or teacher misplacing the stimuli is concerning because the effects of the interventions do not readily generalize in the absence of the stimuli.

For example, Fisher et al. (2020) demonstrated that presenting the S^{Δ} during longer-than-typical extinction periods (similar to if the tablet battery depleted and the reinforcer could not be delivered for 30 min) was successful in retaining low levels of destructive behavior and incorrect FCRs. However, the same individuals exhibiting these results in Fisher et al. often displayed treatment relapse in an equivalent condition that did not contain the S^{Δ}. The authors of this chapter have used a variety of procedures clinically to address practicality issues, such as by correlating arbitrary stimuli with naturalistic stimuli (e.g., pairing the presentation of arbitrary stimuli with caregiver vocal behavior and fading the former stimuli) and by using common discriminative stimuli with multiple students in a classroom (e.g., all students complete work when a red poster is on the chalkboard and can request breaks and other reinforcers when it is absent). However, a pressing aim for future research using mult and chained FCT should be demonstrating how to minimize practicality issues empirically, perhaps by combining the interventions with some aspects of the delay and denial tolerance training noted below.

Delay and Denial Tolerance Training

As mentioned above, a potential limitation of FCT is that the FCR may occur at times when it is unlikely to produce reinforcement (Fisher et al., 1993). For instance, in applied settings there are times when reinforcement of the FCR may be delayed or even denied. This may occur for several reasons: (a) The requested reinforcer is not readily available (e.g., tablet needs charging), (b) the requested reinforcer is not appropriate (e.g., providing conspicuous attention during a church service), or (c) the FCR may occur more often than is practical for caregivers to deliver (e.g., caregiver is unable to respond immediately to all bids for attention). Or, as we discussed earlier, discriminative stimuli may be cumbersome to manage or may be misplaced. When reinforcement is delayed or denied in these situations, there is a risk that the FCR may be weakened (Lattal, 1984) and problem behavior will resurge (e.g., Briggs et al., 2018b). Thus, behavior analysts might consider arranging tolerance training to prepare the individual for situations when reinforcement of the FCR is delayed or denied or if caregivers do not prefer to, or cannot, use discriminative stimuli.

Common procedures for teaching delay and denial tolerance are to program delays between the FCR and the delivery of the reinforcer (i.e., delay schedule; Fisher et al., 2000) or deliver the reinforcer for only a portion of emitted FCRs (i.e., intermittent schedule; Hanley et al., 2014). These delay and denial trials are initially brief exposures or occur for a very small proportion of total FCRs. Then, over time, the delays are increased systematically or the intermittent schedule of reinforcement is decreased such that a larger proportion of FCRs are denied reinforcement. Because we are describing two separate procedures (i.e., delay schedules and intermittent schedules), we will discuss them as independent components that behavior analysts can choose to implement in isolation (e.g., Fisher et al., 2000; Mace et al., 2011) or in combination (e.g., Ghaemmaghami et al., 2016a; Hanley et al., 2014; Jessel et al., 2018). In the sections below, we provide an overview of delay and denial tolerance training along with the conditions under which behavior analysts might use this approach to thin reinforcement.

Overview

Regardless of whether behavior analysts are programming (a) delay schedules (b) intermittent schedules, or (c) a combination of delay and intermittent reinforcement schedules, this delay and denial period is typically signaled with an auditory stimulus resembling something that might occur naturally in the individual's life (e.g., "Nice asking, but you need to wait," "Not now," or a similar phase; Hagopian et al., 2005; Hanley et al., 2014). The purpose of this "cue" is to serve as a discriminative stimulus that signals reinforcement is either forthcoming or not available. Signaling the delay or unavailability of the reinforcer may decrease the aversiveness of this condition, thus increasing the likelihood of an appropriate tolerance response, which might decrease the likelihood of resurgence. This stimulus may also bridge the delay between the response-reinforcer relation, thus preventing this contingency from weakening (e.g., Fisher et al., 2000). Some iterations of this approach have also found it beneficial to teach the individual to engage in a tolerance response (e.g., to take a breath and say, "Okay") following the denial statement (Hanley et al., 2014; Luczynski & Hanley, 2013) such that the individual will engage in behavior that is calming (i.e., taking a breath) and contingency-based (e.g., "Okay") which might mitigate the aversiveness associated with delayed or denied requests and increase the likelihood of their successful compliance with these events. The therapeutic goal is to strengthen these responses by providing the functional reinforcers following these tolerance responses.

Desired Response Pattern

As indicated above, delay and denial tolerance training procedures are intended to simulate situations when reinforcement of the FCR may be delayed or even denied and prepare individuals to tolerate these situations. That is, the individual will (a) continue to request access to their functional reinforcers, (b) appropriately respond to the denial statement with a tolerance response, and (c) wait for the desired amount of time (or complete the response requirement) during the delay period without engaging in additional requests or problem behavior. The goal is that this desired response pattern will occur across a wide range of evocative situations, denial statements, delay durations, response requirements, individuals (e.g., caregivers and peers), and settings (e.g., therapeutic and home environment). To evaluate whether the intervention is producing the desired effect, behavior analysts would determine if levels of problem behavior (e.g., frequency, rate) are reduced and remain low as a function of the levels of FCRs (e.g., frequency, rate) increasing and maintaining at optimal levels as delays and denials are introduced and the durations of delays are increased until the terminal delay is reached. Additionally, if a response requirement is programmed during the delay, behavior analysts would closely monitor the percentage of compliance to ensure that the individual is complying with a high percentage of these instructions (e.g., greater than 80%).

Thinning Progression

Delay and denial trials can be programmed to follow each FCR (e.g., Fisher et al., 2000) or a proportion of FCRs (e.g., 2 of every 5 FCRs result in immediate reinforcement and 3 of every 5 result in a delay or denial response; i.e., probabilistic delay fading; Hanley et al., 2014) during the delay and denial tolerance training phase. Scheduled delay periods can be either time-based (e.g., Fisher et al., 2000) or contingency-based (e.g., Ghaemmaghami et al., 2016a). That is, the delay period is terminated after a certain amount of time has elapsed (i.e., time-based delay) or the individual must engage in additional specific responses for a period of time in order to terminate the delay (i.e., contingency-based delay). Over time, duration of reinforcer access is gradually reduced by systematically increasing these delay periods. Delays typically increase in a geometric progression starting at 1 s (i.e., 1 s, 2 s, 4 s, 8 s, 15 s, 30 s, …) until the terminal delay is reached (e.g., Hagopian et al., 1998). The target terminal delay is typically determined on an individual basis and is often guided by caregiver and setting requirements (Hanley et al., 2014). Duration of delays can be either fixed at a given level (e.g., 30-s delay following every FCR; e.g., Hagopian et al., 2005) or variable at a given level that averages a particular mean (e.g., 20-s, 40-s, 15-s, 45-s delays that average a 30-s delay level; e.g., Rose & Beaulieu, 2019). Progressing to longer delays or increased response requirements is often based on success at a given step, such as appropriately responding without problem behavior (i.e., differential reinforcement of other behavior; Jessel et al., 2018). However, if problem behavior occurs during the delay period, the delay duration or the response requirement is reset (e.g., Jessel et al., 2018). The duration of time the individual has access to the reinforcer can also be fixed (e.g., 30-s access; e.g., Fisher et al., 2000) or variable (e.g., 30–240-s access; e.g., Rose & Beaulieu, 2019).

Considerations

Enhancing tolerance to reinforcement delay A technique suggested by the basic literature for teaching tolerance to delayed reinforcement has been to provide the participant with an alternative activity during the wait interval (Grosch & Neuringer, 1981; Mischel et al., 1972). This has been accomplished in applied settings by providing noncontingent access to a low-to-moderately preferred activity (e.g., Ghaemmaghami et al., 2016a; Hagopian et al., 2005; Rose & Beaulieu, 2019) or alternative functional reinforcers (e.g., Austin & Tiger, 2015; Sumter et al., 2020). Typically, items are identified through a competing item (e.g., Hagopian et al., 2005) or stimulus preference assessment (e.g., Piazza et al., 1996). Offering free access to other stimuli provides an opportunity for the individual to interact with the alternative activity while they wait for the delay interval to elapse. The mere presence of the alternative activity during the delay may simply enrich the environment, making the delay period more tolerable or it may signal the availability of alternative reinforcement thus evoking interaction with it. Under these potential value altering conditions, the presence of an alternative activity may make the delay context less aversive, decrease the motivation for continued requests or resurgence of problem behavior to access the reinforcer, and facilitate tolerance of delayed or denied reinforcement.

In addition to simply providing an alternative activity noncontingently, another technique is to require that the individual engage in a response during the delay period to terminate the delay (e.g., Drifke et al., 2020; Ghaemmaghami et al., 2016a). This DRA contingency likely helps to suppress continued requests or problem behavior by strengthening an appropriate competing response during the delay. If offering alternative activities or programming contingencies during the delay period does not promote delay tolerance, one might consider adding a punishment component for engaging in the problem behavior during the delay (e.g., Fisher et al., 2000).

Situations in which reinforcement is not available Although the procedures described above program opportunities for teaching delay and denial tolerance, access to the reinforcer is almost always offered eventually. In reality, there are situations wherein reinforcement for a request will not be available for some extended duration (e.g., days, months, years) or at all. Therefore, behavior analysts might need to consider incorporating "denied access" procedures that target "accepting no" in which the individual makes a request, is told "no" and, if they do not engage in problem behavior, they are offered an alternative reinforcer to strengthen the "tolerating no" response. Like the procedures described above, this process would begin with short intervals between denial, being told "no," and alternative reinforcement delivery and then gradually increase the time between denial and reinforcement delivery.

Some Strengths and Limitations of Delay/Denial Tolerance Training

Procedures for training delay and denial tolerance nicely simulate situations encountered in the natural environment in which the individual's requests for reinforcement cannot be honored immediately. Strategies for teaching this initial tolerance to delayed reinforcement, increasing the delay, and enhancing the tolerance during extended delays are based on procedures derived from basic laboratory experiments with nonhuman organisms that have been applied with success to humans in real-world settings and situations. Similar to the approach described above of using compound schedules with discriminative stimuli for effectively thinning schedules of reinforcement, delay and denial tolerance training procedures have seen a recent surge in research and application to offer an additional (or alternative) approach toward the goal of maintaining therapeutic effects under more realistic conditions that are feasible for those responsible for implementing the intervention in the individual's everyday environment.

Despite this noted increase in research and application, a major limitation has yet to be sufficiently addressed. That is, as the delay is increased, the contingency between the communication response and the delivery of reinforcement may be weakened, which may result in the reemergence of problem behavior (Fisher et al., 2000; Hanley et al., 2001). In fact, after examining data presented in the recent research applications of delay and denial tolerance training, multiple examples of resurgence of destructive behavior are observed during the "response chaining" (i.e., Hanley et al., 2014; Santiago et al., 2016; Ghaemmaghami et al., 2016a) and "reinforcement thinning" (i.e., Jessel et al., 2018) phases. Across these cases, at least one instance of resurgence was observed in 8 of the 12 applications (67%; i.e., Gail, Dale, & Bob in Hanley et al., 2014; Zeke in Santiago et al., 2016; Will in Ghaemmaghami et al., 2016a; John, Joe, & Kane in Jessel et al., 2018) using the definition of *schedule-thinning transition* and *resurgence* described by Briggs et al. (2018b; p. 624). In addition, in the three applications in which the investigators identified the individual reinforcement thinning steps (i.e., Jessel et al., 2018), resurgence is observed in 9 of the 20 steps (45%). Overall, the percentage of applications with resurgence (67%) and percentage of thinning steps with resurgence (45%) are nearly identical to the findings of Briggs et al. (2018b; i.e., 76% of applications and 42% of thinning steps). Only one study using delay and denial tolerance training procedures has directly evaluated the durability of their treatment outcomes with two participants by assessing maintenance of effects after 6 weeks without programmed treatment, extended denial probes, and caregiver generalization probes (Rose & Beaulieu, 2019). Problem behavior reemerged at low (Owen) or variable (Anna) levels during the denial probes (Anna), treatment extension (Anna), and caregiver probes (Anna and Owen). These data suggest that delay and denial tolerance training procedures are not immune to relapse and there is a need to investigate strategies for mitigating resurgence caused by the delay between the communication response and the delivery of the reinforcement weakening this contingency, and renewal caused by failure to program for generalization.

To prevent or mitigate relapse, researchers might consider using more salient condition-signaling stimuli to teach individuals to discriminate between periods in which their responses will and will not be reinforced, similar to procedures described above for using compound schedules with discriminative stimuli. Currently, delay and denial tolerance training procedures only program a fleeting auditory stimulus (e.g., "Wait") and future researchers might consider evaluating the effects of long-lasting visual or auditory stimuli (e.g., a colored card or wristband that signals the "Wait" period), as research has shown that signaled delays to reinforcement can be used to facilitate greater tolerance for these delays (e.g., Fuhrman et al., 2016) and promote transfer of treatment effects across caregivers (e.g., Greer et al., 2019).

Given Rose and Beaulieu (2019) represent the only study to conduct extended denial probes (e.g., 20 min) with a participant, there is a need to determine whether currently programmed delay and denial tolerance training adequately promote tolerance to naturally occurring periods of delayed or denied reinforcer access (e.g., 30 min, 1 h, 1 day, 1 week). Currently, training conditions only program a large delay during maybe 1 out of 5 trials that lasts a maximum of 12 min (Rose & Beaulieu, 2019), while denser, more immediate schedules of reinforcement are programmed for the majority of the other responses. Thus, it is unknown whether these current procedures are effective at teaching tolerance to delay or denied reinforcement under more extensive denial scenarios.

Finally, although Ghaemmaghami et al. (2016a) have shown that arranging contingencies during the delay period promotes tolerance, this approach requires caregivers to maintain access to materials and to prompt engagement, which may be effortful, less than ideal, and even undesirable to caregivers who may be expected to implement these procedures over extended periods of time. Complex and highly involved procedures may increase the likelihood that caregivers do not implement the intervention with high integrity, which may lead to errors of omission and commission that could lead to the emergence and intermittent reinforcement of problem behavior. Therefore, future researchers should consider exploring other procedures for promoting delay and denial tolerance or identifying procedures that are less effortful for caregivers to manage (e.g., teaching individuals to use activity schedules).

Reducing Extrinsic Reinforcers in Skill Acquisition Procedures

Many times, individuals receiving behavior-analytic services (e.g., early intensive behavioral intervention) have goals to improve skill acquisition (e.g., learning new tacts) without the need to concurrently reduce problem behavior in a manner we described above. When targeting a new skill, reinforcers may need to be provided after every or nearly every response to produce rapid behavior change (Lovaas, 2003). Ideally, consequences that have a “natural relation” to the response (i.e., intrinsic or automatic reinforcers; Catania, 2013, p. 77) will increase and maintain the response. For instance, coloring on paper is likely maintained by the intrinsic reinforcers produced by the brightly colored lines and patterns that drawing with crayons inherently creates. Sometimes, however, intrinsic consequences may not function as reinforcers and it may be necessary to arrange immediate consequences that have an “arbitrary relation” to the response (i.e., extrinsic or contrived reinforcers; Catania, 2013, p. 77) to produce sustained behavior change. That is, if the product of coloring is not enough to reinforce the child’s behavior, extrinsic reinforcement in the form of caregiver compliments or edible reinforcers could be delivered to achieve the behavior change goal.

Once the newly acquired response is occurring reliably, behavior analysts should reduce extrinsic reinforcers to (a) reduce satiation, (b) increase the number of learning opportunities within a session, (c) maintain the target response, (d) facilitate generalization, (e) transition to intrinsic reinforcers, and (f) potentially improve social validity of the behavior-change procedures (see the overjustification hypothesis/effect; e.g., Akin-Little et al., 2004). The primary method of reducing extrinsic reinforcers discussed in the present chapter is to transition from continuous to intermittent schedules.

Transitioning from Continuous to Intermittent Schedules

Although a dense schedule of continuous (i.e., FR1) reinforcement is initially recommended to produce rapid behavior change (Lovaas, 2003), the schedule should be thinned to an intermittent one once an individual is engaging in high levels of correct independent responses (LeBlanc et al., 2002). Schedule thinning can involve either an increase in the response requirement before delivery of a reinforcer or an increase in the time interval preceding delivery of the reinforcer (LeBlanc et al., 2002). Because behavior analysts tend to focus on thinning the frequency of reinforcement rather than delay (Love et al., 2009), this section will focus on dense-to-lean schedules rather than delay schedules (see Carroll et al., 2016, for an example of the effects of delay on acquisition; see Freeland & Noell, 2002, for an example of delay thinning in special education).

There are few resources to guide reinforcement-schedule thinning during skill-acquisition interventions. For example, manuals by Fovel (2013), Lovaas (2003), and Maurice et al. (1996) all recommend moving to intermittent reinforcement schedules; however, none of them include recommendations for accomplishing this. Given the paucity of clear recommendations, LeBlanc et al. (2002) suggested that behavior analysts are likely relying on “common lore and best guesses.” Below, we offer an overview of strategies researchers have used to transition from continuous (i.e., FR1) to intermittent schedules of reinforcement and describe the conditions under which behavior analysts might select to achieve a leaner schedule of reinforcer delivery.

Overview

In general, behavior analysts begin transitioning from a FR1 to an intermittent schedule once the individual has demonstrated skill acquisition mastery under a FR1 schedule of reinforcement (e.g., Conine et al., 2020). A behavior analyst can accomplish thinning by arranging reinforcers to follow either a certain number of responses (i.e., ratio schedule) or the first response after a certain amount of time has passed since the last reinforcer (i.e., interval schedule). Additionally, these ratio and interval schedules can be arranged in a fixed (i.e., recurring value) or varied (i.e., mixed values) manner, with each combination producing different patterns of responding (Catania, 2013; Ferster & Skinner, 1957). The therapeutic goal of transitioning from a dense schedule to a lean schedule of reinforcement is to maintain the newly acquired response on a schedule of reinforcement that is more feasible for those responsible for managing it in the everyday environment.

Thinning Progression

There is no prescribed process to thin reinforcement in skill-acquisition programs. However, there are general suggestions and examples available throughout the literature that can be drawn upon for behavior analysts to use as a reference when deciding upon an approach to meet their client's needs. First, behavior analysts should begin the thinning process after responding has met a predetermined criterion (e.g., three consecutive sessions with 100% correct responding; see Richling et al., 2019, for a review and experimental analysis of mastery criteria). Second, a reinforcement delivery schedule should be decided upon and followed systematically during the thinning process. There are examples of interval schedules in the behavior analytic literature (e.g., Garner et al., 2018; Martens et al., 2002); however, survey data suggest that most behavior analysts are likely to rely on the use of ratio schedules to thin in practice (Love et al., 2009). In fact, LeBlanc et al. (2002) recommend increasing the number of responses required to produce a reinforcer when target behavior should occur at moderate-to-high levels with a steady or increasing trend. Because this is often the goal for target behavior in skill-acquisition programs, transitioning from dense-to-lean ratio schedules may be most recommended.

Third, a schedule-thinning progression should be decided upon and followed systematically during the thinning process as well. Due to the issues generated by fixed schedules of reinforcement (i.e., pausing, scalloping), the use of variable schedules to thin reinforcement may be most desirable (Bancroft & Bourret, 2008). A behavior analyst can arrange reinforcers to follow an average number of responses or an average amount of time since the last reinforcer in a variable ratio (VR) and a variable interval (VI) schedule, respectively. A VR schedule is likely to lead to steady responding at lower levels than a fixed-ratio schedule, but the VR schedule is also likely to reduce pausing following delivery of the reinforcer. This is because the reinforcer is delivered after a range of responses with a specified mean (Catania, 2013), so the response which will produce a reinforcer varies from one opportunity to the next (DeLeon et al., 2013). A VI schedule is likely to generate moderate and relatively stable levels of responding (Catania, 2013). The selection of the distribution values in VR and VI schedules is important (i.e., more shorter intervals than moderate or long intervals will generate higher response rates following reinforcer delivery, DeLeon et al., 2013).

Fourth, during the thinning process, it is recommended that each thinning step is experienced for at least two sessions to verify that the response is consistent before advancing. Slow, gradual thinning can promote steady progress, but there is no indication that this is an efficient practice (LeBlanc et al., 2002). To potentially increase efficiency, a behavior analyst may decide to probe responding under leaner schedules of reinforcement to determine whether the gradual thinning of reinforcement is necessary (LeBlanc et al., 2002). However, behavior analysts should wait until the individual has progressed through half of the thinning steps before probing performance under the terminal schedule (LeBlanc et al., 2002). The behavior analyst should proceed with caution as gains can be lost if reinforcement is thinned too quickly. Responding may change briefly when each phase of thinning is initiated, but responding should return to similar levels with continued exposure. If responding continues to decrease or stabilizes at a low or moderate level, then the behavior analyst should return to a previous schedule until high, stable levels of responding return before initiating further thinning.

Importantly, behavior analysts should make informed decisions about when to begin and how to proceed with the thinning process if they continually monitor and make changes based on the individual's response to thinning. Additional research needs to be conducted to identify the optimal procedures to thin reinforcement in behavior-analytic skill-acquisition procedures.

Desired Response Pattern

The goal of reinforcement thinning in skill-acquisition interventions is to maintain the levels of performance achieved during dense, FR1 schedules of reinforcement under lean, intermittent schedules of reinforcement. That is, the goal is for the individual to emit the target response under relevant antecedent conditions despite changes in reinforcer delivery.

Considerations

Deciding between variable- or random-ratio schedules Behavior analysts may choose an arithmetic progression with values that change by a fixed constant (e.g., VR2, VR4, VR6, VR8) or a geometric progression by doubling the previous value (e.g., VR2, VR4, VR8, VR16; DeLeon et al., 2013). Using this approach, the probability for reinforcement increases across successive trials without reinforcement, and the passage of unreinforced trials could become a discriminative stimulus. However, doubling the response requirement in this manner can pose a problem when the requirement becomes quite large (LeBlanc et al., 2002), especially if there are few short ratios included. Therefore, DeLeon et al. recommend using a random ratio (RR) schedule when values become relatively large, because the probability that a response will be reinforced remains constant over successive responses. Behavior analysts can incorporate this strategy into their practice by using Microsoft Excel macros to generate RR (and VR) schedules (Bancroft & Bourret, 2008) or rolling a die (available with four to 100 sides; DeLeon et al., 2013) following a response to determine whether it will be reinforced. Additionally, the ubiquity of devices like smartphones and tablets could provide a digital option for creating and applying VR or RR schedules of reinforcement across responses.

Using a VI schedule To use a VI schedule in practice, a behavior analyst must carefully select and specify the distribution of intervals (Catania & Reynolds, 1968). Baker (1979) recommends a VI with values falling within a range of plus or minus one unit (p. 56). For example, a VI 1-min schedule would have a minimum of 1 s and a maximum of 2 min. Like the VR, the probability that a response will be reinforced increases as time passes without a reinforcer in VI (DeLeon et al., 2013). Therefore, the use of a random interval (RI) schedule may be beneficial.

Bancroft and Bourret (2008) provide a tutorial for setting up Microsoft Excel Macros to generate VI and RI schedules to use in practice. Baker (1979) provides instructions on how to create audio recordings that include a stimulus (e.g., tone, beep) at different intervals; the instructions can be updated to take advantage of audio recording applications on electronic devices. A behavior analyst may choose to purchase an interval timer to help with implementation, too. There are many different interval timers available as physical timers or digital applications, but few appear to have the capacity to run a VI or RI schedule. A physical timer with FI, VI, and RI capabilities is the MotivAider® by Behavioral Dynamic, Inc. A digital application with the capacity to use VI schedules with preset mean durations between 1 min and 15 min is R+ Remind™ by Pyramid Educational Consultants.

Some Strengths and Limitations of Transitioning from Continuous to Intermittent Schedules

As already mentioned, there is little practical guidance as to how to thin reinforcement including: (a) when to start the thinning process, (b) how quickly to thin reinforcers, and (c) how to communicate thinning to the individual (Katz & Vinciguerra, 1982). Nevertheless, a behavior analyst should not adopt a train-and-hope approach; rather, a behavior analyst should plan how and when to thin the reinforcement schedule (LeBlanc et al., 2002). No matter which intermittent schedule a behavior analyst selects in practice, one should not expect that a behavior acquired under dense schedules of reinforcement will maintain and generalize when the extrinsic reinforcers are removed or reduced abruptly (Stokes & Baer, 1977). For instance, a behavior analyst should be aware that as the reinforcement schedule is thinned, the reinforcer becomes more "expensive." That is, the individual needs to emit more and more instances of the target behavior to attain the same amount of reinforcement. As the unit price increases, it is possible that the reinforcer may become inefficacious (DeLeon et al., 2013). This may be especially likely if the therapist offers access to the same reinforcers outside of skill-acquisition programs in an open economy (DeLeon et al., 2013). When thinning, it could be beneficial to restrict access to reinforcers outside of instructional time in a closed economy. Further, if the "price" of accessing the item is increased, it may also be advantageous to alter the relevant dimensions of the reinforcer (e.g., quality, magnitude) to maintain an appropriate work-to-reinforcement ratio (Briggs et al., 2018a, 2019). A behavior analyst should also recognize that preferences change over time and conduct preference assessments regularly (Piazza et al., 2011).

It can be difficult to determine the terminal schedule when thinning reinforcement. A behavior analyst may determine the terminal schedule by monitoring the individual's response to thinning and maintenance of responses over time. A behavior analyst could also consider using a progressive-ratio schedule to identify an individual's break point to guide the selection of terminal-reinforcement schedules to use in skill-acquisition interventions (Catania, 2013). Using the learner's response to thinning, duration of responding under maintenance or extinction conditions, and a progressive-ratio schedule to determine the terminal schedule for thinning could be beneficial in practice. These suggestions require systematic investigation in research.

It is important to consider the behavior-change agent's repertoire and competing contingencies when designing a plan for thinning reinforcement. If opting to use an interval schedule, a behavior analyst may select intervals that are easy for therapists and caregivers to use (e.g., 15 s, 1 min; LeBlanc et al., 2002). If opting to use a VR schedule, a behavior analyst should plan which responses will produce a reinforcer. This requires monitoring responding across opportunities, avoiding the presentation of any additional antecedent stimuli that may become correlated with the delivery of reinforcement, and creating different combinations to avoid potential schedule control (Baker, 1979). A behavior-change agent may find a VR2 easy to use in applied contexts because it only requires three ratios (i.e., 1, 2, 3); nevertheless, the order of these ratios needs to be randomized and monitored to ensure that reinforcers are delivered on a truly variable schedule rather than a predictable sequence of numbers.

Concern about additional controlling stimuli may be especially important when reinforcement thinning is used to promote generalization. When arranging indiscriminable contingencies (Stokes & Baer, 1977), it is important that stimuli present in the environment prior to the response do not predict whether a response will be reinforced. For example, the therapist could move her hand close to a reinforcer when the next response will be reinforced. These antecedents could come to be discriminative for reinforcement and negatively affect the likelihood that an individual will respond during generalization probes (i.e., false negative).

Immediate, continuous (i.e., FR1) reinforcement schedules are often unsustainable in most natural settings (Fisher et al., 2000), so another benefit of intermittent schedules is that the reinforcement procedure should be more manageable in the clinic or home environment. In addition, descriptive analyses of treatment integrity of behavioral interventions revealed inconsistent tangible, edible, and social stimuli (e.g., praise) delivery by paraprofessionals, special education teachers, and behavior therapists working with students and clients with autism spectrum disorder (e.g., Breeman et al., 2020; Carroll et al., 2013; Kodak et al., 2018). However, descriptive analyses of treatment integrity in behavioral skill-acquisition programming should examine adherence to different reinforcement schedules more closely.

Concluding Comments

Familiarity with the various methods for thinning reinforcement is critical for behavior analysts if their goal is to promote durable treatment outcomes. That is, when the intervention does not require much caregiver involvement because naturally occurring reinforcement contingencies are in effect, long-term treatment success is much greater. This outcome is accomplished when behavior analysts thoughtfully and systematically thin an intervention's reliance on reinforcement while simultaneously maintaining its desirable treatment effects. We review general approaches for achieving this outcome and provide considerations that may improve the likely success of each thinning progression. Another method for reducing the reliance on delivering potent primary reinforcers on relatively dense schedules of reinforcement is by transitioning from using primary to conditioned reinforcers. Strategies for establishing conditioned reinforcers are discussed in the *Stimulus Pairing* chapter (Chap. 10) and methods for operating a reinforcement system that involves exchanging generalized conditioned reinforcers for backup reinforcers are discussed in the *Token Economies* chapter (Chap. 32) of this book.

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7 Behavioral Momentum Theory

Sean W. Smith and Brian D. Greer

The concept of response strength was one of the first principles of behavior to be identified within the field of behavior analysis. Thorndike's (1911) initial formulation of the law of effect is often considered the origin of the concept of response strength (Nevin & Wacker, 2013). Thorndike's initial description suggests that "impulses" would be "stamped in" if they were "successful" and "stamped out" if they were unsuccessful, but the more general finding was that organisms learn based on the consequences of their responses, and this learning influences how the organism responds in the future. Said another way, the consequences of a response would strengthen or weaken the response. Although this strengthening or weakening can influence future responding along numerous dimensions (e.g., resistance to change, amplitude, latency), Skinner staunchly advocated for response probability as the primary measure for the science of behavior (e.g., Skinner, 1963, 1966). Although this conceptualization creates difficulties because response probability cannot be observed or measured directly, Skinner and other researchers argued that response rates measured during free-operant procedures serve as a reliable index of response strength. The field of behavior analysis came to adopt a refined conceptualization of the law of effect in the form of reinforcement theory, which generally states that the consequences that follow a response will influence the future probability (i.e., strength) of that response in similar contexts. A notion implicit in reinforcement theory is that more reinforcement will produce more response strength (Shahan, 2017). Notably, this reformulation not only establishes that consequences influence the strength of a response, it also focuses on response probability, as measured by response rate, as the primary dimension of behavior.

This refined conceptualization of reinforcement theory has had an indelible effect on subsequent behavior-analytic research. In the basic laboratory, development of the matching law

Author Note
Grants 2R01HD079113, 5R01HD083214, and 5R01HD093734 from the National Institute of Child Health and Human Development provided partial support for this work.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_7

(Herrnstein, 1970) was directly influenced by the idea that reinforcement strengthens behavior and that response rate is the appropriate index for response strength. Indeed, this was the primary theoretical explanation for Herrnstein's successful quantification of the functional relation between reinforcer deliveries and response rates. In the applied domain, Thomasson-Sassi et al. (2011) used the concept of response strength to develop a novel method for assessing severe problem behavior. Behavior-analytic theory has also benefited. Palmer (2009) leveraged the concept of response strength to provide behavior-analytic interpretations of complex verbal behavior. This conceptualization has and continues to influence research with nonhuman and human animals, in basic and applied settings, with simple and complex responses.

Despite the pervasive application of the concept of response strength, there are important limitations to focusing on response rate as an index of response strength. One simple example of this limitation is the different steady-state response patterns generated by ratio and interval schedules of reinforcement. Response rates under ratio schedules tend to be higher than those under interval schedules when obtained reinforcer rates are comparable (Baum, 1993). As noted previously, the concept of response strength generally suggests that more reinforcement will produce greater response strength, but these schedules of reinforcement produce different response rates with the same amount of reinforcement. Other research has shown that varying reinforcer magnitudes have different effects on response rates maintained by interval and ratio schedules of reinforcement (Lowe et al., 1974), suggesting that other aspects of the reinforcement schedule also influence response rate. These and other research findings suggest that response rate is not a reliable measure of response strength because response rate can be influenced by variables that are not hypothesized to be associated with response strength. Said another way, response rate does not fully describe the strength of a response.

Resistance to Change as a Measure of Response Strength

Although Skinner suggested that response strength should be measured by the rate that organisms engage in observable responses, Nevin and Grace (2000) argued that a behavior's resistance to change may be an equally, if not more, valid measure of response strength. Nevin and Grace (2000, p. 75) provided the following analogy:

> Concrete is said to be reinforced with steel rods to make it stronger as a building material. In this expression, "reinforcement" implies an increase in durability or resistance: Under an added load, a reinforced concrete wall does not collapse as readily as an unreinforced wall. However, an observer could not determine, by looking at it before a load test, whether the wall had been reinforced or how many steel rods had been used… By analogy, we suggest that more frequently or generously reinforced behavior becomes more resistant to challenge or disruption, and this increase in its resistance need not imply an observable increase in the rate or probability of currently observed behavior. Instead, the strengthening effects of reinforcement may be evident only when responding is disrupted in some way.

Measuring Resistance to Change

Researchers typically measure resistance to change by establishing steady state responding and then introducing a disrupter to the environment. This allows the researcher to compare response patterns before and after introduction of the disrupter. If the disrupter has little effect on responding, behavior is said to be resistant to change. The greater the disruption in responding, the less resistant to change the behavior is said to be. Notably, resistance to change is not a dichotomous concept, and responses are not typically categorized as resistant to change or not. Rather, researchers typically describe the relative resistance to change of behaviors by comparing the resistance to change of behavior in one context to the same behavior in a different context or by comparing the resistance to change of one behavior to another.

To compare the relative resistance to change of two or more responses, researchers frequently use multiple schedules of reinforcement. A multiple schedule of reinforcement is composed of two or more simple schedules of reinforcement that are presented successively in separate components signaled by discriminative stimuli. For example, in one component of a multiple schedule, a green light is correlated with pressing a lever to produce food according to a fixed ratio (FR) 5 schedule of reinforcement, but in another component, a red light is correlated with pulling a chain to produce the same food according to a variable interval (VI) 10-s schedule of reinforcement. These components alternate successively, and responding comes under the control of each schedule of reinforcement in the presence of each discriminative stimulus. Recall that resistance to change is typically evaluated by comparing the effects of a disrupter across two or more contexts or responses. Multiple schedules of reinforcement facilitate such comparisons by allowing for the presentation of a single disrupter across schedule components. Researchers can then assess response disruption across the schedule components.

Common Disrupters

Disrupters can take many forms depending on the experimental preparation and the experimental question. For example, a researcher using food reinforcers to maintain lever pressing in rats may disrupt responding by delivering food noncontingently between schedule components or immediately before session (e.g., Nevin, 1974, 1992). Such a procedure would affect the rat's motivation to obtain food, which would allow the researcher to evaluate resistance to change under reduced motivation.

Another common disrupter entails changing the schedule of reinforcement (e.g., terminating reinforcement across multiple-schedule components; Nevin, 1974). Initiating extinction allows researchers to evaluate response persistence, or resistance to extinction, produced by the reinforcement schedules previously in effect. Another common disrupter is the simultaneous presentation of alternative reinforcement (e.g., Nevin et al., 1981). For example, Mace et al. (1988) taught adults with disabilities to engage in a beading task maintained by access to preferred edibles across two components of a multiple schedule. Researchers turned on a television in the room to provide an alternative source of reinforcement to evaluate the extent to which this disrupter would change response patterns across the components of the multiple schedule. These are but a few of the environmental events that can disrupt responding.

Proportion of Baseline

Resistance to change is typically quantified as a proportion of baseline responding. Researchers calculate the mean response rate during the portion of baseline in which responding has stabilized. Researchers then divide the response rate from each session with the disrupter present by the mean baseline response rate. This exercise expresses the results of sessions with the disrupter present as a proportion of baseline responding. Values greater than 1.0 indicate responding above baseline rates, and values less than 1.0 indicate responding below baseline rates. Researchers typically present proportion-of-baseline data as a time series to see fluctuations across time.

Although there are multiple reasons why researchers evaluate resistance to change as a proportion of baseline, the primary reason is that it helps when accounting for differences in baseline response rates (i.e., the starting points of each response). This can be helpful when assessing resistance to change, as the rate of change in responding across conditions is a primary consideration for determining relative resistance to change. Plotting responding as a proportion of baseline enables a visual analysis of how quickly and to what extent the same disrupter affected responding across conditions when considering their respective starting points.

Implications of Resistance to Change as Response Strength

Shifting the conceptualization of response strength away from response probability as measured by response rate and toward resistance to change has several implications for both research and clinical practice. The first implication is that it directs focus away from response–reinforcer relations as the sole determiner of response strength. Skinner's hugely influential work focused primarily on how response strength increases or decreases as a function of whether it was followed by a reinforcing stimulus and how response strength could be quantified as response rate. As noted previously, however, response rates do not accurately reflect response strength because other variables appear relevant. Thus, considering resistance to change as the primary measure of response strength represents a significant shift in how researchers and clinicians conceptualize response strength.

Second, measuring resistance to change rather than response rate shifts the focus of research and clinical practice away from current responding toward what responding will look like when disrupted. The earlier conceptualization that response strength was best quantified as response probability, as measured by response rate, focuses research and practice on responding as it is now. By changing the focus of research to resistance to change, researchers shift their evaluations to focus on what will happen to behavior when disrupters are introduced. In other words, researchers evaluate how much a behavior will persist in the future, despite changes in the environment. Not only does this foster a focus on responding in the future, this focus also has broader implications for clinical practice because the environment is constantly changing in applied settings, making it especially important for clinicians to consider how common disrupters (e.g., a change in context or treatment integrity) may affect treatment efficacy. Although research involving response rates can inform conditions to optimize current response patterns, findings from research on resistance to change can inform treatment modifications that reduce the persistence of problem behavior and increase the persistence of appropriate behavior.

Finally, resistance to change itself can be a clinical concern. For example, core symptoms of oppositional defiant disorder (ODD) and autism spectrum disorder (ASD) can be conceptualized as issues related to resistance to change. People diagnosed with ODD may resist change to such an extent that it causes dysfunction in daily life. Similarly, the restricted interests or behaviors associated with ASD can be conceptualized as resistance to change. Treatments that specifically target resistance to change may target the core symptoms of these disorders by targeting the basic behavioral processes underlying their etiology.

Clinical Treatments for Resistance to Change

Few behavior-analytic studies have referred to treating resistance to change; however, this is likely because resistance to change may be an underlying process from which other problem behavior arises. That is, clinical research may have focused on treating problematic topographies of behavior rather than treating the underlying functions of these responses. For example, it is easy to see how behavior that is resistant to change could simply be considered noncompliance, leading clinicians to consider their treatment as targeting noncompliance rather than resistance to change. We will begin this section with a brief review of one strategy, the high-probability (high-p) sequence, that leverages the concept of resistance to change to address noncompliance. Another important consideration for applied work is whether treatments target the *cause* of change-resistant behavior. We end this section with a discussion of a few recent studies that have begun to probe this consideration.

High-P Sequences

Mace et al. (1988) developed the high-p sequence as a treatment for noncompliance. Before applying this treatment, the clinician first identifies instructions with which the client does not comply. These instructions are considered low-probability (low-p) instructions and are the target of treatment. Next, the clinician identifies instructions with which the client does comply. Typically, these high-p instructions often involve brief, simple responses (e.g., clapping hands). To apply the treatment, the clinician presents several high-p instructions in rapid succession, reinforces compliance with each instruction, and then presents a low-p instruction. The clinician also reinforces compliance with the low-p instruction. Researchers have shown the high-p sequence to be efficacious for treating noncompliance across a wide range of ages, diagnoses, and types of instructions (see Lipschultz & Wilder, 2017 for a brief review). The primary advantage of this treatment compared to other treatments for noncompliance is that it does not require physical guidance, which is important when physical guidance is impossible (e.g., vocal responses) or impractical (e.g., guiding an individual of large physical stature).

Mace et al. (1988) originally attributed the efficacy of the high-p sequence to overcoming the resistance to change of noncompliant behavior. In this conceptualization, all compliant responses are considered a single response class, and noncompliance is a separate response class. By presenting high-p instructions first, the clinician provides the client with the opportunity to engage in compliant responses that the client is likely to emit, increasing the probability that the clinician can then reinforce multiple compliant responses. When compliant responses produce reinforcement, the class of compliant responses is strengthened, which increases the response class's resistance to change. This increased resistance to change causes compliant responses to persist despite the presentation of a disrupter—the low-p instruction. Thus, the client engages in a compliant response to the low-p instruction because of the increased resistance to change of the compliant response class.

There are a number of parameters that clinicians must consider when developing a high-p sequence. First, research has shown that providing high-p instructions without reinforcing compliance will not increase compliance with low-p instructions (Pitts & Dymond, 2012; Zuluaga & Normand, 2008). Second, delivery of more highly preferred and more reinforcing stimuli following compliance with high-p instructions produces higher levels of compliance with low-p instructions than stimuli that are less preferred and less reinforcing (Wilder et al., 2015). Third, other research has demonstrated that shorter intervals between high-p instructions enhance the efficacy of the high-p sequence (Mace et al., 1988; Pitts & Dymond, 2012; Wilder et al., 2015). Fourth, some have recommended using the minimal number of high-p instructions that reliably occasion compliance with the low-p instruction (Cooper et al., 2020). Once compliance is occurring with the low-p instruction, the number of high-p instructions can further decrease while maintaining the treatment effect (Axelrod & Zank, 2012; Belfiore et al., 2008). These findings and recommendations are consistent with the conceptualization that the treatment's efficacy comes from modifying resistance to change.

However, not all research findings bode well for a resistance-to-change conceptualization of the high-p sequence, and some findings present serious obstacles for this account. For example, Bullock and Normand (2006) showed that noncontingent delivery of reinforcers for two children produced increases in low-p compliance similar to that produced by arranging a high-p sequence, and a later study by Normand and Beaulieu (2011) replicated this finding. These findings suggest that simply delivering reinforcers close in time to presenting a low-p instruction is primarily responsible for the efficacy of the high-p sequence. Thus, an alternative account consistent with these findings and those of the prior studies discussed above is that the efficacy of the high-p sequence relies on the arousing (Killeen, 1975; Killeen et al., 1978) and/or discriminative (Cowie & Davison, 2016) properties of reinforcement.

Choice-Based Interventions for Resistance to Change

Fisher et al. (2019) theorized that resistance to change can be described in terms of extreme choice behavior across concurrently available response alternatives (i.e., a change-resistant response and an alternative response). In so doing, Fisher et al. invoked the concatenated generalized matching law (Baum, 1974; Baum & Rachlin, 1969) to describe how extreme choice behavior might develop. They pointed to recent fMRI research that suggests that change-resistant behavior in people with ASD might be maintained by both positive and negative reinforcement contingencies. Based on this account, the authors evaluated a choice-based treatment for the change-resistant behavior of four participants with ASD. In the free-choice condition, the participant could engage in either a change-resistant or alternative response and contact the natural reinforcers associated with each response without any additional programmed consequence. The asymmetrical-choice condition was identical except that participants also received their most highly preferred item following alternative behavior, whereas no additional reinforcers were provided following the change-resistant behavior. In the guided/single-choice condition, alternative behavior was the only response option, but it produced the same reinforcer as choosing the alternative response during the asymmetrical-choice condition.

Fisher et al. (2019) found that most participants continued to engage in change-resistant behavior exclusively during the free-choice condition and that initial exposure to the asymmetrical-choice condition either had no effect or caused insufficient alternative responding to be clinically acceptable. Exposure to the guided/single-choice condition always produced high levels of alternative behavior. Importantly, for four of six applications of these procedures, repeated exposures to the guided/single-choice condition resulted in higher levels of alternative behavior during reversals to the asymmetrical-choice condition. This last finding suggests that engaging in an alternative response and experiencing reinforcement following that response may be sufficient to overcome some clinically significant change-resistant behavior.

Crowley et al. (2020) extended the research of Fisher et al. (2019) by applying the same general procedures to seven participants with clinically significant food selectivity. For two participants, the asymmetrical-choice condition was sufficient to allocate responding to the alternative response and away from the change-resistant response. The remaining five participants engaged in similar patterns of responding as participants in the study by Fisher et al., with the asymmetrical-choice condition alone producing clinically significant increases in alternative responses following forced exposure to the consequences associated with the alternative response. Importantly, responding for every participant shifted from the change-resistant response during the asymmetrical-choice condition by the end of the experiment. Further, for five of the seven participants, exposure to the guided/single-choice condition not only shifted response allocation during subsequent asymmetrical-choice conditions for those foods, but also for other, nontarget foods. This last finding is particularly important because it suggests that exposure to reinforcing consequences for engaging in alternative responses can generalize to untreated choice situations.

A Theory of Behavioral Momentum: Extending the Concept of Resistance to Change

Behavioral momentum theory (BMT) asserts that response strength is defined by a behavior's resistance to change and extends this notion using an analogy. Newton's second law of mechanics states that changes in an object's velocity are directly proportional to the magnitude of the force exerted on the object and inversely proportional to the object's mass. This general principle is often reformulated to describe momentum, which is equal to the product of the object's mass and the object's velocity. Nevin et al. (1983) suggested that a similar analogy can be applied to behavior such that response rate is analogous to an object's velocity, a disrupter (as described above) is analogous to the force exerted on the object, and the behavior's resistance to change is analogous to the object's mass. Based on this conceptualization, a change in the response rate of ongoing behavior will be directly proportional to the size of the disrupter and inversely proportional to the behavior's resistance to change. Stated more simply, a larger disrupter will cause a larger change in response rate than a smaller disrupter, and a response with more resistance to change will be disrupted less than a behavior with less resistance to change. Although this may seem intuitive, the implications of this conceptualization are far-reaching and have been highly influential in the field of behavior analysis.

BMT was a major step forward for behavior analysis in that it provided an empirically derived and plausible alternative to the Skinnerian conceptualization that response strength is defined by response probability as expressed by response rate. BMT states that resistance to change is driven by stimulus–reinforcer relations (i.e., Pavlovian conditioning) and not response–reinforcer relations (i.e., operant conditioning) that underpinned prior conceptualizations of response strength. This marked an important change in our understanding of response strength because BMT invoked both a different measure for response strength and a different behavioral process by which response strength was thought to be governed.

A second implication of BMT was that the variables determining behavioral persistence could now be described quantitatively. Although a full description of the mathematics underlying BMT is outside the scope of this chapter (interested readers should refer to Nevin & Grace, 2000), expressing behavioral principles mathematically is advantageous for a number of reasons. Quantitative models allow researchers to (a) efficiently summarize large amounts of data, (b) formalize the behavioral processes believed to underlie the phenomena of interest, (c) clearly describe relations that are difficult to convey in words, (d) make explicit and novel predictions that can be empirically evaluated, and (e) allow for revisions in theory when predictions are not supported by empirical evaluation (Critchfield & Reed, 2009; Greer & Shahan, 2019; Mazur, 2006).

Resistance to Change and Response Rate

In a now seminal study, Nevin et al. (1990) showed that response rate and resistance to change are separate dimensions of behavior. In Experiment 2, pigeons experienced a three-component multiple schedule in which each component was signaled by the color of two response keys. Across components, two schedules of reinforcement were concurrently in effect for pecking the right (target) and left (alternative) response keys. Available reinforcers were delivered according to VI schedules. In Component A, both response keys were green. Target responses produced 15 reinforcers per hour, and alternative responses produced 45 reinforcers per hour for a total of 60 reinforcers available per hour across the two keys. In Component B, both response keys were red. Target responses produced 15 reinforcers per hour, and alternative responses were placed on extinction for a total of 15 reinforcers available per hour across the two keys. In Component C, both response keys were white. Target responses produced 60 reinforcers per hour, and alternative responses were placed on extinction for a total of 60 reinforcers available per hour. The experimenters established steady state responding within each component and then introduced extinction for both responses across the three components to evaluate relative resistance to change. This general arrangement allowed the researchers to compare resistance to change when the total number of reinforcers differed but were held constant for the target response (Component A compared to Component B) and when the total number of reinforcers were held constant but their distribution differed (Component A compared to Component C). Figure 7.1 depicts representative data from this experiment.

In Experiment 2, Nevin et al. (1990) found lower baseline rates of target responding when

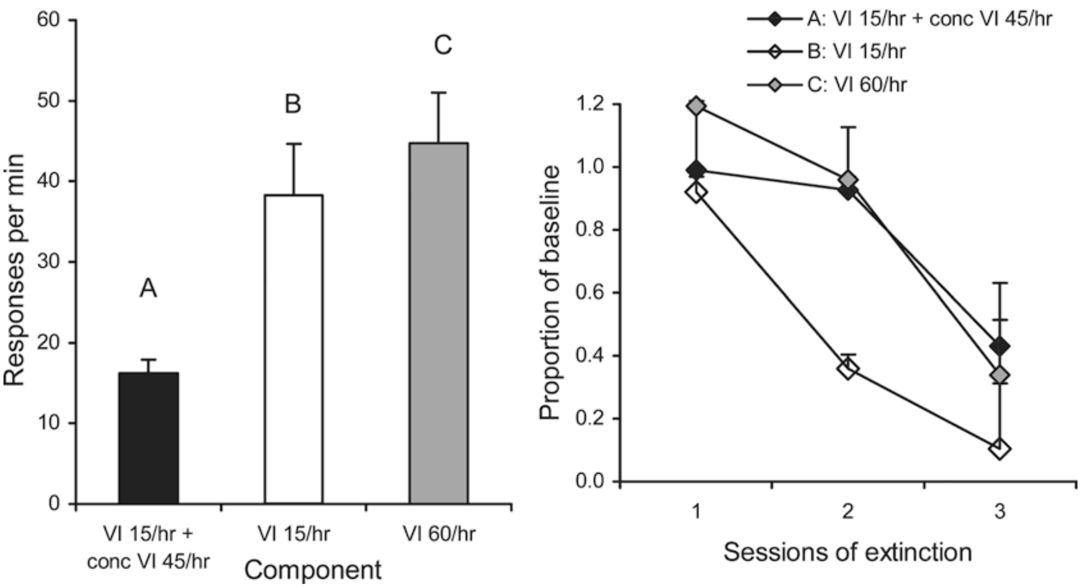

Fig. 7.1 Nevin et al. (1990) Data Reanalyzed by Nevin and Shahan (2011). *Note*. Data represent averages and standard error for three pigeons from Nevin et al. (1990, Experiment 2) as reanalyzed by Nevin and Shahan (2011). In the left panel, each bar represents target response rates. Component A = differential reinforcement of alternative behavior (DRA) available; Component B = DRA unavailable; Component C = DRA unavailable but with reinforcer rate yoked to Component A. The right panel shows target responses for each component during extinction, expressed as a proportion of baseline responding

reinforcers were available for the alternative response (Condition A) as compared to when alternative reinforcement was unavailable (Conditions B and C). However, the most important finding of Experiment 2 was that the total number of reinforcers delivered in baseline determined the persistence of target responding during extinction and that this finding was not attributable to baseline response rates or whether reinforcers were delivered for target or alternative responding. Responding persisted to a similar and greater degree in Components A and C than it did in Component B, even though Components A and B arranged the same schedules of reinforcement for target responding. The additional reinforcers delivered in Component A for alternative responding and in Component C for target responding increased the resistance to change for target responding to a greater extent than in Component B.

The study by Nevin et al. (1990) is important for at least two reasons. First, it demonstrated that response rate and resistance to change are independent dimensions of behavior. A comparison of Components A and B in Fig. 7.1 shows that decreased response rates in baseline did not lead to decreased resistance to change during extinction. Interpreting this finding from another perspective suggests that response rates during disruption cannot be predicted by baseline response rates alone.

Operant vs. Pavlovian Processes

A second important contribution of Nevin et al. (1990) was the demonstration that stimulus–reinforcer pairings impact resistance to change. Recall that when extinction sessions began, the only difference between the components was the discriminative stimuli. This suggests that the discriminative stimuli facilitated the differentiated responding during extinction. More specifically, it was the prior pairing of the discriminative stimuli with different numbers of reinforcer deliveries during baseline that produced differences in resistance to change during extinction. Because Components A and B delivered a similar number of reinforcers contingent on target responding, differences in resistance to change could not have been caused by a different number of response–reinforcer pairings. The additional reinforcer deliveries for the alternative response in the presence of the specific discriminative stimulus likely increased resistance to change. Thus, resistance to change is likely impacted by stimulus–reinforcer pairings.

The development of BMT marked a profound change in how researchers and clinicians conceptualized response strength. It also had important implications for clinical practice in that it placed greater emphasis on response persistence and the role of Pavlovian conditioning histories as they relate to clinical effectiveness. Revisions to what constitutes treatment maintenance were also driven by clinical researchers developing an increased awareness and interest in BMT (Nevin & Wacker, 2013).

Behavioral Momentum Theory and Treatment Relapse

Treatment relapse is the recurrence of problem behavior to clinically unacceptable levels following successful intervention. There are many reasons why treatment relapse occurs (e.g., momentary decreases in reinforcer rate, a change in setting or implementer), and researchers have found some success in extending BMT to explain one form of relapse, called resurgence. Before diving into these extensions of BMT, an overview of resurgence is in order.

Resurgence is a prevalent form of treatment relapse that occurs following treatments involving differential reinforcement of alternative behavior (DRA), such as functional communication training (FCT; Briggs et al., 2018; Muething et al., 2020). Resurgence in the clinic is said to happen when problem behavior recurs because of worsening in alternative reinforcement conditions (Lattal et al., 2017). Such a worsening in alternative reinforcement conditions can take many forms, such as increasing the delay between an alternative response and its reinforcer, decreasing alternative reinforcer magnitude, increasing response effort or the response requirement for an alternative response, thinning the schedule of alternative reinforcement, and programming extinction for an alternative response. From a clinical perspective, some of these events may be planned (e.g., reinforcement schedule thinning), but others occur at unplanned times and can be considered treatment integrity errors. Resurgence is a particularly important phenomenon to understand because treatments involving DRA are common in clinical practice (Petscher et al., 2009).

Shahan and Sweeney (2011) extended BMT by developing a quantitative model of resurgence. We will not get into the weeds so to speak with the nuances of the quantitative model itself but will provide a narrative overview.

According to the BMT account of resurgence described by Shahan and Sweeney (2011), reinforcers delivered during DRA-based treatments serve two important functions. First, they act as a source of disruption for problem behavior, helping to suppress problem behavior when DRA is in effect. Second, reinforcers delivered in treatment strengthen the stimulus–reinforcer relations that enhance resistance to change, regardless of how those reinforcers are delivered (e.g., response independently or for alternative behavior or the nonoccurrence of problem behavior). One important implication of this interpretation is that DRA-based treatments for problem behavior may suppress problem behavior in the here and now, but the delivery of additional reinforcers in treatment increases the strength of alternative behavior, as well as problem behavior. Fast forward to when treatment is challenged by a disrupter (e.g., extinction), alternative reinforcement may suppress problem behavior to a lesser extent (or not at all), and recently strengthened, but not recently occurring, problem behavior is likely to recur.

There are two important considerations worth making at this point. First, a BMT account of resurgence is not limited to DRA-based interventions (see Nevin & Shahan, 2011; Shahan & Sweeney, 2011 for elaboration), meaning that other commonly used treatments for problem behavior that involve alternative reinforcement are also susceptible to resurgence. Second, the quantitative model put forth by Shahan and Sweeney (2011) provided the ability to predict in advance the results of different types of baseline histories and treatment procedures on the magnitude of the resurgence effect. This latter point is especially important because basic and applied researchers alike could now reevaluate previously published resurgence data through a BMT lens and develop new methods for manipulating resurgence in future research (see Greer et al., 2016 for a tutorial on using BMT for such purposes).

Validation of a BMT Account of Resurgence

Figure 7.2 shows target response rates depicted as a proportion of baseline from three laboratory-based studies on resurgence, shown here for the purposes of conveying the accuracy of BMT's quantitative predictions of resurgence. In each of the four panels of Fig. 7.2, dotted and dashed lines are superimposed onto the data paths for two conditions—a treatment phase in which alternative reinforcement was available (labeled "R_a") and a subsequent phase of extinction (labeled "No R_a"). Solid data points and solid lines depict responding and BMT model fits for conditions in which a dense (or rich) schedule of alternative reinforcement was in effect during treatment. Open data points and dashed lines depict responding and BMT model fits for conditions in which a lean schedule of alternative reinforcement was in effect during treatment. In each case, the quantitative model of BMT closely matched the obtained data in both the treatment and extinction phases, accounting for >90% of the variance in the obtained data for each study.

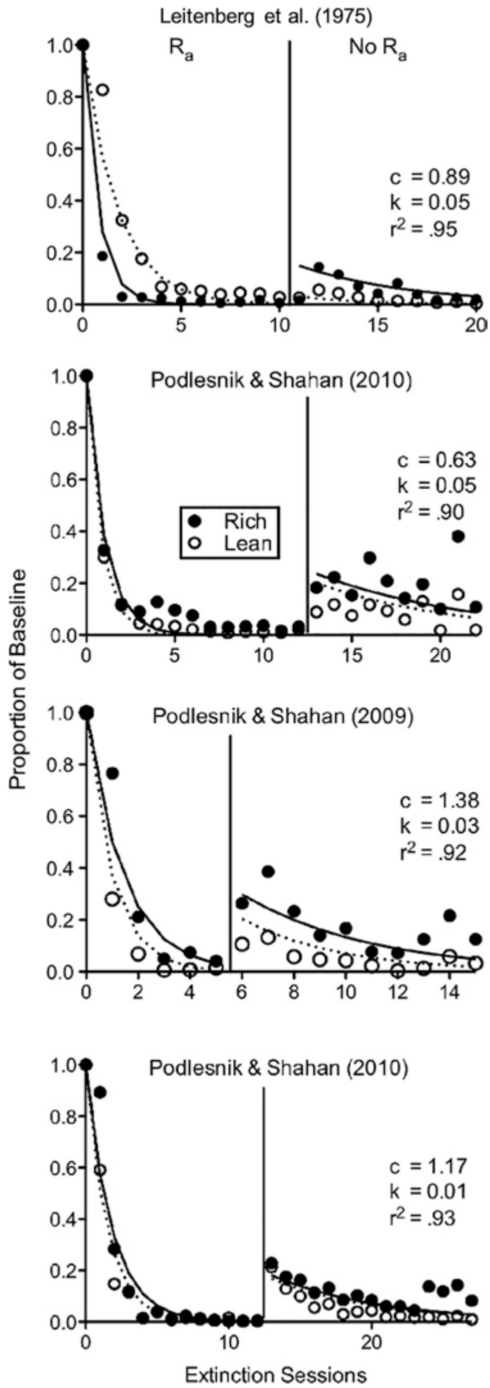

Fig. 7.2 Data Reanalyzed by Shahan and Sweeney (2011). *Note.* Data points represent target responding during extinction of target responses expressed as a proportion of baseline responding obtained during experiments evaluating resurgence with non-human subjects. Solid and dashed lines represent values predicted by BMT for the closed and open data points, respectively. The top panel represents data from an experiment that programed rich

Fig. 7.2 (continued) (closed circles) or lean (open circles) rates of reinforcement for alternative responses in the R_a phase. The bottom three panels represent data from experiments that programed rich or lean rates of reinforcement for target responding during baseline (not depicted)

Perhaps more importantly, each experiment involved a manipulation of some independent variables across experimental groups, and the effect of each manipulation was predicted accurately. For example, in the top panel of Fig. 7.2, after the researchers established stable baseline target responding (not depicted), the researchers delivered reinforcers for alternative responses (i.e., R_a) according to a dense (i.e., VI 30-s) or lean (i.e., VI 240-s) schedule, then implemented extinction (i.e., No R_a). In this experiment, the denser schedule of alternative reinforcement produced more rapid reductions in target responding but resulted in more target responding when alternative reinforcement was suspended. The quantitative model of BMT described these findings well.

The bottom three panels in Fig. 7.2 depict data from similar experiments except that the reinforcement schedules during baseline varied across experimental groups. Because BMT suggests that resistance to change and response strength are caused by Pavlovian stimulus–reinforcer relations, denser schedules in baseline should strengthen the target response to a greater extent than leaner schedules, which should generate more persistence of target responding when the DRA disrupter is introduced and more resurgence when that disrupter is later removed. Data from these three experiments support this assertion as well. These and other promising findings eventually gained the attention of applied researchers who began using the conceptual framework of BMT and its quantitative predictions to refine clinical service delivery.

Applications to Clinical Practice

Numerous translational studies have been conducted based on the predictions of BMT that have suggested improvements to traditional treatment procedures. Fisher et al. (2018a) synthesized the results of four such studies to evaluate the overall predictive validity of BMT as it applies to resurgence and its utility for mitigating resurgence. In this paper, the research team reanalyzed data from studies evaluating (a) the effects of a BMT-informed treatment and a non-BMT-informed treatment on the resurgence of problem behavior (Fisher et al., 2018b), (b) DRA-based treatments for problem behavior with and without discriminative stimuli (Fuhrman et al., 2016), (c) DRA-based treatments with and without extinction in place for problem behavior (Brown et al., 2020), and (d) NCR-based treatments with and without extinction in place for an analogue to problem behavior (Saini et al., 2017). Each study compared two conditions, one informed and one not informed by the predictions of BMT. For example, BMT predicts that arranging leaner schedules of reinforcement in baseline and in treatment and conducting more treatment sessions than typical should lessen resurgence when compared to a condition that arranged dense schedules of reinforcement in baseline and in treatment and fewer treatment sessions. Fisher et al. (2018b) tested this hypothesis using a clinical population and found that the BMT-informed condition better suppressed the resurgence of problem behavior. Each of the other translational studies similarly showed that the BMT-informed condition better suppressed resurgence than did the non-BMT-informed condition. Figure 7.3 displays the results of fitting the BMT model of resurgence to the data from those four studies. Although the model accounts for less of the variability in these datasets compared to the studies with nonhuman animals in Fig. 7.2, the BMT model of resurgence captured the translational data from human participants and clinically relevant responses to a satisfactory degree, suggesting reasonable predictive validity of using BMT to modify clinical interventions.

In addition to the general accuracy of the predictions made by the quantitative model, the BMT-informed condition used in Fisher et al. (2018b) reduced resurgence by an average of 65.1% relative to the non-BMT-informed condition, and the BMT-informed condition in Fuhrman et al. (2016) produced an average reduction of 82% in destructive behavior relative to the non-BMT-informed condition. In a follow-up to the study by Fuhrman et al. (not depicted in Fig. 7.3), Fisher et al. (2020) showed that the same BMT-informed treatment produced 81%

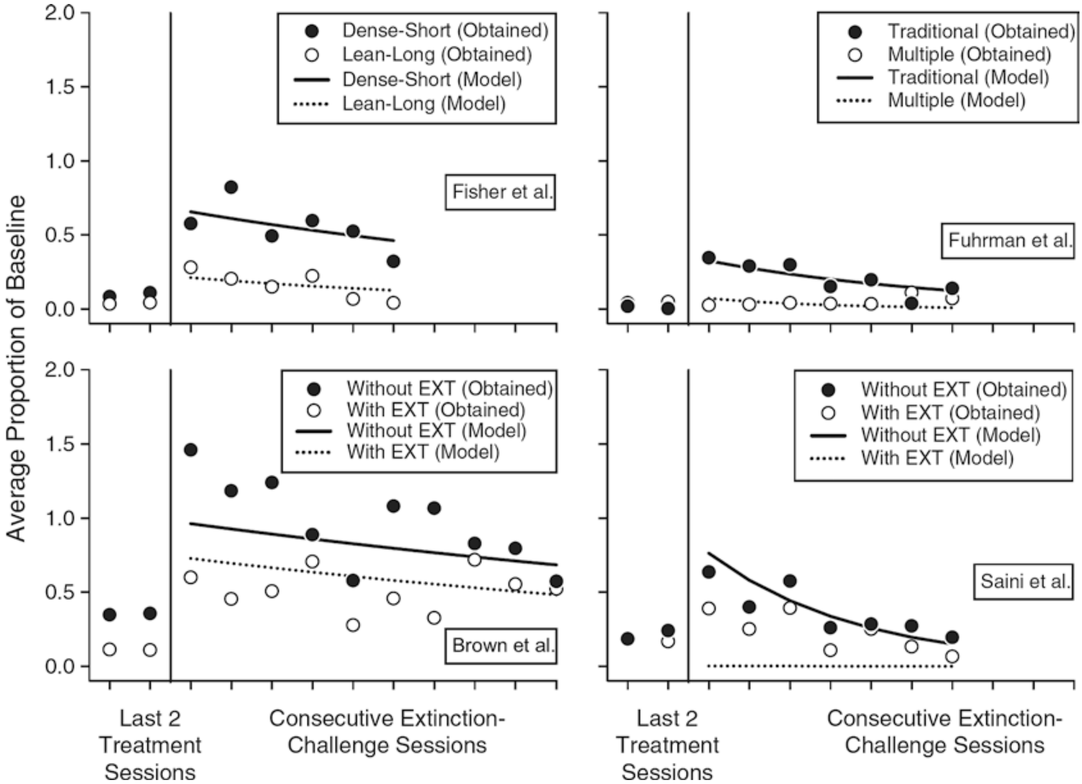

Fig. 7.3 Data Reanalyzed by Fisher et al. (2018a). *Note.* Data points represent the average rate of target responding for participants expressed as a proportion of baseline responding during the last two treatment sessions and extinction-challenge sessions (i.e., when all reinforcement was withheld) during four different studies evaluating resurgence with human participants. Open and closed data points represent BMT-informed conditions and non-BMT-informed conditions, respectively. Dashed and solid lines represent values predicted by BMT for the open and closed data points, respectively

less resurgence on average than a non-BMT-informed treatment for four additional participants. Similar reductions in resurgence can be seen for the other two studies in Fig. 7.2. Taken together, these translational studies demonstrate the potential for BMT to refine clinical practice and the value of translating basic research findings into practice more generally.

Limitations of BMT

Despite the influential role that BMT has played in both the basic and applied realms, there are notable empirical and conceptual limitations to BMT. For example, there are several studies showing that factors other than simple Pavlovian stimulus–reinforcer relations affect resistance to change, and BMT fails to account for extinction bursts (see Nevin & Grace, 2000, p. 84–85 for brief discussions of both topics). Further, the extensions of BMT to applied issues may have conceptual limitations. For example, although the high-p sequences discussed earlier were originally conceptualized as an effect of behavioral momentum, ultimately it seems unlikely that behavioral momentum is responsible for the efficacy of high-p sequences (Nevin, 1996). Based on the results of Nevin et al. (1990) and BMT more generally, delivering reinforcers for compliance with high-p instructions should also increase the strength of noncompliance, so it remains unclear whether the principles of BMT are actually related to the efficacy of high-p sequences (see Nevin, 1996 for a discussion of this and other considerations).

Other conceptual concerns arise with the extension of BMT to resurgence (see Craig & Shahan, 2016; Greer & Shahan, 2019; Shahan & Craig, 2017 for more comprehensive discussions of the points that follow). One conceptual flaw with the extension of BMT to resurgence comes from the underlying assumption that resistance to extinction is caused by Pavlovian stimulus–reinforcer relations. Based on this assumption, the extension of BMT to resurgence asserts that reinforcers delivered for both target and alternative responses are additive, which leads to unusual predictions. First, it suggests that exclusively reinforcing a target response and then exclusively reinforcing an alternative response will produce twice as much Pavlovian stimulus–reinforcer relations than reinforcing either response in isolation. Second, it suggests that each reinforcer-rate change must be additive, but this suggests that gradually thinning reinforcer rates would produce more Pavlovian conditioning, not less. Both of these predictions are counterintuitive and not supported by empirical findings. An additional conceptual flaw is that BMT fails to account for numerous dimensions of reinforcers that are likely to be relevant to resurgence. For example, BMT does not make predictions about how reinforcer quality or response effort may affect resurgence. Both the concatenated generalized matching law (Baum, 1974; Baum & Rachlin, 1969) and clinical experience suggest that these types of variables affect resurgence, but BMT has no way of accounting for such variables.

Beyond these conceptual limitations, there are important empirical flaws. For example, BMT predicts that target behavior will recur to the greatest extent immediately upon removal of the disrupter. However, a recent review of the literature has revealed that target responding can be low at first and increase before subsequently decreasing (i.e., a bitonic function, Podlesnik & Kelley, 2014). BMT also predicts that introducing DRA as a disrupter will decrease target response rates. However, empirical studies have shown that introducing low rates of reinforcers for alternative responses can increase target responding relative to an extinction control (e.g., Craig & Shahan, 2016; Sweeney & Shahan, 2013). Further, BMT predicts that complete removal of differential reinforcement as a disrupter will produce more recurrence of target behavior than partial removal. However, empirical studies have shown the opposite effect (e.g., Craig & Shahan, 2016; Sweeney & Shahan, 2013). Unfortunately, these empirical shortcomings are caused by inaccuracies in the core assumptions made by BMT as it applies to resurgence, which is why research on resurgence has largely shifted toward applying other conceptual frameworks, such as Resurgence as Choice in Context (Shahan & Craig, 2017; Shahan et al., 2020) and Context Theory (Bouton & Todd, 2014).

Response Strength Revisited

With the aforementioned limitations in mind, it is worth noting that another potentially major conceptual issue with BMT is that it continues to leverage the concept of response strength. Researchers have recently begun to highlight significant concerns inherent in the concept of response strength (see Shahan, 2017 for discussion).

For the present purposes, it is sufficient to note that response strength is a hypothetical construct that provides little to no explanatory power. Response strength cannot be observed or measured directly. Indeed, a good deal of the beginning of this chapter explained how certain behavioral parameters, specifically response probability and resistance to change, have been assumed to be indicators of response strength, but even these dimensions of behavior cannot be measured directly. These dimensions (i.e., response probability and resistance to change) are inferred based on response rates or changes in response rates before and after disruption. Thus, to obtain a measure of response strength, researchers have resorted to measuring behavior directly, inferring that different patterns represent different dimensions of behavior (i.e., response probability or resistance to change) and then making another inference that this is related to response strength. Based on these inferences, it seems problematic to suggest that response strength determines behavior or behavioral persistence.

Further, the concept of response strength is typically used to explain how reinforcement works. However, as Catania (2013) explains, the term reinforcement is merely descriptive, not explanatory. Using reinforcement to explain why behavior is occurring introduces circular reasoning into the explanation. Reinforcement describes "a response–consequence functional relation in which a response is followed immediately by a stimulus change that results in similar responses occurring more often" (Cooper et al., 2020). Saying reinforcement *caused* the response to increase would involve circular reasoning because it uses the definition of the process to explain why the process is occurring. Beyond the fact that circular reasoning is conceptually problematic, such reasoning fails to provide additional insight into the relevant behavioral processes, and it stifles additional exploration into the actual mechanisms behind this process.

Instead of relying on the concept of response strength to explain reinforcement, clinicians and researchers should explore alternative accounts of behavior. Indeed, several alternative accounts from within the field of behavior analysis have been proposed (e.g., Baum, 2012; Cowie & Davison, 2020; Gallistel & Balsam, 2014; Killeen & Jacobs, 2017; Shahan, 2010; see Shahan, 2017 for a discussion of these alternatives). These alternative explanations are too complex to cover in substantive detail, but in general, they tend to focus on the role of timing processes and stimulus control rather than the strengthening process of reinforcement. They hinge on the premise that organisms learn correlations between stimuli in the environment, and their histories with these correlations influence current and future behavior. These newer conceptualizations can account for a broader range of behavior that cannot be explained by reinforcement as a strengthening process alone (see Cowie & Davison, 2016 for a review). Perhaps most importantly, these new conceptualizations allow for the possibility that learning can occur without reinforcement, which is an empirically supported finding (e.g., St. Claire-Smith & MacLaren, 1983), and they shift research towards understanding what organisms perceive regarding the correlations among stimuli (Shahan, 2017). Just as the development of BMT marked a paradigm shift in how researchers approached the basic principles of behavior analysis, the growing shift toward an account of behavior focused on timing processes and stimulus control may mark yet another fundamental shift in how behavior analysts approach their science.

Conclusion

Despite the aforementioned limitations, BMT has had an extensive and important impact on research and practice. The development of BMT marked an important divergence from the traditional conceptualization of response strength and, perhaps more importantly, has led to the development of numerous strategies to address socially significant behavior, such as noncompliance, resistance to change, and treatment relapse.

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Differential Reinforcement Procedures

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Differential reinforcement is a procedure in which one response class is reinforced to a greater degree than another response class. Differential reinforcement can consist of reinforcement for one response class and extinction for another, or it can involve a difference in reinforcement along some other dimension (Vollmer et al., 2020). For example, one form of behavior could result in more frequent, immediate, or higher quality reinforcement than another form of behavior (Athens & Vollmer, 2010). The rationale for differential reinforcement procedures is based on the matching law, which states that the rate of behavior matches the relative rate of reinforcement for that behavior (Herrnstein, 1961; Reed & Kaplan, 2011). In other words, organisms allocate responding in a manner that maximizes reinforcement. Differential reinforcement procedures, therefore, are those that alter concurrent schedules in a way that favors the emission of appropriate behavior over that of problem behavior.

This chapter is dedicated to Dr. Jose Martinez-Diaz, who never failed to inspire his students.

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Differential Reinforcement of Alternative Behavior

Differential reinforcement of alternative behavior (DRA) is a procedure used to decrease problem behavior by replacing it with an appropriate, alternative response. This is achieved by minimizing or withholding reinforcement for the problem behavior and reinforcing an alternative response (Deitz & Repp, 1983). Often times in a DRA, the function of problem behavior is identified and an alternate means of meeting that same need is taught and reinforced. In other words, an appropriate, alternative behavior that results in the same reinforcer as the problem behavior is prompted and reinforced. For example, a student who engages in disruptive behavior maintained by teacher attention might be taught to raise their hand rather than blurt out answers or stomp their feet. It should be noted, however, that a functionally equivalent alternative response is not a defining feature of a DRA. For example, Lalli et al. (1999) used a DRA to treat problem behavior maintained by escape by reinforcing compliance with edible reinforcers.

DRA is preferable to extinction or punishment alone for eliminating problem behavior. As problem behavior is maintained by reinforcement, the use of extinction or punishment alone to eliminate problem behavior could result in a client losing access to a source of reinforcement, or possibly developing other problem behaviors to

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_8

access it again. For example, if a child's only means of accessing parent attention is emitting a tantrum, punishing the tantrum may eliminate it, but will not give the child a means to access parent attention. As attention deprivation increases, the child may engage in more severe behavior that would be hard for a parent to ignore, such as property destruction or aggression. In cases like this, failing to teach an alternative response could result in an escalation of the problem behavior, or social isolation of a child with no clear way to access adult attention. DRA procedures offer a constructive approach for decelerating problem behavior by expanding a client's repertoire.

Implementing DRA

Implementing a DRA procedure involves several steps including identifying the function of the problem behavior, selecting an alternative response, teaching the new contingency, and thinning the schedule of reinforcement for the alternative response. There are several variables one should take into account when implementing a DRA; the guidelines below are meant to inform and guide the successful implementation of a DRA procedure.

Identify the Function of the Problem Behavior A functional assessment of the problem behavior is necessary to identify the reinforcer(s) that maintain the problem behavior. Identifying these reinforcers is important because it allows practitioners to withhold (or minimize) the relevant stimuli contingent on problem behavior and select an alternative response that serves the same function, if possible. While there are many forms of behavioral assessments, the current 'gold standard' remains the functional analysis (Iwata et al., 1994; Iwata & Dozier, 2008; Saini et al., 2020). A functional analysis is a type of behavior assessment that uses experimental comparisons to identify the function of problem behavior. As the functional analysis is carefully controlled, it allows for the determination of function, rather than only hypothesizing function. Several variants have been developed to allow for assessment of dangerous or otherwise difficult to assess responses, such as latency-based, trial-based, and synthesized analyses (Hanley, 2012; Hanley et al., 2014; Lambert et al., 2012; Thomason-Sassi et al., 2011). In the event that barriers prevent conducting a functional analysis, descriptive assessments may be an appropriate alternative, or beneficial supplemental assessment (Hollo & Burt, 2018).

Select the Alternative Response The two foremost considerations for the alternative response are response effort and access to reinforcement (Horner & Day, 1991). The effort required to emit the response is an important consideration because effort affects reinforcement value, with greater effort requiring greater reinforcement magnitudes to sustain it. If the alternative response requires more effort than the problem behavior, it will be difficult for it to completely replace the problem behavior (Wilder et al., 2020). Selecting brief, simple responses is preferred to complex or lengthy responses for this reason. For example, a brief vocal response such as, "Cookie," may be preferable, at least initially, to longer responses such as, "May I have a cookie, please?" Selecting an alternative behavior in which the client is already fluent, or, if not, training it to fluency can assist with response effort.

When selecting an alternative response, it is also important to consider the extent to which the response will access reinforcement in the natural environment. If the behavior is maintained by socially-mediated reinforcement, the ideal alternative response would be one that is likely to evoke the relevant reinforcer from novel people who are not familiar with the treatment plan. Selecting a response topography that will reliably contact reinforcement in the natural environment is important for the generalization and maintenance of treatment effects.

Consider Motivation Motivating operations should be considered when developing a DRA procedure. Establishing operations for reinforcement increase the reinforcer's value and efficacy, evoking behavior that produces that reinforcer. In a DRA procedure, the establishing operation should be directly tied to the reinforcer for the alternative response and the problem behavior. To produce strong motivation to emit the relevant behaviors, one might need to schedule a deprivation period for the relevant reinforcers prior to treatment sessions.

As DRA procedures are often combined with other procedures in an intervention package, it is important to consider what impact other treatment components might have on motivation. Behavior-change procedures that rely on abolishing effects, such as noncontingent reinforcement (NCR), may interfere with acquisition of a function-based alternative response because NCR could abate the response, limiting the opportunities for reinforcement and decreasing the value of the reinforcer when the alternative response does occur (Goh et al., 2000; Wallace et al., 2012).

Consequences Differential consequences for the problem behavior and the alternative response are integral parts of the DRA procedure. In a DRA procedure, the alternative response that replaces the problem behavior should result in richer reinforcement than the problem behavior (e.g., denser schedule, higher magnitude). In the event that the alternative response does not reliably produce the reinforcer in the natural environment, the practitioner will need to teach the mediators in the natural environment (e.g., teachers, caregivers, employers, etc.) to reinforce the alternative response. For example, if a client is taught to request a break by signing "break," it is important for all of the relevant people in the natural environment to learn what the sign means and to provide adequate breaks when they are requested.

It is equally as important that mediators learn to minimize, if not completely eliminate, reinforcement for the problem behavior as much as possible. Researchers have shown that treatment integrity failures during DRA that provide reinforcement for the problem behavior, even intermittently, can have detrimental effects (St. Peter-Pipkin et al., 2010). Intermittent schedules of reinforcement can increase resistance to extinction. This is especially true if such errors occur at the beginning of treatment. This may occur when a caregiver begins implementing a DRA procedure and makes errors in the initial sessions by accidentally reinforcing the problem behavior. The impact of these errors may slow the acquisition of the alternative response. For this reason, it is recommended that problem behavior be placed on extinction, when possible, and that all implementers be trained to fluency before implementation begins.

However, while extinction for the problem behavior is ideal, it is not always feasible. For example, some automatic reinforcers directly produced by the behavior may be difficult or impossible to prevent. Additionally, extinction for behavior maintained by attention may not be possible with severe behaviors such as self-injury or aggression, which often require blocking due to health and safety concerns. Though DRA procedures require a difference in reinforcement between the alternative response and the problem behavior in order to be effective, they do not necessarily require that the problem behavior be placed on extinction (Vollmer et al., 2020). In these cases, minimizing reinforcement may be the best available option. Athens and Vollmer (2010) found that a combination of manipulations to reinforcer duration, quality, and delay to delivery produced larger and more consistent changes to behavior rates than manipulating a single dimension alone. One should consider combining differences across multiple dimensions of reinforcement for best treatment results.

Schedule Thinning A continuous schedule of reinforcement for the alternative response is often used in the initial implementation of a DRA procedure. However, such a schedule is likely difficult for caregivers or instructors to implement with consistency in the long-term, as it can be disruptive to other activities. For example, a student whose requests for breaks are continuously reinforced throughout the day may never complete tasks necessary for learning. In most cases, in order for the alternative response to maintain in the natural environment, the schedule should be thinned from the dense training schedule to a leaner schedule. Gradually thinning the schedule of reinforcement for the alternative response will reduce the likelihood of ratio strain when transferring to contexts that do not support high rates of reinforcement.

Chain schedules of reinforcement are one common method for thinning reinforcement for the alternative response in a DRA procedure. Chain schedules involve gradually increasing either the number of tasks that must be completed, or the duration of time spent engaging in a specific activity, before the alternative response will be reinforced (Hagopian et al., 2011; Hanley et al., 2014; Lalli et al., 1995). For example, say a student's problem behavior was maintained by escape from academic tasks and the teacher implemented a DRA procedure in which the student learned to request a break as an alternative to engaging in problem behavior during class time. Initially, the teacher would provide a break each time the student requested one, but this arrangement would not be sustainable long term if the student's requests were excessive. To thin the schedule of reinforcement, the teacher could use a chain schedule by requiring the student to complete a task before allowing a break. The student's requests after task completion would be reinforced, but requests prior to task completion would not. With time, the teacher could slowly increase the number of completed tasks required before a break request would be reinforced. This method is also known as *demand fading*.

Multiple schedules are another common method used to thin the schedule of reinforcement for the alternative response. In a multiple schedule, discriminative stimuli signal alternating 'on' and 'off' periods of reinforcement and extinction for the alternative response (i.e., one schedule provides reinforcement for the alternative response and the other schedule does not). Thinning the reinforcement schedule using this method involves gradually decreasing the duration of the signaled reinforcement period while increasing the signaled extinction duration. Betz et al. (2013) used such a schedule with four children with autism, using bracelets, posters, or colored vests as the discriminative stimuli for the reinforcement. As sessions continued, rates of the alternative response and the problem behavior remained stable even as the duration of the extinction schedule gradually increased and the duration of reinforcement schedule decreased. The researchers also compared a multiple schedule to the same arrangement as a mixed schedule, without discriminative stimuli, and found that rates of problem behavior reemerged, demonstrating that the discriminative stimuli were a critical component of the fading procedure. Establishing stimulus control over the alternative response may facilitate schedule thinning and transfer of stimulus control to contexts outside of the training environment.

Functional Communication Training

Functional communication training (FCT) is a variation of DRA in which the alternative response is a mand, often referred to in the context of FCT as a *functional communication response* (FCR; Carr & Durand, 1985). A mand is a type of verbal operant that is primarily controlled by an establishing operation and reinforced through the actions of others, specifically the reinforcer requested or indicated. For example, if a child has not eaten in a while, they may say, "Can I have a cookie, please?" to a parent, and the parent may give them a cookie as a consequence. "Can I have a cookie, please?" would be considered the mand, or the FCR if it were used as an alternative response in a DRA procedure. In an FCT procedure, the FCR serves the same function as the problem behavior and may take any of a variety of communication forms, such as vocalizations, sign language, written text, card exchange, sound buttons, or pointing and other gestures (Sundberg & Sundberg, 1990). The specific form that is taught should be tailored to the needs and repertoire of the individual.

Carr and Durand (1985) introduced FCT as a treatment for problem behavior in a study with four children in a classroom setting. First, the researchers assessed the function of the participants' problem behavior. Of the four participants, two were disruptive when tasks were difficult and attention was plentiful, indicating the behavior was likely maintained by escape from difficult tasks. One participant was disruptive when tasks were easy but attention was low rate, indicating attention-maintained disruption. The final participant was disruptive when easy tasks were presented with low rates of attention and when difficult tasks were presented with high rates of attention, suggesting multiple functions for their disruptive behavior.

Next, the researchers identified and taught appropriate FCRs to each participant. The FCR for escape from difficult tasks was, "I don't understand," as it directly solicited help. Similarly, the FCR for attention was, "Am I doing good work?" as it not only evoked interaction from the adult, but solicited praise specifically. In order to evaluate whether teaching any communicative response, functionally related or not, would produce improvements in problem behavior, the researchers also taught an irrelevant communication response that produced an outcome unrelated to the functional reinforcer. For example, if problem behavior was maintained by escape from difficult tasks, the irrelevant response would be, "Am I doing good work?" because it did not result in any assistance. Results showed that, for all four participants, rates of FCRs were highest, and disruption lowest, in the relevant FCR condition. Rates of disruptive behavior in the irrelevant FCR condition were similar to responding in baseline, occurring at high rates. This indicates that merely teaching *a* communicative response is insufficient; the response must meet the same need as the problem behavior it is to supplant.

FCT is one of the most common and empirically supported interventions for problem behavior among children with autism spectrum disorder (ASD; Anderson & St. Peter, 2013; Tiger et al., 2008). However, its utility is not limited to ASD populations. A review by Durand and Moskowitz (2015) found FCT effectively decreased a variety of problem behaviors across multiple developmental or speech and language disorders, and Hollo and Burt (2018) found similar results with children with or at risk of developing emotional and behavioral disorders. FCT has also been shown to be effective in educational settings (Walker et al., 2018), as well as with adults (Gregori et al., 2019). This is particularly noteworthy as adults typically have more extensive learning histories supporting challenging behavior than children, often leading to more resistance to behavior change (Heath et al., 2015).

Implementing FCT Precise descriptions of FCT procedures and components vary across studies. In general, FCT programming has similar steps to general DRA procedures: (1) functional assessment of the problem behavior, (2) FCR selection, (3) training FCR, and (4) testing for maintenance and generalization (Tiger et al., 2008; Mancil & Boman, 2010). Because FCT is a DRA treatment, the same considerations listed above for DRA also apply to FCT.

Selecting an FCR FCRs can be either specific, in which a particular reinforcer is identified, or a broader mand that includes multiple functions at once, known as an omnibus mand (Bachmeyer et al., 2009; Ward et al., 2020). When the problem behavior has a specific function, it is best to have the FCR specify the function of the problem behavior as precisely as possible. For example, if problem behavior is maintained by escape from task demands, an appropriate FCR would be a request for a break (e.g., "Can I have a break?"). However, if problem behavior reliably produces multiple, different consequences, it may be more efficient to teach an omnibus FCR. For example, if problem behavior consistently results in attention, escape from task demands, and access to toys, an appropriate FCR might be less specific (e.g., "Can I have my way?").

Omnibus FCRs could be less likely to have broad social recognition of the response (e.g., a substitute teacher might not know exactly what "my way" means), but the tradeoff is that an omnibus FCR could make FCT more effective and efficient when problem behavior is multiply maintained. Teaching individual FCRs for each consequence may require more time to teach and could result in the client needing to emit multiple responses in quick succession to access the same combination of reinforcers as a single maladaptive response (Mitteer et al., 2019). In other words, an omnibus FCR may be appropriate when addressing problem behavior with multiple functions, whereas a specific FCR may be more appropriate for problem behavior with a single function.

Differential Reinforcement of Incompatible Behavior

Differential reinforcement of incompatible behavior (DRI) is a variation of DRA in which the alternative response is incompatible with the problem behavior, meaning both responses cannot occur at the same time. For example, if a client is causing self-injury from high rates of skin picking, an incompatible response would be anything that occupies the hands so that fingers cannot pick on the skin, such as toy play. As the incompatible response increases in rate, opportunities to engage in the problem behavior decrease.

Smith (1987) successfully applied a DRI procedure to decrease pica in a 23-year-old man with an intellectual disability. The participant consumed nonfood items such as paper clips, bottle caps, and other hazardous materials, which could be potentially life-threatening. Additionally, he would engage in aggression whenever his attempts to engage in pica resulted in the removal of these items. In the DRI treatment, completing work tasks and interacting with work materials at the desk were reinforced, which was incompatible with the problem behavior because pica required leaving the work area and picking up nonfood items. While pica was not entirely eliminated, the DRI procedure reduced pica to less than a third of baseline rates and did not evoke aggression.

Differential Reinforcement of Other Behavior (DRO)

Differential reinforcement of other behavior (DRO) is a reinforcement schedule in which reinforcement is delivered contingent upon the nonoccurrence of a target response (Reynolds, 1961). That is, a reinforcer is presented after a predetermined interval of time during which the target response does not occur. Contingent on the target response, the reinforcer is withheld or delayed. This schedule results in a decrease in rate for the target response. The DRO schedule is commonly used to treat a wide range of problem behavior (Matson et al., 2011; Weston et al., 2018) including severe problem behavior (e.g., aggression, self-injurious behavior, and disruption; Iannaccone et al., 2020), elopement (e.g., Roane & DeRosa, 2014), stereotypy (e.g., Healy et al., 2019), chronic tic disorders (e.g., Capriotti et al., 2017), substance use disorders (e.g., Higgins et al., 1991), and medical noncompliance (e.g., Dufour & Lanovaz, 2020).

DRO Behavior Reduction Processes

Though the term DRO implies that this procedure is similar to the DRA in that it reinforces "other" behavior, the contingency only specifies that the target response does not occur during the interval, independent of the occurrence or nonoccurrence of any other behavior. For this reason, some researchers prefer different terms for the DRO including omission training (Uhl & Garcia, 1969) and differential reinforcement of no responding or zero responding (Poling & Ryan, 1982; Zeiler, 1970). Though the DRO is commonly used, the behavioral processes responsible for the decelerative effects of the DRO schedule remain unclear. There are three main hypotheses for the behavioral processes responsible for the decreases observed in the target response during a DRO: extinction, adventitious reinforcement, and negative punishment. These processes are not mutually exclusive and it is likely that more than one influence responding simultaneously or in conjunction with one another (see Jessel & Ingvarsson, 2016 for a discussion).

Extinction Some researchers have suggested that the DRO contingency simply disrupts the contingency between the reinforcer and the target response, consistent with the effects of extinction (e.g., Lattal et al., 2013; Mazaleski et al., 1993). Extinction is certainly at least partially responsible for behavior reduction when reinforcement for the target response is withheld. However, it is unlikely that extinction is the sole mechanism responsible for behavior reduction because many applied studies have shown that DRO schedules can successfully reduce problem behavior even without the use of extinction (e.g., Cowdery et al., 1990; Lanovaz et al., 2014; Lustig et al., 2014; Ringdahl et al., 2002; Roane et al., 2007; Vance et al., 2012).

Adventitious Reinforcement Adventitious reinforcement of other behavior is another hypothesis for the process underlying the effectiveness of DRO schedules (e.g., Jessel et al., 2015; Reynolds, 1961). This hypothesis relies on the temporal relation between nontarget behaviors and the delivery of reinforcers. Specifically, the DRO schedule adventitiously reinforces any nontarget response occurring in close temporal contiguity with the delivery of reinforcers. This interpretation implies that any other, nontarget behavior reinforced with DRO contingencies is considered "superstitious" (see Skinner, 1948). For adventitious reinforcement to decrease the target response in a DRO, these other behaviors must be incompatible with the target response and strengthened to the extent they compete with target responding. The question as to whether or not adventitious reinforcement increases other, nontargeted behavior during DRO has received a lot of attention, but research directly addressing this matter thus far has yielded mixed results likely due to differences in research methodology (e.g., Hangen et al., 2020; Harman, 1973; Jessel et al., 2015; Rey et al., 2020a; Rey et al., 2020b; Zeiler, 1970).

Negative Punishment Rather than considering the DRO schedule a type of differential reinforcement procedure, it might be more conceptually coherent to include it under a negative punishment paradigm (Catania, 2013; Goldiamond, 1975; Lattal, 2013; Malott & Trojan Suarez, 2004; Rolider & Van Houten, 1990). Specifically, engaging in the target response during DRO postpones the reinforcer delivery, which decreases target responding. To illustrate, contrast it with the two types of negative reinforcement: escape and avoidance. In the *escape* type of negative reinforcement, an aversive stimulus is *present* and removed contingent upon some response. Escape, then, would be analogous to negative punishment, in which an appetitive stimulus is *present* and withdrawn contingent upon some response. However, in the *avoidance* type of negative reinforcement, an aversive stimulus is not present, but has historically been presented. The presentation of the aversive stimulus is withheld or delayed contingent upon some response. The DRO may operate under a similar type of contingency, albeit a punishing one, in which an *appetitive* stimulus which has previously been presented is withheld or delayed contingent upon some response, resulting in a decrease in that response (Rolider & Van Houten, 1990). For example, a child may spend her Saturday afternoons at the park with her father, but when she tantrums at school, the father cancels the typical Saturday trip to the park.

Whole-Interval DRO

In a *whole-interval DRO*, a reinforcer is delivered only if the target response is omitted during the entire duration of the interval. The first response to occur within the interval will cancel the opportunity for reinforcement for that interval. The interval for this procedure can be fixed or varied. A *fixed interval* is set at the same duration for each interval in a session. For example, if the interval is set at 5 min, after a successful interval in which there is no occurrence of the target response, a reinforcer will be delivered and another 5-min trial will begin. A *varied interval* is set at varying durations, centering on some average value. For example, in a varied interval of 5 min, each interval would be set at different durations that average to 5 min (e.g., intervals ranging from 1 to 10 min).

Resetting Versus Non-resetting Intervals In whole-interval DRO schedules, the target response can either reset the DRO time interval or have no effect on the time interval. In a *resetting DRO*, the time interval starts over each time that the target response occurs. For example, if the DRO interval is 30 s, and the target response is emitted after 15 s, the 30-s interval is reset to zero. This immediately begins a new opportunity for reinforcement. Alternatively, in a *non-resetting DRO*, the target response does not restart the interval. Instead, the current interval must elapse before the new interval with an opportunity for reinforcement begins. For example, if the DRO interval is 30 s, and the target response is emitted after 15 s, the rest of the interval (15 s) must elapse before a new 30-s interval begins. Until a new interval begins, there is no consequence for the target response after the interval has already lost the opportunity for reinforcement. Both the resetting and non-resetting DRO variations have been used to effectively reduce problem behavior, but there is limited research directly comparing their effects. Thus far, basic (Nighbor et al., 2020) and applied (Gehrman et al., 2017) research has found no difference in their relative efficacy.

Momentary DRO

In a *momentary DRO*, a reinforcer is delivered if the target response is not occurring at the end of the DRO interval. The occurrence of the target response before the end of the interval does not affect the delivery of reinforcement. For example, if the DRO interval is set at 5 min and the target response is emitted after 2 min, a reinforcer would be delivered at the end of the 5-min interval. On the other hand, if the target response was instead emitted after 5 min, a reinforcer would not be delivered for that interval. Because responses that occur before the end of an interval do not affect reinforcer delivery in a momentary DRO, a resetting interval is irrelevant for this procedure.

Like the whole-interval DRO, the momentary DRO can be implemented with a *fixed interval* or a *varied interval*. Research on the effectiveness of momentary DROs is rather mixed (e.g., Miller & Jones, 1997; Repp et al., 1983; Sisson et al., 1988; Toussaint & Tiger, 2012). Because the momentary DRO delays reinforcement only if the target response occurs at the specific moment at the end of the interval and at no other times, the effectiveness of the momentary DRO might depend on either (a) the indiscriminability of the contingency (specifically, the momentary response criterion), or (b) the inability to detect the end of the interval. Indeed, there is evidence indicating momentary DROs are more effective when there are no cues signaling the end of the interval (Hammond et al., 2011). Similarly, momentary DROs with variable intervals might be more effective than fixed intervals because changes in interval length make the end of the interval more difficult to predict.

DRO Reinforcer

Functional Reinforcers Function-based reinforcers are the same reinforcers that maintain the target behavior. For example, if disruptive behavior is maintained by attention, the functional reinforcer is attention. In this case, using a functional reinforcer within a DRO procedure would consist of providing attention contingent on the absence of disruptive behavior. It is advisable to use extinction or minimize reinforcement for the target behavior as much as possible during a DRO. This is especially important in a function-based DRO because otherwise, responding and non-responding will both result in the same reinforcer and the contingency would likely favor high rates of target responding.

For example, say a child engages in attention-maintained disruption during class and the teacher implements a DRO in which they provide attention at the end of every 15-min interval that the child does not engage in disruptions. If the teacher is unable to put the disruption on extinction by withholding their attention contingent on disruptions, the child can access attention by both, engaging in disruptions and by not engaging in disruptions. In this scenario, the child will access attention a maximum of four times per hour by not engaging in disruptions during the DRO, but they would access a higher rate of attention if they engaged in disruptions more than four times an hour.

Arbitrary Reinforcers Arbitrary reinforcers are any stimuli different from the reinforcers that maintain the target behavior. For example, if the target response is maintained by attention, edibles presented within the DRO contingency would be considered arbitrary reinforcers. Arbitrary reinforcers are often used when it is not possible to manipulate the functional reinforcer (e.g., automatic reinforcement) or when the function of the problem behavior is unclear. When using arbitrary reinforcers, extinction of the problem behavior might not be critical if the arbitrary reinforcer is of higher value, or more preferred, than the functional reinforcer.

Setting the DRO Interval

The initial DRO interval should be set at the mean inter-response time (IRT) during baseline (Repp et al., 1974; Repp et al., 1991). The IRT is the time between two successive responses. Mean IRT is calculated by dividing the total number of minutes in a session by the total number of responses that occurred during that time. Setting the DRO interval equal to the mean IRT during baseline increases the likelihood that the behavior will regularly contact the DRO contingency. Shorter initial DRO intervals are more likely to be effective than longer intervals (Rozenblat et al., 2009). Setting the initial DRO interval longer than the mean baseline IRT can decrease the likelihood that the DRO will be effective in reducing responding because the nonresponding might seldom contact reinforcement. This is especially the case if one is not able to use extinction for the problem behavior.

The initial DRO interval might not be conducive for implementing the procedure in the natural environment or to maintain over time with treatment integrity. Once the DRO procedure has effectively reduced the problem behavior, the initial interval can be slowly increased over time to thin the schedule of reinforcement and make the DRO procedure more manageable to implement. The DRO interval can be increased by a constant duration each time (e.g., 30 s), by a proportion of the interval (e.g., 30%), or by adjusting the interval to match mean IRT from previous session each new session (Poling & Ryan, 1982).

Additional Considerations

Including additional components to the DRO or combining it with other interventions can enhance treatment effectiveness. Providing rules or statements describing the DRO contingency (e.g., "If you do not pick your skin for 5 min, you will get a token") can enhance treatment effects for some learners (Watts et al., 2013). Providing feedback or a statement indicating that the opportunity for accessing reinforcement has been lost contingent on problem behavior (e.g., "You don't get a token because you picked your skin") can also enhance the effectiveness of a DRO treatment (Iannaccone et al., 2020). Finally, practitioners should consider combining a DRO with DRA when possible. For example, instead of directly presenting a reinforcer at the end of a successful DRO interval, one can consider presenting a discriminative stimulus signaling that requests for the reinforcer will be honored. Incorporating a DRA component to the DRO ensures that a client acquires or maintains the ability to appropriately request the reinforcer.

Differential Reinforcement of Low Rate Responding (DRL)

Differential reinforcement of low rate of responding (DRL) is a schedule of reinforcement in which a reinforcer is delivered contingent on a reduced rate of responding. This is an approach to reducing behavior that is often used when the goal is to reduce but not to eliminate responding completely, either because the behavior is mild enough to tolerate at low levels (e.g., classroom disruptions), or because the behavior itself is appropriate and desirable but the rate at which it occurs makes it problematic (e.g., excessive requests for assistance during independent work time). There are several procedural variations of the DRL: spaced responding, full session, and interval (Deitz, 1977).

Spaced-Responding DRL

In a *spaced-responding DRL* (*s*-DRL), also known as DRL-IRT, a response is reinforced if it occurs after a minimum amount of time since the previous response (Deitz, 1977; see also Ferster & Skinner, 1957). As rate and IRT are inversely related, this variation of DRL decreases response rates by differentially reinforcing longer IRTs. The purpose of this procedure is to space out responding. For example, Wright and Vollmer (2002) used an *s*-DRL to decrease dangerously high rates of food ingestion in a teenage girl with developmental disabilities. During the intervention, a timer was set with a predetermined IRT interval. Each attempt to take a bite of food before the minimum IRT elapsed resulted in the bite being blocked and the timer reset. Only bites that occurred after the interval elapsed resulted in successful access to food. In another example, Deitz (1977) decreased students' excessive inappropriate questions by having the teacher answer a student's question only if a set amount of time had passed since their last question. Because the target response must occur to access reinforcement in the *s*-DRL, this procedure maintains some level of target responding.

***s*-DRL Reinforcers** Typically, the reinforcer used in *s*-DRL procedures is the same reinforcer that naturally maintains the target behavior. For example, food is the reinforcer for taking bites (e.g., Wright & Vollmer, 2002), and teacher responses to questions are the reinforcer for asking questions (e.g., Deitz, 1977). Those responses that meet the *s*-DRL criterion are reinforced and those that do not are placed on extinction (or reinforcement is otherwise minimized). However, it is possible to implement an *s*-DRL with arbitrary reinforcers when the functional reinforcer cannot be easily manipulated.

For example, Singh et al. (1981) used an *s*-DRL to reduce excessive rates of stereotypy among three adolescents with intellectual disabilities. Though the researchers did not conduct a functional assessment, stereotypy occurred at high rates during baseline sessions in which socially mediated reinforcers were unavailable, indicating a likely automatic function. During the *s*-DRL intervention, each stereotypic response that met the IRT criterion resulted in praise, while responses that did not meet the criterion reset the *s*-DRL interval but were not otherwise affected (i.e., they were not blocked, interrupted, or provided programmed consequences). Assuming these stereotypic responses were indeed automatically reinforced, extinction was not a component of the intervention because all responses—including those that did not meet the *s*-DRL criterion—were continuously reinforced. As with the DRA, when extinction cannot be implemented consistently, the reinforcer used for the *s*-DRL procedure should be of higher value or magnitude than the functional reinforcer that naturally maintains responding.

Non-Resetting *s*-DRL Interval Because an *s*-DRL requires that a response is separated from the previous response by a minimum IRT to access reinforcement, responses that occur before the end of the IRT criterion will reset the interval. In other words, each response that occurs before the end of the IRT interval requires that the interval starts over. However, a common modification found in applied *s*-DRL research is not resetting the interval with each response that does not meet the reinforcement criterion. Instead, those responses go unreinforced and the first response that occurs after the end of the interval is reinforced independent of IRT. This modification makes use of a simple interval schedule by changing the reinforcement contingency so that instead of requiring a minimum amount of time between two successive responses, the contingency only requires a set amount of time to pass before a response is eligible for reinforcement.

Anglesea et al. (2008) effectively used a non-resetting *s*-DRL to reduce rapid eating among three teenage boys with autism by using a vibrating pager that was set to vibrate at predetermined intervals and indicated when taking a bite of food would be reinforced. Attempts to take a bite before the end of the interval were blocked but did not reset the interval. The effectiveness of the non-resetting *s*-DRL likely depends on whether one can arrange extinction contingencies for the responses that occur within the interval (i.e., those that do not meet *s*-DRL reinforcement criteria).

Setting the *s*-DRL Interval The *s*-DRL interval should be initially set at the mean IRT during baseline. Setting the *s*-DRL interval within the range of baseline IRTs increases the likelihood that the behavior will contact the *s*-DRL reinforcement contingency. Setting the initial criterion at an interval longer than IRTs observed during baseline can decrease the likelihood that the procedure will effectively reduce responding because the behavior will seldom contact reinforcement. Once the *s*-DRL schedule is successfully met with some consistency, practitioners can further decrease rate of responding by slowly increasing the length of the *s*-DRL interval criterion.

Full-Session DRL

In a *full-session DRL* (*f*-DRL), the reinforcer is delivered at the end of a session or specified time period if the number of responses during that time are less than or equal to a specified criterion (Deitz, 1977). In this procedure, it does not matter when the responses occur, as long as the total number does not exceed a specified limit. For example, if the *f*-DRL criterion is five responses, an individual would receive a reinforcer at the end of the session if they engaged in the target response no more than 5 times (i.e., engaging in the response 0–5 times would result in reinforcement, 6 would not).

A common use of an *f*-DRL, at the group level, can be found in a classroom management procedure called the Good Behavior Game. The Good Behavior Game typically involves splitting a class into two or more teams, setting class rules (e.g., no getting out of seat without permission), setting a maximum number of points allowed, and marking a point for a team each time a member of that teams breaks a rule (Joslyn et al., 2019). The team that remains at or below the set point criterion wins the game and gets access to some reward. In the first demonstration of the Good Behavior Game, Barrish et al. (1969) divided a fourth grade class of 24 students into two groups to play the game in which each time a student engaged in out-of-seat behavior or talking-out behavior, their team received a mark on the chalkboard. A team would win the game if they received the fewest marks or if neither team received more than five marks. The winning teams earned special privileges such as wearing victory badges and 30 min of extra recess. Barrish et al. found that the game reduced occurrences of talking-out behavior from 96% of intervals to 19% of intervals and out-of-seat behavior from 82% to 9% of intervals.

Reinforcement for Individual Responses The *f*-DRL prescribes reinforcer delivery at the end of a session contingent on a maximum number of responses, but there is no specification regarding reinforcement for each individual response. There are several considerations one must take into account when deciding whether or not to reinforce individual responses within the session. First, one must determine if withholding reinforcement for individual responses is possible. Extinction may not be an option if the practitioner is not in control of the reinforcers that maintain the problem behavior. For example, if disruptive behavior in the classroom is reinforced by peer attention, a teacher is unlikely to be able to completely withhold that attention.

Second, one must consider whether complete elimination of the behavior would be preferable to low rates, or vice versa. In cases when complete elimination of the behavior is desirable, withholding reinforcement for each individual response would be ideal. For example, if disruptive classroom behavior is maintained by teacher attention, the teacher would withhold their attention during disruptions and only provide attention at the end of the session if disruptions did not exceed the *f*-DRL criterion. In cases where the occurrence of the response is desirable (e.g., hand raising), it is important that the occurrence of the desirable behavior continues to contact reinforcement.

When a practitioner is able to control the reinforcer that maintains the target response, an alternative way to implement an *f*-DRL is to reinforce only a limited number of responses in a session (e.g., a maximum of three responses will be reinforced and any response that exceeds that threshold in the session will not be reinforced). For example, Friman et al. (1999) used a version of the *f*-DRL in an intervention called the bedtime pass to decrease bedtime resistance (e.g., leaving the bedroom after bedtime) with two brothers aged 3 and 10 years. During the intervention, the children were each given a card that they were allowed to exchange for one visit out of the room after bedtime. The visit had to be short and had to have a specific purpose that could be met with an action (e.g., going to the bathroom, getting a hug, etc.) and then the child was expected to give up the card and return to their room for the remainder of the night. After the bedtime pass was used, any further attempts to leave the room would result in parents returning the child to the room while providing minimal attention. Results showed that the bedtime pass intervention effectively reduced bedtime resistance to no more than the one allowable opportunity to use the bedtime pass in one night for both children.

Another option is to combine these strategies so that there are both, limits to the number of responses that access reinforcement within a session as well as a criterion for a reinforcer at the end of session. Austin and Bevan (2011) effectively used this approach to reduce children's rate of requests for their teacher's attention during independent work time in an elementary school classroom (see also Otalvaro et al., 2019). Three children were identified by the teacher because their requests for teacher attention were excessive and interfered with completing their work. During the *f*-DRL intervention, each child received an index card with boxes corresponding to the *f*-DRL response criterion plus one. For example, if the criterion was set at two requests, the card would have three boxes. The teacher then responded only to the first 2 requests for attention and provided additional reinforcement at the end of the work period if the child did not exceed the specified number of requests.

Setting the *f*-DRL Response Criterion The number of responses allowed per session should be determined, in part, by the number of responses that occur during baseline or prior to treatment. To be successful, one should select a number that is roughly equal to average baseline levels. If the criterion number of responses is set too low, the client's behavior might not contact the *f*-DRL reinforcement contingency, which would make the procedure ineffective. Once the reinforcement criterion is consistently met and there is a reduction in behavior, one can gradually decrease the response criterion to further reduce levels of responding.

Interval DRL

In the interval DRL (*i*-DRL), a session is divided into a number of intervals and a reinforcer is delivered at the end of each interval if no more than one response occurs; if a second response occurs, the interval is reset and the opportunity for reinforcement is postponed (Deitz, 1977). This procedure is similar to a DRO except that the reinforcement criterion allows for up to one response to occur during the interval. The duration of the interval is set at the average IRT during baseline and can be gradually increased to further reduce responding as the procedure reduces behavior. Deitz (1977) used an *i*-DRL to effectively reduce classroom talk-outs by a

6-year-old girl in the first grade. During the *i*-DRL, the 30-min session was divided into 5-min intervals in which the child received a piece of chocolate caramel if she did not talk-out more than one time. Each 5-min interval was reset upon the second occurrence of a talk-out.

According to Deitz (1977), the *i*-DRL is similar to the *s*-DRL in that it decreases response rates by separating each response by some amount of time. Instead of differentially reinforcing discrete IRTs like in the *s*-DRL, the *i*-DRL targets average or variable IRTs because the response can occur anywhere in the interval. Another critical difference between the *i*-DRL and the *s*-DRL is that the reinforcement contingency in the i-DRL does not require the occurrence of a response. Over time, it seems that the definition of the *i*-DRL has shifted in the literature and many researchers now describe the *i*-DRL as a variation of the *f*-DRL differing only in that the session is broken up into smaller intervals and that the reinforcement criterion is met for each interval instead of the full session. This shift differs from the original definition in two ways: First, the one-response-limit criterion is no longer specified and it is left open for the practitioner to set (as is the case with the *f*-DRL). Second, the resetting interval is rarely mentioned as an inherent part of the procedure.

Selecting the Appropriate DRL Procedure

When deciding which variation of the DRL to implement, one must take several factors into consideration. First, it is important to consider the feasibility of each procedure. The *s*-DRL is the most cumbersome of the three procedures because each response resets the interval and it requires close monitoring. The *f*-DRL, on the other hand, is much easier to implement and is likely more manageable for someone with other demands on their time, such as a teacher who is attending to more than one child at a time. The *i*-DRL is less cumbersome that the s-DRL, but more so than the *f*-DRL.

Second, one should consider whether it is important to space out responding or whether low overall rate of responding is sufficient. For example, if the target behavior is rapid food consumption that puts an individual at risk for choking, the goal would not be to decrease the number of bites taken in a session. Instead, one would aim to space out the bites by targeting longer IRTs. In such cases, the *s*-DRL procedure would be most appropriate for achieving the desired outcome. If, on the other hand, lower overall rate of responding is the goal, and the time between each response does not matter (e.g., student talk-outs), then an *f*-DRL would be appropriate. For example, if the goal is to decrease excessive tardiness, it might only be important to reduce tardiness to three instances in the month and not necessarily to evenly distribute when in the month they occur.

Finally, it is important to determine whether complete elimination of the response is a desirable outcome or if it is important to maintain some level of responding. Because the *s*-DRL procedure requires the occurrence of a response to access reinforcement, this procedure is most likely to maintain responding. The *f*-DRL and *i*-DRL procedures, on the other hand, do not require a response because a reinforcer can be earned at the end of an interval or session if a response does not occur at all. As a result, these procedures can sometimes eliminate responding completely (Jessel & Borrero, 2014). Therefore, if response elimination would be detrimental, one might want to avoid the *i*-DRL and *s*-DRL variations.

Conflict of Interest We have no known conflict of interest to disclose.

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Part II

Applied Behavior Analysis

9 Prompt and Prompt-Fading Procedures

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Let us begin with an exercise—take a few seconds to explore your environment with all your senses. One of the first things that you may notice is that you perceive numerous stimuli, of different modalities (e.g., visual, auditory, tactile), concurrently. Our behavior continuously changes as a function of these stimuli. When presented with multiple stimuli or with multimodal stimuli, we are likely to attend and respond to the more salient ones (i.e., novel, surprising, or that stand out for other reasons; Hall et al., 1977). We are also more likely to respond and learn from stimuli that we have been exposed to before (Coon & Miguel, 2012; Kay et al., 2019; Roncati et al., 2019). In this way, stimuli come to control behavior, by evoking behavior that has in the past been followed by reinforcement.

Stimulus control is demonstrated when (a) stimuli come to indicate that a reinforcer is available given a response and (b) the absence of stimuli or another, unrelated stimulus comes to indicate that a reinforcer is not available given a response. Stimuli that indicate the availability of reinforcers are called *discriminative stimuli* (S^D), whereas stimuli that indicate the unavailability of reinforcement are called *delta stimuli* (S^Δ). For example, we have learned that the sign "Open" on a restaurant's door indicates that, if we walk in and order, we will get food. Therefore, for most of us, the sign "Open" functions as an S^D for walking in restaurants to get food. We have also learned that walking into a restaurant that does not have a visible "Open" sign or that has a "Closed" sign is not likely to be reinforced, in that the door may be locked or that the servers may ask us to leave. Therefore, for most of us, the sign "Closed" functions as an S^Δ for walking in restaurants to get food.

Assume that upon seeing the sign "Open" (antecedent) we enter the restaurant (behavior) and, as a result, we receive food (consequence). This sequence of events is called the *three-term contingency*. We all likely learned the three-term contingencies involving "Open" and "Closed" signs on restaurants' doors incidentally, through everyday life experiences. However, some things are difficult to learn incidentally—and this is where direct teaching comes in place. Stimulus control is especially important when learning new responses in school environments. From preschool to higher education, the instructors' job is to teach new, appropriate behavior repertoires and to bring these repertoires under stimulus control. For example, an instructor would be unlikely

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_9

to teach her learners to raise their hands under all circumstances. Instead, she would likely reinforce the learners raising their hands during lectures, only when they have a question or when they want to respond to a question.

Most often, teaching someone to perform a response and to bring it under the appropriate stimulus control requires careful selection and use of prompts and prompt-fading procedures. In the first part of this chapter, we will describe different types of prompts and their use, and the second part of this chapter will describe how these prompts can be faded to promote independent, correct responding. Finally, we will describe how to select prompts and prompt-fading procedures, as well as how to develop individualized assessments to increase the effectiveness and efficiency of instruction.

Prompts

We define prompts as supplemental stimuli that evoke correct responding, but that are not a critical part of the three-term contingency (Cengher et al., 2018, 2020). For example, an instructor may want to teach a child to identify numbers. In this case, the three-term contingency consists of the sight of a number, the verbal response (e.g., "five"), and a reinforcing consequence (e.g., praise). Because initially the child cannot respond correctly when presented with a number alone, the instructor may use a verbal prompt, such as telling the child the correct response. In time, this prompt can be faded to facilitate the development of the desired three-term contingency, which in this case consists of number identification.

In the example above, the prompt consisted of telling the child the correct response (e.g., verbal prompt). However, other antecedent stimuli can effectively evoke the behavior of saying numbers, such as visual prompts (e.g., a picture of five little monkeys next to the number 5). Any stimulus that evokes correct responding can be used as a prompt. The difference between these different prompts is not functional, in that they have the same effect on behavior. Rather, the difference between these prompts is formal, in that each of them has a different topography.

Prompts fall into two categories, based on whether the prompt is embedded in the natural S^D or not. In *stimulus-prompting procedures*, the configuration of the S^D is changed to evoke correct responses (Cengher et al., 2018). This can be accomplished in two ways, and, as such, there are two stimulus-prompting procedures: *stimulus fading* and *stimulus shaping*. Given that their configuration and how it changes is related to fading, these are described in detail in the prompt-fading procedures section below.

In *response-prompting procedures*, the prompt is a supplemental stimulus that is added to the three-term contingency. The prompt can be presented at the same time as the S^D, or the two stimuli can be presented in succession: first the prompt, and after a brief delay the S^D (Cengher et al., 2018). Response-prompting procedures are: model, gestural, visual, textual, and physical prompt. A model prompt consists of showing the learner how to perform the response. An example of a model prompt is the instructor raising her hand to prompt the child to raise their hand. The child can observe the modeled behavior of the instructor by orienting to them (e.g., standing face to face). However, being able to observe both the modeled behavior and the imitative behavior can provide better visual feedback, in that it makes it possible for the learner to evaluate how well the two match. Assuming that parity between the modeled and the imitative response is reinforcing (Palmer, 1996), administering model prompts through a mirror should facilitate the correct performance of the behavior. Indeed, Miller et al. (2015) compared two procedures to teach children with Autism Spectrum Disorder (ASD) to imitate: one where modeled prompts were delivered through a mirror, and one where model prompts were delivered face-to-face (no mirror). Participants learned to imitate more effectively and efficiently when the model prompt was delivered via the mirror.

A gestural prompt consists of pointing to or touching the S^D or other stimuli relevant to performing a response, for example, pointing to the child's arm to have them raise their hand. A visual prompt consists of a picture or a video[1] that displays a cue to perform the response. Examples of visual prompts are a picture of hands being washed displayed in a public restroom or a video of someone washing hands. A textual prompt displays written instructions to perform the respective behavior, or behavior chain, for example, displaying a sign with the words “Employees must wash hands at all times” in a public restroom. Finally, a physical prompt consists of physically guiding the learner to perform a behavior. Physical prompts can range from a gentle touch (e.g., gently pushing someone’s hands in the direction of the sink to prompt washing hands) to a full physical prompt (e.g., assisting someone hand-over-hand to prompt washing hands).

Use of Prompts

By now, it should be clear that prompts and prompt-fading procedures are at the front-end of teaching new behaviors. However, there are other important uses of prompts, including (a) to bring behavior under stimulus control, and (c) establishing a chain of previously mastered behaviors. We will discuss each of these below.

Using prompts to bring behavior under stimulus control is not just useful when teaching children, but adults as well. Workplaces are abundant with signs and pictograms that are meant to prompt employees to engage in safe behaviors, such as wash hands each time using the bathroom, use of protective equipment, or wearing a seat belt while driving. The problem is not that employees have not learned how to engage in these behaviors independently, but rather that these behaviors do not occur reliably under the conditions that their employers want them to. For example, Davis et al. (2013) assessed hand washing in public restrooms under three conditions: (a) baseline (no intervention), (b) handwashing sign, and (c) posters displaying the effects of influenza along with the handwashing sign. The sign increased handwashing as compared to baseline, whereas, surprisingly, the posters decreased hand washing at or below baseline levels. These results suggest that signs can function as effective prompts that can bring safe workplace behaviors under the appropriate stimulus control.

Another use of prompts is to establish a chain of previously mastered behaviors. Anyone who has ever baked or cooked has likely, at one or more points in time, followed a recipe. A recipe consists of written, pictorial, or video instructions (prompts) that involve multiple behaviors that should be performed sequentially. None of these behaviors are likely new to adult individuals, but their combination can be novel. For example, most individuals have performed some or all of the following behaviors: preheated the oven, mixed ingredients in a bowl, beat eggs, roll dough on cookie sheets, and placed the tray into the oven. However, one may engage in this unique combination of behaviors for the first time when following a recipe, and as a result, enjoy freshly homemade cookies. After following a recipe a few times, one may learn to make it in the absence of prompts. However, prompts are a necessary first step in learning how to bake and cook, among other complex behavior chains.

Finally, prompts for behavior chains are very helpful in establishing and maintaining routines, two very important goals of education. Anyone who has ever been in a classroom has probably noticed that there are visual and written schedules on the walls. Such schedules can help establish and maintain routines that can increase the productivity of children.

Procedures to Fade Prompts

In most cases, prompts are considered artificial, as the instructor arranges their presence and they are unlikely to occur in the natural environment. Thus, the ultimate goal is to fade these prompts to ensure that the natural antecedent accrues stimulus control and becomes an S^D. To achieve this goal, we employ transfer of stimulus control procedures. Procedures to fade prompts, known as

[1]The use of video prompts is commonly referred to as *video modeling*.

prompt-fading procedures, are used to systematically fade prompts and transfer responding to naturally occurring S^Ds (Cengher et al., 2018; Green, 2001). For example, in teaching a learner to differentially respond to pictures of common objects, the instructor may place three cards in front of the learner, each depicting a different picture of common objects, and say “find the ball,” then prompt the response by manually guiding the learner’s hand to the picture of the ball. As the learner responds correctly with the prompt, the instructor can start to implement a prompt-fading procedure until the learner can point to the picture of the ball, when verbally instructed to do so, in the absence of prompts. In the previous example, the terminal goal is for the learner to select the picture of the ball when asked by the instructor.

Common response prompt-fading procedures include decreasing assistance (most-to-least), increasing assistance (least-to-most), and time delay procedures (MacDuff et al., 2001).

When using most-to-least prompt fading, the instructor uses the most intrusive prompt type then systematically fades the intrusiveness of the prompt as instruction continues and the learner responds correctly (Fentress & Lerman, 2012; Seaver & Bourret, 2014). For example, when teaching a learner to complete a block design, the instructor may initially implement a full physical prompt (i.e., a hand-over-hand physical prompt). Then, contingent on the learner demonstrating responding at a certain mastery criterion, the prompt is faded such that the instructor uses a less intense form of the prompt, changes the location of the prompt (i.e., graduated guidance; hand-over -wrist, -forearm, -elbow, -shoulder, then shadow prompt; MacDuff et al., 2001), or uses a less intrusive prompt type (i.e., model prompt).

When using least-to-most prompt fading, the intrusiveness of the prompt is increased as necessary to occasion correct learner responding. For example, when teaching a learner to complete a block design, the learner might initially be allowed to engage in an independent response. If the learner engages in an incorrect response the instructor may lightly guide the learner’s arm at the elbow in an attempt to occasion the correct response. If unsuccessful, the instructor may then increase the intrusiveness of the prompt by guiding the learner at the wrist or use a hand-over-hand prompt (Fentress & Lerman, 2012; Seaver & Bourret, 2014).

A prompt delay involves fading prompts by imposing a period of time between the presentation of the antecedent stimulus and the delivery of the prompt (MacDuff et al., 2001). This period of time is systematically increased during or across instructional sessions (i.e., progressive prompt delay) or held constant (i.e., constant prompt delay). When using a progressive prompt delay or constant prompt delay, it is common for the initial instructional trials or sessions to include a 0-s prompt delay (Walker, 2008). During 0-s prompt delay trials, the instructor provides a prompt immediately following the presentation of the antecedent stimulus. After a predetermined number of instructional trials or sessions with the 0-s prompt delay in place, a brief period is provided following the presentation of the antecedent stimulus and the prompt. For example, when teaching a learner to respond to the social question, “What’s your address?,” the instructor may initially provide an immediate vocal model prompt (e.g., “120 Bloomfield Ave.”) that the learner should imitate. Then, after two instructional sessions with the 0-s prompt delay in place, the instructor delivers the vocal model prompt if the learner does not respond correctly within 5 s (i.e., 5-s prompt delay).

Graduated guidance occurs in conjunction with other prompt-fading procedures (e.g., most-to-least, least-to-most, progressive prompt delay, time delay) and involves manipulation of the intensity or location of a manual prompt (Jimenez & Alamer, 2018). For example, the instructor may initially use a hand-over-hand manual prompt during teaching, and over successive trials will move the prompt to the learner’s wrist, elbow, and then shoulder before removing the manual prompt and providing a gesture and then allowing for independent responding.

Common stimulus prompt-fading procedures include stimulus fading and stimulus shaping (MacDuff et al., 2001). In stimulus fading, only one dimension of the S^D is manipulated, whereas in stimulus shaping the entire configuration of the S^D is manipulated. For example, in teaching a child to respond differentially to the words, *car and cat*, a stimulus fading procedure would consist of highlighting the letters *r* and *t,* respectively. In contrast, a stimulus shaping procedure may consist of superimposing a picture of a car on the word *car* and a picture of a cat on the word *cat.* These prompts would be gradually faded so that the words *car* and *cat* come to evoke correct responding, in the absence of the prompt (i.e., the picture of the car and the cat).

Prompt Dependency

Whenever prompts are used during instruction, there is a risk that the learner will become prompt-dependent. *Prompt dependency* refers to occasions in which a learner's correct responding becomes consistently dependent on the controlling prompt and attempts to fade prompts during teaching are unsuccessful (Cividini-Motta & Ahearn, 2013). Prompt dependency may occur for several reasons. One reason may be that the instructor does not systematically fade prompt use. In these cases, the controlling prompt gains stimulus control over the learner's response while the natural S^D does not, resulting in the continued requirement for the prompt to be present for responding to occur (Clark & Green, 2004; Jones & Zarcone, 2014). For example, when teaching a learner to match to sample, the instructor may initially begin teaching trials by using a gestural prompt. During these trials, the instructor gestures to the correct corresponding stimulus immediately after delivering the vocal antecedent "match." Reinforcement is then delivered for prompted correct responses, establishing a teaching contingency (i.e., antecedent, controlling prompt, response, consequence) and involving the controlling prompt. Without the use of a systematic prompt-fading procedure, it is likely that the learner's response will continue to occur only when the prompt is presented.

Schedules of reinforcement play an integral role in preventing the development of prompt dependency. During instruction, instructors must be cautious when delivering the same quality reinforcer contingent upon learner prompted or unprompted responses (Cooper et al., 2020) and be prepared to shift reinforcement from prompted responses to unprompted responses as early as possible (MacDuff et al., 2001). This strategy, referred to as *differential reinforcement*, occurs when higher quality, higher magnitude, or denser schedules of reinforcement follow unprompted responses, whereas prompted responses result in lower quality, smaller magnitude, or leaner schedule of reinforcement. Research shows that a differential reinforcement procedure facilitates the transfer of stimulus control from the prompt to the natural S^D (Johnson et al., 2017; Karsten & Carr, 2009). For example, when teaching a learner to imitate a model, the instructor may initially deliver a manual prompt to evoke a correct response. Praise is then delivered contingent upon the learner engaging in the prompted correct response. After several learning trials, the instructor may deliver the S^D and withhold the prompt. When the learner engages in an unprompted, correct response, the instructor delivers praise plus access to the learner's favorite toy.

Given that there are several variables that can be manipulated in a differential reinforcement schedule, it can be arranged in different ways. Research has examined the optimal arrangements to promote transfer of stimulus control from prompts to natural S^Ds. Johnson et al. (2017) evaluated the effects of reinforcement schedules on responses to intraverbal, tact, and auditory-visual matching tasks. Assessments of differential reinforcement (i.e., quality, schedule, and magnitude) and nondifferential reinforcement were conducted to determine the most efficient arrangement for participants. Differential reinforcement procedures yielded superior outcomes when compared to nondifferential reinforcement procedures, and this outcome is consistent with previous research (Johnson et al., 2017; Karsten & Carr, 2009). However, there were within and across-participant differences concerning which schedule of differential reinforcement (i.e., quality, magnitude) yielded more efficient acquisition.

These outcomes speak about the necessity of using individualized differential reinforcement procedures to establish independent and efficient responses in learners.

Variables that Influence the Selection of Prompt Topographies and Prompt-Fading Procedures

With so many prompt topographies and prompt-fading procedures, one is left with the somewhat daunting task of choosing among them. This choice should be guided by: (a) the learner's behavioral repertoire, (b) the learner's instructional history, (c) the natural S^D, (d) the response being taught, (e) preference, and (f) professional ethics. We will discuss each of these below.

It is important to consider that each learner has a unique repertoire of skill and skill deficits. This is especially true for heterogeneous groups such as individuals with developmental disabilities, such as ASD, who typically benefit most from instruction that involves a carefully designed technology of prompt and prompt-fading procedures. One should assess each individual's repertoire of skills and skill deficits to choose a procedure that is not only effective but also least intrusive. For example, remember that we should only use prompts that are effective in evoking the desired behavior. If we are trying to teach a child to perform one-step directions (e.g., touch nose when instructed to do so), a model prompt is only going to be effective insofar the child can imitate other people's actions. If a child does not have a generalized imitation repertoire, another prompt topography, such as a physical prompt, should be selected. In sum, it is important to determine whether a specific stimulus topography has stimulus control over the desired behavior and, thus, is in the learner's repertoire before prescribing it as a prompt.

The learner's instructional history is equally important in the selection of prompt topographies and prompt-fading procedures. Research (Coon & Miguel, 2012; Kay et al., 2019; Roncati et al., 2019) shows that learners perform better when using a prompt topography and prompt-fading procedure to which they had been exposed previously. For example, a learner who was taught to tact a set of stimuli using an echoic (model) prompt using a gradual time delay procedure will learn a new set of tacts more efficiently when using an echoic prompt as compared to a never-before-experienced prompt topography (e.g., textual prompt; Coon & Miguel, 2012). These outcomes suggest that clinicians should choose the optimal prompt topography and prompt-fading procedure for each learner and use it consistently across skills taught and in time.

Since in most cases the goal of instruction is to fade the prompts and to transfer stimulus control from the prompt to the natural S^D, it is important to choose a prompt that can facilitate that transition. In other words, the prompt should guide the learner's attention to the natural S^D, rather than away from it. In this respect, stimulus-prompting procedures are more effective and efficient than response-prompting procedures (Arick & Krug, 1978; Collier & Reid, 1987; Richmond & Bell, 1983; Schreibman, 1975; Wolfe & Cuvo, 1978). However, stimulus-prompting procedures are not amendable to all S^Ds and responses. For example, if a child doesn't know how to clap hands and the clinician wants to teach them to clap on command, using a stimulus prompt (e.g., emphasizing the sounds of the command) is not likely to yield correct responding. Instead, a response prompting procedure, such as a model prompt, may be effective if the child has a generalized imitation repertoire. Similarly, the response being taught can influence the choice of prompt. Specifically, a response that is not in someone's repertoire can only be taught using response-prompting procedures. For example, if a child cannot tie the shoelaces, an appropriate prompt would be a model prompt, a visual prompt, or a physical prompt.

Preference for prompting procedure has not been considered until very recently. For example, Halbur et al. (2020) taught parents to implement three commonly used prompt-fading procedures, each assigned to a different set of stimuli. Throughout the study, the authors evaluated the parents' acceptability of the procedures. After the children met the mastery criterion with all three procedures, they evaluated preference for procedures in a concurrent arrangement, whereby the parents could choose between the three prompt-fading procedures available at the same time. The results showed that parents preferred the least-to-most prompt-fading procedure and that their acceptability ratings improved throughout the study. These results are important because treatment acceptability may be correlated (or is a causal factor) for treatment adherence. However, no studies to date evaluated learners' and caregivers' preference for prompt topographies. Clinicians and researchers should evaluate preference and its indirect effect on performance, as it is very likely that some prompt topographies are more preferred than others. For example, many individuals with developmental disabilities find physical contact aversive (Vostanis et al., 1998). If a clinician had this information, she could design teaching procedures that utilize prompt topographies that do not involve physical contact. Such a selection of prompt topographies may not only have implications for the effectiveness of instruction but may also be more ethical.

Finally, behavior analysts and educators should aim to teach using the least intrusive procedures necessary and should fade all supports as the child performs well to increase the child's independence and foster the transition to less restrictive teaching environments. In that respect, some prompt topographies and prompt-fading procedures are better than others. Let's get back to the example above with physical prompts—putting your hand on someone to guide them in doing something is, by all accounts, more intrusive than asking or showing someone how to do something. Therefore, physical prompts should only be used when necessary. Similarly, procedures that minimize the number of errors (i.e., stimulus fading, stimulus shaping, gradual time delay, progressive time delay, and most-to-least prompting) during transfer of stimulus control from the prompt to the S^D should be used over procedures that allow errors to occur for two reasons. First, learners can acquire new responses while almost continually contacting reinforcement when using errorless teaching procedures, assuming a continuous schedule of reinforcement is programmed for correct responses (Touchette & Howard, 1984). Second, Schilmoeller et al. (1979) found that procedures that allowed participants to make errors not only hindered the acquisition of new skills but also precluded their acquisition when the experimenters attempted to teach them using errorless teaching procedures (i.e., a final-best treatment approach). Possibly, the participants developed faulty (in the eye of the experimenter) stimulus control, which subsequently blocked the acquisition of stimulus control as intended by the experimenters. In sum, errorless teaching procedures are more ethical and more effective and should be used over procedures that allow errors to occur during the transfer of stimulus control from the prompt to the natural S^D.

Using prompts in the classroom requires other ethical considerations. If prompts are used in a classroom environment where peers are present, educators should make all efforts to minimize the use of intrusive prompts and to decrease their salience to others to avoid the learner being stigmatized. For example, if a child needs visual reminders to stay on task, the educator may make small visual stimuli and place them on the child's desk, in a space where it is not visible to her peers, rather than provide verbal reminders or physical prompts to stay on task that the other children can observe.

If an instructor considers all the aforementioned variables when selecting procedures, they should be able to narrow down the number of prompt topographies and prompt-fading procedures that are optimal for a learner. However, recall that the effectiveness, efficiency, and possibly preference for these procedures vary across individuals. As such, to identify the optimal procedure for each learner, an instructor should conduct individualized assessments of prompt topographies and prompt-fading procedures.

Recent research focused on developing assessments to identify the most effective and efficient prompt topographies and prompt-fading procedures for individuals with ASD (Cengher et al., 2015; Schnell et al., 2020; Seaver & Bourret, 2014). For example, Schnell et al. (2020)

conducted what they referred to as a *prompt-topography assessment* followed by a *prompt-fading assessment*. During the prompt-topography assessment, experimenters compared responses on a visual-auditory conditional discrimination task (i.e., also known as receptive labeling) across the use of model, partial physical, and full physical prompts. In each experimental condition, the participants were exposed to a different set of auditory-visual conditional discriminations using a different prompt topography. The experimenters evaluated the acquisition of these auditory-visual conditional discriminations across conditions. Trials were presented in a matching-to-sample format, whereby the experimenter presented an instruction (e.g., "Point to the car!") along with three pictures of different items that the participant could choose from. During the prompt-fading assessment, the authors compared response acquisition under three different conditions, each employing a different prompt-fading procedure: most-to-least prompting, least-to-most prompting, and progressive time delay. For each participant, the prompt topography that was identified as most efficient during the prompt-topography assessment was included in the design of the prompt-fading procedure. For example, if for a participant the model prompt was identified as most effective and efficient, the authors only used model prompts and gradually increased the time interval between the presentation of the natural S^D and the prompt in the progressive time delay condition. The outcomes of these assessments were replicated both within participants (i.e., across different sets of stimuli) and across participants. The authors identified the optimal prompt topography and prompt-fading procedure for each participant.

Instructors could easily replicate the procedures described above in clinical practice. Instructors routinely design protocols to teach skills, such as audio-visual conditional discriminations. Conducting such an assessment of prompt topographies and prompt-fading procedures would only involve teaching such skills concurrently, using different procedures. For example, if the instructor planned to teach auditory-visual conditional discriminations, instead of only using one procedure they may assign sets of stimuli to two or more different procedures (e.g., most-to-least prompting, progressive time delay, least-to-most prompting) and compare the efficiency of skill acquisition across them, as described by Schnell et al. (2020). Such assessments can be especially helpful for learners who do not make adequate progress (i.e., as estimated by the instructor) or for learners who demonstrate prompt dependence. For such learners, identifying the optimal prompt topography and prompt-fading assessment and using it consistently across programs can result in a meaningful increase in the number of skills learned, or a reduction in the number of sessions to mastery criterion across targets and programs.

Recent research focused on developing assessments to identify the most effective and efficient prompt topographies and prompt-fading procedures for individuals with ASD (Cengher et al., 2015; Schnell et al., 2020; Seaver & Bourret, 2014). For example, Schnell et al. (2020) conducted what they referred to as a *prompt-topography assessment* followed by a *prompt-fading assessment*. During the prompt-topography assessment, experimenters compared responses on a visual-auditory conditional discrimination task (i.e., also known as receptive labeling) across the use of model, partial physical, and full physical prompts. In each experimental condition, the participants were exposed to a different set of auditory-visual conditional discriminations using a different prompt topography. The experimenters evaluated the acquisition of these auditory-visual conditional discriminations across conditions. Trials were presented in a matching-to-sample format, whereby the experimenter presented an instruction (e.g., "Point to the car!") along with three pictures of different items that the participant could choose from. During the prompt-fading assessment, the authors compared response acquisition under three different conditions, each employing a different prompt-fading procedure: most-to-least prompting, least-to-most prompting, and progressive time delay. For each participant, the prompt topography that was identified as most efficient during the prompt-topography assessment was included in the design of the prompt-fading procedure. For example, if for a participant the model prompt was identified as most effective and efficient, the authors only used model prompts and gradually increased the time interval between the presentation of the natural S^D and the prompt in the progressive time delay condition. The outcomes of these assessments were replicated both within participants (i.e., across different sets of stimuli) and across participants. The authors identified the optimal prompt topography and prompt-fading procedure for each participant.

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Conclusion

Let us finish with the same exercise that we started with—take a few seconds to explore your environment with all your senses. Think about something that you may learn from your environment or something you may want to teach a learner about your environment (e.g., labeling items in a foreign language, responding differentially to colors, labeling locations). Next, think about how you would arrange the environment to facilitate learning. How can you increase directing the learner's attention to your programmed natural S^D? What kind of prompts would you use, and how would you fade them? What variables would you consider when making these decisions? How would you develop individualized assessments to identify the optimal prompt topography and prompt-fading procedures for learners? We hope this chapter provided the foundational knowledge that can help make such decisions in clinical practice and sparked an interest in learning more about learning.

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Stimulus-Stimulus Pairing

10

Natalia A. Baires and Mitch Fryling

Chapter Overview

This chapter focuses on the use of stimulus-stimulus pairing (SSP) procedures in the development of behavior. In particular, this chapter focuses upon the use of these procedures in the development of early language, with a focus upon using SSP to promote language with individuals with language delays (e.g., those associated with autism spectrum disorder; ASD), and in particular, individuals with very minimal or no vocal language. The chapter begins with a conceptual overview of the principles involved in SSP intervention strategies. This includes a consideration of both the respondent and operant principles that are thought to be the foundation of SSP. In addition, as some of the literature on stimulus pairing is related to other areas of application and research (e.g., derived stimulus relations), the chapter concludes with a brief consideration of how stimulus pairing procedures are fundamental to many areas in applied behavior analysis.

One more thing before we begin. Although this chapter focuses upon stimulus pairing procedures in the development of behavior (especially language skills), we recognize that stimulus pairing procedures are also used to reduce challenging behavior. For example, the literature on environmental enrichment could be interpreted from the perspective of SSP in the sense that stimuli are paired with (or added to) the current environment (e.g., Gover et al., 2019). In addition, many fearful or "phobic" responses likely develop as a result of stimulus pairings, and behavioral intervention to reduce those responses involves stimulus pairing, specifically stimulus *un*-pairing (e.g., Shabani & Fisher, 2006). Although these lines of research are interesting and pertain to meaningful clinical issues, they are not the focus of the present chapter. We mention them to acknowledge that a multitude of interventions may be considered to involve stimulus pairing; the focus of this chapter is rather specific in this regard. We turn now to conceptual foundations pertinent to our review of stimulus pairing and the development of language.

Conceptual Foundations

Applied behavior analysis (ABA) has a long history of scholarly work in the area of verbal behavior. Like many areas of behavior analysis, this particular area of application has been heavily influenced by the work of B. F. Skinner. In particular, Skinner's (1957) text *Verbal Behavior* has had a significant influence on research and practice in ABA for many years (e.g., Dixon et al., 2011; Sundberg, 2008; Sundberg & Michael, 2001). Consistent with much of Skinner's work, this area of focus has largely focused on an operant analysis of verbal behavior in an effort to understand how contingencies participate in language development. Other chapters in this text (Chaps. 22 and 68) have focused on providing an overview of this work, including the

We have no known conflict of interest to disclose.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_10

verbal operants and the various areas where Skinner's analysis has been demonstrated to be particularly helpful (also consult Garcia et al., 2020; Rosales et al., 2020 for recent reviews of the research in this area).

Approaches to language development within ABA have not been limited to applications based on operant conditioning, however. Like other areas of practice (e.g., the treatment of phobias), the area of language development has also been influenced by the respondent conditioning paradigm. Respondent processes may be particularly relevant in circumstances when there is no behavior to reinforce, such as when an individual has not yet begun to engage in vocal behavior or only engages in very minimal vocal behavior. Whereas operant conditioning places heavy emphasis on the assessment and manipulation of the *consequences* of behavior to develop and influence particular behavioral targets (in this case verbal behavior), respondent procedures place emphasis on the pairing (i.e., co-occurrence) of stimulus events together in space and time to develop and influence the development of behavior. We turn now to reviewing the conceptual foundations of SSP more specifically.

Stimulus-Stimulus Pairing

This section provides an overview of the respondent and operant processes involved in SSP. While it is unlikely that the processes occur in a precise order, we attempt to review them sequentially to lay out the mechanisms involved in the procedure.

The stimulus-stimulus pairing (SSP) procedure is derived from conceptual work in the area of behavioral development (e.g., Bijou, 1993) and Skinner's (1957) verbal behavior. Interestingly, this area of conceptual analysis may have developed, at least partially, in response to the traditional idea that some language seems to develop in the absence of a specific history of reinforcement. Indeed, at first thought, the idea that language might develop in the absence of a particular history of reinforcement would seem to threaten the most fundamental assumptions in behavioral thinking. Not surprisingly, this issue has been used as a critique of the behavioral position as an explanation of language development for years (consult Sundberg et al., 1996 for an overview). Behaviorists have attempted to explain this development of behavior in the absence of a history of reinforcement by emphasizing the distinct processes involved – and they are fundamental to understanding SSP.

From the behavioral perspective of language development, a great deal of language may be influenced by a sequence of three processes and related outcomes (e.g., Sundberg et al., 1996). *First*, and perhaps most fundamentally, there is the pairing of sounds with preferred or non-preferred stimulus events. For example, parents/caregivers often make sounds and say words while holding an infant, providing access to food, playing with the infant, and more (i.e., the sounds are paired with stimulus events). Following the respondent conditioning paradigm, the sounds, words, and more may be considered neutral stimuli that are paired with unconditioned reinforcers (e.g., food) or stimuli that are already conditioned reinforcers (e.g., the sight of a toy). As a result of these stimulus-stimulus pairings, those sounds, words, and more, while previously neutral stimuli, become conditioned stimuli themselves. This sort of pairing is pervasive throughout the lives of young children, and a great deal of early learning likely involves respondent conditioning. Readers of this chapter are encouraged to pause for a moment and consider the extensive number of sound-event pairing trials that likely occur in the day-to-day lives of young children from the time they wake until they go to sleep. At the same time, considering this may also lead to the understanding of the impact of childhood neglect on language development (e.g., Hart & Risley, 1995).

This first step explains how sounds and words first develop the stimulus properties of unconditioned and already conditioned stimuli – how those sounds become conditioned stimuli themselves. The *second step* points to the development of operant functions for the sounds targeted in step one. Specifically, it is hypothesized that this history of respondent conditioning (i.e., the stimulus-stimulus pairing) leads to those previously neutral stimuli (i.e., the sounds) now functioning as conditioned reinforcers in the operant sense of the phrase (and indeed, all conditioned reinforcers are established via respondent processes). In this sense, the respondent conditioning (Step 1) sets the stage for subsequent operant conditioning. Furthermore, when something functions as a conditioned reinforcer, the presentation of the conditioned reinforcer increases the future frequency of behavior that resulted in its presentation. In this case the conditioned reinforcer is the sound (i.e., the previously neutral stimulus), and the presentation of the sound (i.e., the hearing of the sound) may reinforce the behavior that produces it (i.e., the vocal behavior on behalf of the person who is developing language). It is this operant conditioning that serves to explain how the initial vocalizations of the individual (e.g., babbling) may begin to increase in frequency.

The *third step* in the process is automatic reinforcement. It probably is not a “step” in the sense that it does not happen *after* step two (more on this in a moment), but it is more of a concept that may be useful in explaining a critical part of SSP. Recall that one of the main issues that may be used to critique the behavioral position is that language seems to develop in the absence of a specific history of reinforcement, for example, that an adult did not mediate reinforcement contingent upon every single vocalization that a child engages in. In fact, it seems likely that it is often the case that a child begins to engage in some vocal behavior *without* there being a particular history of reinforcement to point to as the explanation. Given the respondent conditioning involved in step one, and the establishment of sounds as conditioned reinforcers in step two, engaging in any behavior that produces a target sound may be reinforced. However, this particular behavior is unique in that the reinforcement is “built in”; it occurs *automatically*. Nobody needs to *do* anything to mediate the reinforcement for engaging in the vocal behavior, and the delivery of reinforcement is not contingent upon any particular environmental condition. In other words, both the behavior (i.e., engaging in the vocalization) and the reinforcer (i.e., hearing the sound of the vocalization) can occur at anytime and anywhere.

Moreover, the shaping process may also occur automatically, whereby the vocalizations and related sound products become more and more similar to the sounds involved in the initial respondent conditioning, still without any requirement that someone mediates reinforcement. All of these make the SSP particularly unique, conceptually speaking, since environmental support is not needed beyond the initial respondent pairing in step one. Although automatic reinforcement may often cause problems when challenging behavior is involved, it is quite helpful when it is built into the process of behavioral development. The automatic reinforcement concept seems to be rather important, not only to finish explaining this part of the behavior analysis of language development, but also to respond to common critiques of behavior analytic approaches to language (readers interested in this may also consult Palmer [1996]).

We have described the respondent and operant processes involved in SSP in a somewhat sequential manner. However, it is important to note that the respondent and operant processes described thus far are more likely to be ongoing (i.e., to co-occur) or to sort of go back and forth. For example, imagine an infant who has a caregiver that says “ba-ba-ba” while playing with the infant. Respondent conditioning may occur, and the infant’s vocalizations may begin to be exposed to operant contingencies. However, it is likely that additional SSP will occur, for example the parent saying “yes, ba-ba-ba!” while tickling the infant after the infant engages in an approximation, meaning that additional respondent conditioning may occur. This respondent conditioning may influence operant processes, and vice versa. Our point here is that while we have described the processes involved in SSP as a series of sequential steps, it seems more likely that they co-occur and together contribute to the development of vocal behavior.

Why Stimulus-Stimulus Pairing?

So far we have described the processes that explain the development of vocal behavior, the processes that are the foundation for SSP as an intervention. That is, the above is a description of how early vocalizations develop, whereas SSP involves the specific application of techniques based upon those processes. The former is a conceptual explanation, whereas the latter is a technique derived from that conceptualization.

Importantly, the SSP is not just any technique, and developing early vocalizations is just one component in a larger effort to develop language. Indeed, these early vocalizations provide the context by which additional conditioning might be applied. The sound "mmm" is not an end goal in itself; it allows for further conditioning that may lead to the word "mom" and "milk", for example. Moreover, applied behavior analysts frequently work with individuals with language delays, including individuals with autism spectrum disorder and related intellectual disabilities, some of whom are minimally vocal or nonvocal altogether (e.g., Centers for Disease Control and Prevention, 2020). Therefore, it may be the case that applications of SSP are crucial to the development of early language. Given the significance of developing language in many areas of day-to-day living, it would seem that applied behavior analysts working on language development should have knowledge of interventions that may be helpful.

On this note, we turn to the research literature on the SSP. We review some of the early studies on SSP, two recent literature reviews, and literature that has been published after these literature reviews (post-2014).

Stimulus-Stimulus Pairing Research

Early Research

To our knowledge, SSP was first empirically examined by Sundberg et al. (1996). In this study, researchers examined the effects of SSP on novel vocal behavior, specifically the babbling repertoires of four children with severe to moderate language delays and one child without any language delays. In the first of two experiments, the four participants were exposed to the SSP procedure, which involved a novel sound, word, or phrase that was paired with a previously established conditioned or unconditioned reinforcer during play periods. During the post-pairing condition, all participants were observed to emit unprompted vocal and verbal behavior, with occasional emissions during participants' vocal play outside of pairing sessions. Moreover, an increase in the overall vocal responses of some participants was seen following SSP. Sundberg et al. suggested that the effect on overall vocal responses might have been a result of SSP functioning as direct reinforcement for vocalizations emitted during baseline conditions (i.e., adventitious reinforcement may have occurred). Yet, there were some instances in which an increase in vocal behavior was not observed following SSP. In order to examine a variety of parameters of the SSP procedure, a second experiment was conducted with the participant whose overall vocal responses did not increase in the first experiment.

A number of variations to the SSP procedure were included in the second experiment. The first procedural variation examined the lack of an increase in vocal behavior during play following SSP. Sundberg et al. (1996) suggested that failures to increase vocal behavior were a result of procedures being delivered by adults unfamiliar to the participant, as well as the participant's current emotional state during procedures. Specifically, Sundberg et al. observed that when the participant was "quiet and sullen," an increase in vocal behavior during periods of play was not observed following SSP. Therefore, the novel topography of a previous vocalization was paired more frequently and with longer durations of reinforcement. Results demonstrated the effectiveness of SSP.

The second procedural variation examined the maintenance of pairing by including an extended baseline and post-pairing condition. Here, procedures were identical to experiment one, with the exception that the session did not conclude until the participant no longer engaged in new topographies of vocal behavior. Results indicated that the post-training condition ceased after five minutes; compared to the pretraining conditioning lasting approximately nine minutes, these results suggested that the effects of SSP were temporary. Sundberg et al. (1996) hypothesized that such effects could be a result of the number of pairings, the extent to which the preferred stimulus functioned as a reinforcer, and the participant's current establishing operations.

Finally, Sundberg et al. (1996)'s third procedural variation introduced a similar sounding, but incomplete phrase in order to disrupt a previously paired vocalization, since it was observed that such vocalizations were emitted after each new pairing. Procedures mirrored those of experiment one, with the exception of the use of a novel yet incompatible vocalization. Results from the post-pairing condition demonstrated that this procedural variation failed to alter the previously paired vocalization, which Sundberg et al. suggest is due to the saliency of history of reinforcement when the previous vocalization compared to contingencies associated with the novel vocalization. In light of the findings obtained from both experiments, Sundberg et al. were the first, to our knowledge, to examine and demonstrate the effectiveness of SSP on increasing vocalizations of children with minimal language.

In a follow-up study, Smith et al. (1996) studied the impact of three pairing procedures on the vocal behavior of two infants without language delays. The first procedure included the neutral condition, where any vocalizations that participants emitted during play were recorded (i.e., pre-pairing and post-pairing) and a sole phoneme was emitted by researchers without being followed by reinforcement (i.e., neutral presentation). The second procedure included the positive condition which was similar to the neutral condition, with the exception of the phoneme that was emitted by researchers being paired with an established reinforcer. To not directly reinforce emitted vocalizations or other behaviors (e.g., eye contact) of participants during pairing in the positive condition, a 15 s time-out period was included, where reinforcement was not delivered following such vocalizations or behaviors (i.e., this procedure was to control for potential operant conditioning, since the study focused on learning about the effects of SSP and not direct reinforcement). The final condition was the negative condition, which was also similar to previous conditions. Here, the researcher-emitted phoneme was paired with an established punisher (e.g., verbal reprimand). The findings of Smith et al. extended those of Sundberg et al. (1996), which demonstrated that the infants' vocalizations increased following the positive pairing condition. Moreover, results from Smith et al. demonstrated minimal effects on vocalizations following the neutral condition and immediate and decreasing effects following the negative pairing condition, which suggested an automatic punishment effect. This study highlighted the importance of pairing a vocalization with a reinforcer during SSP.

These early studies set the stage for subsequent research on SSP, and indeed, there is a growing body of research in the area. In fact, review papers on SSP have been published in recent years, and in the subsequent section we provide attention to these overviews of the SSP literature. As the SSP procedure may be implemented in a variety of ways, the first review (Shillingsburg et al., 2015) analyzes the extent to which studies on SSP have varied across several dimensions. After reviewing this analysis of the SSP literature, we will provide an overview of a second review done by Petursdottir and Lepper (2015). This second review paper builds upon the work of Shillingsburg et al. in the sense that additional procedural variations on the SSP procedure are suggested. There are many opportunities for further research on SSP, and we call attention to these opportunities throughout.

Reviews of the Stimulus-Stimulus Pairing Literature

Shillingsburg and colleagues (2015) conducted a review of the research on SSP as a means to induce vocalizations. The researchers specifically looked at all of the literature published between the years 1996 and 2014 in an effort to assess how effective the SSP is, its variations, implications for practice, and opportunities for additional research. The review is noteworthy, as the researchers found a number of variations within the literature on SSP that may account for the varied outcomes found when the procedure has been researched.

The review by Shillingsburg et al. (2015) included 13 studies and a total of 39 participants. While many variables were coded in their review, we focus on those that seem especially relevant to further research and practice in this chapter. For example, one area that Shillingsburg et al. considered in their review of the literature was the participants' language skills at the time of the study. It would make sense that the participants' prerequisite skills may impact the extent to which the procedure is effective in promoting language. The researchers noted that a variety of measurements have been used in the literature (e.g., the Early Echoic Skills Assessment; Esch, 2008; the Peabody Picture Vocabulary Test-III; Dunn & Dunn, 1997), whereas some studies described the participants' verbal skills but it was not clear whether or not an assessment was used. The researchers also distinguished between participants with functional language skills (i.e., those who vocally mand, tact, and/or engage in intraverbals) and those who did not have functional language skills (i.e., participants who make some sounds and/or engage in echoics). The authors found that 28/39 (72%) of the participants in the SSP studies reviewed did *not* have any functional language skills, whereas 11/39 (28%) did have some functional language. Thus, there have been differences regarding the incoming prerequisite skills of participants within the SSP literature.

Shillingsburg et al. (2015) also found that there was some variation regarding the sounds targeted during intervention across the SSP literature. Specifically, Shillingsburg et al. were interested in the extent to which entirely novel sounds were targeted relative to sounds that were already in the participants' repertoire to some extent. Researchers found that 17/39 participants (44%) were exposed to SSP with novel target sounds, and 22/39 (56%) of participants were exposed to SSP with sounds that were already in their repertoires to some extent. In addition to these broad differences, the researchers noted that specific studies identified sounds to be targeted during SSP in idiosyncratic ways. That is to say that there is a lack of consistency with how sounds are identified within the "novel" and "within repertoire" groupings. This topic appears to be ripe with implications for additional research, as targeting a sound which has never occurred, occurs very rarely, or occurs with some reliability seems like it could differentially impact the effectiveness of the SSP procedure.

As we have described earlier in the chapter, SSP involves the pairing of a sound with another stimulus (i.e., a stimulus that already functions as an unconditioned stimulus, conditioned stimulus, and/or operant reinforcer). What is not specified in this general framework is the *number* of times the researcher/therapist makes the sound during each pairing trial. As with the areas described above, this topic too seems to be one where there is some inconsistency across the literature reviewed. In some studies, the target sound was made once per pairing; in others it was made three times, five times, and even seven times. Thus, there is great variety in how the specific pairings occur across the SSP literature reviewed by Shillingsburg et al. (2015). Interestingly, Shillingsburg et al. did not find that more pairings corresponded to better outcomes. Still, as the data on this are preliminary, more data are needed.

Another variable analyzed by Shillingsburg et al. (2015) is the *number of pairings per minute.* While a previous variable pertained to the number of times a sound was made *per pairing trial,* the present variable pertains to the number of sound-stimulus pairings per minute. In some ways, this could be considered a measure of the intensity of the intervention. The authors noted that this information is not always specifically stated within the research literature, but that it may be derived from descriptions of experimental procedures. Here too, Shillingsburg et al. noted great variation across studies, with the number of pairings per minute ranging from 1 to 15. This means that, in the same amount of time, participants in the SSP studies reviewed were exposed to 1–15 pairing trials per minute. This too is another area where the procedure is implemented quite differently across studies.

As a procedure involving respondent processes, Shillingsburg et al. (2015) also evaluated the *type* of pairing procedure that was used across SSP studies. The authors specifically evaluated the studies for the use of simultaneous, delay, trace, and discrimination training procedures. *Simultaneous* was defined as the sound and item/reinforcer being presented at the same time, *delay* was defined as the sound being presented (alone initially) with the preferred item being presented while the sound was still active, *trace* conditioning involved the presentation of the sound, with the sound stopping, and then the preferred item being presented, and finally, *discrimination training* involved the sound serving as a discriminative stimulus, such that a response was reinforced with the item, but only when the sound was present. As with other variables assessed in this review, Shillingsburg et al. found that this is yet another area indicative of inconsistency across the literature on SSP (conditioning procedures are given additional consideration in our review of Petursdottir and Lepper (2015) in the subsequent section).

Shillingsburg et al. (2015) also assessed the extent to which studies in the SSP literature controlled for adventitious (i.e., accidental) operant reinforcement. As we noted in the introduction to the chapter, the SSP procedure is based upon respondent conditioning, with stimulus-stimulus pairing being the fundamental feature of the intervention (in this case it is a sound-stimulus pairing). However, the *participants* in the studies may engage in the target sound at any time. Given this, it would be possible for the participants to engage in the target sound just before the preferred item is presented, resulting in the potential for operant conditioning (i.e., the participant engages in the target sound and this is followed by the presentation of an unconditioned or already conditioned reinforcer). If this happened, the target vocalization may increase in frequency, but this outcome may occur by way of operant conditioning, direct reinforcement contingencies, and not necessarily because of the SSP procedure. Given that the research studies reviewed aimed to study the SSP procedure, and not operant reinforcement contingencies, it is interesting to consider how many of the studies controlled for such adventitious reinforcement. Shillingsburg et al. found that 48% of the participants in the studies reviewed participated in studies that controlled for adventitious reinforcement, and 52% of the participants in the studies did not. Moreover, the procedures used by studies that did attempt to control for adventitious reinforcement were not consistent. This too seems to be an area with opportunities for further research, with specific implications for understanding the mechanisms responsible for the behavior change found in SSP studies. These issues may seem less important from a clinical perspective at first, but they may help to focus the attention of clinical work such that practitioners place emphasis on behavioral processes that are more critical to effective outcomes.

Yet another variable related to the use of SSP as an intervention pertains to the specific stimulus paired with the sound (remember the early study by Smith et al. related to this topic). Given that the pairing (in space and time) between the sound and the stimulus is the foundation of the SSP, it would make sense that the stimulus being paired with the sound be given a great deal of consideration. Generally, we might assume that pairing a sound with an item that is highly preferred, and demonstrated to function as a very reliable reinforcer, might result in better outcomes than pairing the sound with an item that is only somewhat or moderately preferred, and a less reliable reinforcer. Shillingsburg et al. (2015) noted that there was some effort to identify and use highly preferred and reinforcing stimuli within the SSP studies reviewed, but that the exact way in which these stimuli were identified varied across studies. Moreover, Shillingsburg et al. found that a range of types of stimuli were used in SSP studies, including social, tangible, and edible stimuli. While it is noteworthy that some consistency is observed in the sense that there seems to be a general effort to identify and use preferred and reinforcing items within this literature, there is room to improve standardization across studies to better understand the extent to which specific stimuli facilitate (or not) the effectiveness of the SSP intervention.

The previous paragraphs focused on reviewing some of the variables targeted in the Shillingsburg et al. (2015) review of the SSP literature. Importantly, the authors concluded their review by considering the overall effectiveness of the SSP intervention, as well as the extent to which different variables were associated with intervention effectiveness. We consider some of these conclusions in the next section.

Overall Effectiveness of the SSP/ Results Obtained

As we have mentioned in the paragraphs above, studies evaluating SSP have been conducted in a variety of ways. This broad finding makes it difficult to draw any firm conclusions regarding the research literature. Still, Shillingsburg et al. (2015) note that there are some themes that may be emerging and point to opportunities for additional research on the procedure. Perhaps most interesting is the overall analysis of the effects of the SSP intervention. When looking at specific evaluations for specific sounds, Shillingsburg et al. found that 34% of the evaluations had a weak effect, 49% had a moderate effect, and 17% had a strong effect. Thus, the effects of the intervention appear to be mixed when they are considered on the whole, while at the same time the majority (66%) of the evaluations of SSP were associated with some effect (moderate or strong). The authors also found that children 5 and younger were more likely to have moderate or strong effects when compared to older children, though at the same time recognized that evaluations with older children were fewer in number. In addition, while assessments of prerequisite language/skills varied across the studies, the authors found that participants with no functional language (i.e., those who only engaged in some vocal behavior and/or echoics) were more likely to have a stronger effect with SSP. This area seems to be of interest to both researchers and practitioners – and again, while firm conclusions are difficult to make, it seems possible that there are implications for future research and practice here.

Also, as the number of specific evaluations the authors reviewed for effect size was limited, the authors were not able to determine potential differences between interventions that involved novel relative to in-repertoire stimuli within SSP. Other factors seemed to be associated with more effective applications of SSP, including the use of procedures to control for adventitious reinforcement, the use of edibles, and delayed pairing procedures. The authors found that the number of researcher/therapist pairings per trial did not necessarily result in better outcomes; and related to this, when there were 5 or more pairings per minute the results were actually more likely to be weak. It seems possible that habituation processes may contribute to this finding. At the same time, there are many variables at play in the research on SSP, and it is difficult to draw any conclusions, let alone any firm conclusions. Much more research is needed to better understand these issues.

As mentioned earlier, a second review paper was published around the same time as the Shillingsburg et al. (2015) paper, and among other things, it focused on additional procedural variations that may warrant consideration within the SSP research.

Procedural Variations

A second review of the stimulus-stimulus pairing procedure was published in 2015, though with a bit of a different focus. Similar to Shillingsburg et al. (2015), Petursdottir and Lepper (2015) provided a general overview of the literature on SSP, noting the range of ways in which SSP has been studied within the research literature as well as the inconsistent outcomes it is associated with. Interestingly, Petursdottir and Lepper noted that there may be many reasons for the inconsistent findings of the research literature, and that one of the factors to consider might be the more general approach to conditioning sounds as reinforcers within the SSP literature; in particular, the fact that the SSP involves presenting stimuli in the absence of any particular response requirement. The authors describe some research which has focused on alternative procedures to condition reinforcers, research with implications for understanding how the SSP might be further studied and refined. We review some of these studies below. For the purposes of this chapter, these conditioning procedures might be categorized as discrimination training and response independent/dependent pairings.

Discrimination Training

One conditioning procedure that involves a response requirement for participants is discrimination training. Whereas the SSP model generally involves presenting sounds and preferred stimuli together in the absence of a response, discrimination training involves the sound being a discriminative stimulus, where engaging in a target response in the presence of the sound results in reinforcement, and engaging in the target response in the absence of the sound does not. In this model the sound becomes a discriminative stimulus, and perhaps as a result of this conditioning, the sound may become a conditioned reinforcer itself. A couple of studies have compared discrimination training with stimulus-stimulus pairing procedures (Isakesen & Holth, 2009; Lepper et al., 2013). Lepper et al. compared the effects of a discrimination training and stimulus-stimulus pairing procedure to establish vocalizations with nonvocal children with Autism Spectrum Disorder. Results showed that both conditioning procedures were effective at increasing vocalizations among the participants, with no difference as far as one being more effective than another. Petursdottir and Lepper (2015) note that this might make the traditional SSP more desirable as it is easier to implement. It is noteworthy that participants in the Lepper et al. study preferred the discrimination training procedure, however. Regardless of all of this, given that we know the traditional SSP procedure has mixed results, Petursdottir and Lepper suggest that the discrimination training procedure may represent an option to explore when SSP is not effective. Though again, much more research is needed to explore this possibility.

Response-Independent/-Dependent Pairings

A study by Dozier et al. (2012) examined two different pairing procedures to condition praise statements as reinforcers. In one of the conditions (Experiment 1), praise statements, which were determined to be neutral and not function as reinforcers prior to the pairing intervention, were paired with highly preferred edible items. This condition was similar to the stimulus-stimulus pairing procedure in that two stimuli, praise statements and preferred edible items, were paired together in space and time. Results showed that this pairing condition was not effective for 3 of the 4 participants, with one participant showing some effect initially though this did not maintain over time. In the second condition, evaluated in Experiment 2, the pairing condition involved a *response*-stimulus pairing, where participants engaged in a target response and this was followed by the presentation of the praise statement and preferred edible item. Subsequent to this response-stimulus pairing condition, there was a test for the reinforcing effects of praise alone – to evaluate the extent to which the response-stimulus pairing condition established praise as a reinforcer. The response-stimulus pairing condition was effective for four of the eight participants in Experiment 2. Moreover, praise was also found to function as a reinforcer for additional responses with these four participants. While Dozier et al. were focused on conditioning praise statements as reinforcers, the response-stimulus pairing procedure studied may have implications for understanding how to improve the effects of SSP to increase vocalizations. Indeed, this was specifically explored in a recent study by Lepper and Petursdottir (2017), which is described in detail in the following section.

In general, the Petursdottir and Lepper (2015) review reminds us that while we may need to focus on understanding some of the details associated with successful applications of SSP, we also need to consider the more general pairing procedure and the extent to which alternatives, particularly those which require a response on behalf of the individual, could increase the effects of intervention efforts.

Recent Research

Following the literature reviews of Shillingsburg et al. (2015) and Petursdottir and Lepper (2015) on the SSP, empirical research on the effects of SSP to increase novel vocalizations and condition vocalizations as reinforcers has continued. In 2017, Lepper and Petursdottir conducted two experiments which evaluated the effects of a response-contingent pairing (RCP) procedure on vocalizations of target syllables for three children with ASD who engaged in minimal functional vocal verbal behavior. As the name suggests, RCP is used to establish vocalizations as reinforcers by pairing a neutral stimulus with a reinforcer and delivering the reinforcer contingent on a response. This procedure was compared to the response-independent pairing (RIP) procedure, similar to the SSP that we have been describing thus far in the chapter, where two stimuli (e.g., a sound and a reinforcer) are presented in the absence of a particular response from the individual.

In the first experiment, Lepper and Petursdottir (2017) compared RCP and RIP. During RCP sessions, 20 sound presentations were included and consisted of 10 target and 10 nontarget sounds presentations. Before undergoing experimental procedures, participants were taught to engage in a button-pressing response, which allowed for delivery of preferred items. RCP sessions began with the button being placed in front of the participants so that an opportunity to press it was presented. After participants pressed the button (in the presence or absence of a prompt), a target or nontarget sound was presented three times with 1 s between presentations, along with the simultaneous delivery of a preferred item and the removal of the button. Once the preferred stimuli were consumed, an intertrial interval began. The button was presented again 10 s into the intertrial interval, with the intertrial interval ending when the participant pressed the button again. If participants engaged in a target or nontarget vocalization just before a preferred item was to be delivered, the item and button were removed and represented after 20 s of no vocalizations; this was done to prevent direct reinforcement of such vocalizations (recall our description of procedures that control for adventitious reinforcement earlier in the chapter).

Sessions of RIP mirrored those of RCP, with the exception of the button not being presented, eye contact being obtained prior to the presentation of nontarget sounds or presentation of target sounds and delivery of a preferred item, the set of target and nontarget sounds differing, and each intertrial interval being yoked to a previous RCP session to equate durations of sessions and to increase deprivation or satiation of preferred items across the two interventions. Results from the first experiment demonstrated that more target vocalizations per minute occurred following RCP, despite absolute rates of such vocalizations being low and ranging from 0 to 1.69 per minute. To increase the rates of these target vocalizations to clinically acceptable levels, Lepper and Petursdottir (2017) utilized differential reinforcement with social reinforcement in a second experiment while including pairings for maintenance.

Procedures of the second experiment consisted of RCP, with the exception of the immediate delivery of preferred items following target vocalizations and the simultaneous removal of the response button if it was present, the response button being presented again only after a 10 s absence of a target vocalization, and prolonged contact with preferred stimuli when target vocalizations occurred while participants were already consuming a preferred stimulus. Data indicated that differential reinforcement increased target vocalizations compared to RCP alone for all participants. While target vocalizations occurred at low rates during extinction in the first experiment and during baseline of the second experiment, the rates of such target sounds increased to clinically relevant levels following differential reinforcement. Results from Lepper and Petursdottir (2017) demonstrated that the efficacy of pairing procedures such as SSP may be enhanced when stimuli are presented contingent on responses and that the effects of pairing procedures such as RCP may be enhanced when differential reinforcement is used in conjunction with maintenance pairings.

Another recent study was conducted by Cividini-Motta et al. (2017), who were specifically interested in better understanding procedures to improve echoic training given the mixed results within this literature. Cividini-Motta et al. devised an assessment protocol to identify the most effective echoic teaching procedure among vocal imitation training, SSP, and the mand-model procedure. The researchers also conducted functional analyses to determine whether trained responses functioned as echoics or mands. Six children diagnosed with autism and related disorders, ranging in age from 7 to 17 years old, completed a series of echoic probes and functional analysis probes, as well as a semi-random order of vocal imitation training, mand-model teaching, SSP, and play sessions. Specifically during the SSP condition, the target sound was presented five times, with 1 s intertrial intervals. Prior to beginning sessions, participants were allowed to select a preferred item, which was presented between the second and fifth presentation of the target sound during SSP sessions. The assessment protocol identified an effective echoic training procedure for five of six participants. Although SSP was the most effective procedure for some participants, authors suggested that carry-over effects might have impacted results. Specifically, participants' echoics were directly reinforced during vocal imitation training and mand-model teaching, which could have increased the likelihood of engaging in vocal imitation during SSP as a result of the novel history of reinforcement for this response. As a result, Cividini-Motta et al. (2017) proposed evaluating the effects of SSP first prior to vocal imitation training and mand-model procedures, in addition to providing direct reinforcement of vocal imitation when utilizing SSP to increase echoic responding.

While early research on SSP involved adults who had a history of implementing procedures with participants (Smith et al., 1996; Sundberg et al., 1996), the majority of SSP evaluations within the research literature have been delivered by researchers (i.e., unfamiliar adults), which may impact outcomes as well as the maintenance and generalization of clinical gains. Moreover, the conceptual model described earlier in the chapter is generally assumed to involve someone who has been paired with a variety of reinforcers (i.e., someone who is likely to be established as a generalized conditioned reinforcer for various behavior the child engages in). Therefore, Barry et al. (2019) assessed the impact of a parent-implemented SSP intervention with two children with ASD who did not engage in vocal verbal behavior. Experimental procedures consisted of five phases: baseline, SSP, direct reinforcement, noncontingent reinforcement, and a return to direct reinforcement. During SSP, one pairing sound per trial was utilized. Prior to intervention phases, behavioral skills training was used to train parents on the delivery of SSP.

Across both participants, higher frequencies of target responses were seen across all experimental procedures relative to baseline, while nontarget responses remained the same. SSP initially increased target responses, such increases continued when differential reinforcement was utilized, and SSP was effective in conditioning vocalizations as reinforcers. Barry et al. (2019) also assessed social validity via a questionnaire inquiring about parents' experiences with the intervention. With mean scores being 4.3 out of five, responses from both parents suggested high social validity in areas such as SSP allowing for meaningful one-on-one time with their children, confidence in the ability to conduct SSP, and increased vocalizations following the intervention. The research of Barry et al. not only extended the literature of SSP, but more importantly provided preliminary support for training parents to deliver procedures to increase their children's early vocalizations, which can allow for increased learning opportunities and generalize and sustain vocalizations.

The most recent study evaluating SSP is that of Freitas et al. (2020). As there has been little attention to how different respondent conditioning procedures influence the outcomes of SSP, Freitas et al. aimed to further link SSP with respondent conditioning research by comparing the effects of forward versus backward pairing on echoics and quantitatively assessing the relation between participants' current skill levels and the efficacy of SSP. Twelve children with ASD, seven residing in the United States and five residing in Brazil, with limited vocal verbal behavior and delays in language served as participants. During baseline, participants' vocalizations were recorded during free play; of those one syllable recorded vocalizations, three were selected to serve as target sounds and were randomly assigned as forward sounds or backward sounds. During the forward conditioning sessions, the forward sound was presented first by researchers, followed by the immediate delivery of the preferred item; this differed from the backward conditioning sessions, where sounds emitted by researchers were also paired with a preferred item, but the order was reversed (i.e., the preferred item was delivered immediately before the backward sound). Control sounds were also included, which consisted of a sound uttered by researchers in the absence of preferred items.

Intervention consisted of target sounds being emitted for 2 s and participants engaged with preferred stimuli for 10 s. Results obtained from Freitas et al. (2020) demonstrated that SSP increased the mean response count per session when forward pairing was utilized. Moreover, there were differences in the effects of forward and backward sounds with SSP; specifically, fewer echoics were emitted with backward sounds in comparison to other sounds (i.e., forward and control). The results also pointed to an inverse relation between the Behavioral Language Assessment Form (BLAF; Sundberg & Partington, 1998) and the effectiveness of SSP. Overall, SSP was more effective for participants who had fewer skills at the beginning of the study. Moreover, results suggested that the forward pairing procedure was more effective than the backward pairing procedure for participants of the study.

Implications for Research and Practice

As we have noted throughout, there are many opportunities for further research to better understand the SSP procedure and its use to develop early vocalizations. We offer some general recommendations and highlight themes for further analysis below, as well as some implications for practice. As always, decisions that researchers and practitioners make should always be informed by research and ongoing progress monitoring. Given what we know about SSP, it should not be *assumed* that SSP will effectively increase early vocalizations. As we have noted throughout this chapter, findings are not consistent and it is difficult to know the exact conditions under which the procedure is most likely to be effective. Practitioners considering the SSP procedure should monitor progress carefully and consider alternative procedures (some of which have been described in this chapter) and discontinue the use of SSP if desired behavior change is not occurring. For example, procedures described by Petursdottir and Lepper (2015) may be promising when traditional SSP is not effective; and this too represents an area for further investigation. Next, current data suggest that SSP is most effective with children who are younger (i.e., 5 and under; Shillingsburg et al., 2015). Though this is quite tentative and additional research is needed to support or counter this hypothesis, it is something that practitioners should be aware of.

Behavior analysts should also always consider the learner's prerequisite skills when conducting studies in this area; even when the SSP procedure does not increase target vocalizations or establish novel vocalizations, the circumstances surrounding less effective applications can still be identified. Paying closer attention to prerequisite skills will not only aid in the understanding of when SSP is more or less likely to be effective, but also help to understand the overall progression of early behavioral development more generally (e.g., to help identify critical cusps to target before SSP). In addition, relatively little is known about the differential effects of targeting novel sounds relative to sounds that are already in the individual's repertoire (even just minimally). Moreover, it's possible that sounds should be targeted in a particular sequence, or that if one or two particular sounds are occurring minimally, one might be a better candidate to target next, etc. These issues, both the topic of assessing prerequisite skills and identifying specific targets for intervention, present opportunities for applied behavior analysts to collaborate with speech-language pathologists who have specific expertise in these areas (Association for Behavior Analysis International, 2021).

Finally, researchers and practitioners should consider the implications of participant histories with different therapists implementing SSP, including familiar adults, unfamiliar adults, and parents/caregivers, and others. It seems possible that different therapist histories with participants will influence the effects of SSP, and this factor is deserving of more attention from researchers and clinicians. Moreover, if results using SSP continue to suggest that the procedure is most effective for children under 5 years old, training parents/caregivers to utilize SSP with high fidelity may facilitate more widespread and lasting influence on child vocalizations.

Conclusion

Before we conclude, we would like to again acknowledge that a great deal of interventions may fall under the purview of stimulus-stimulus pairing. For example, researchers interested in the development of stimulus equivalence have studied the extent to which two stimuli may be presented in a respondent manner in efforts to promote the development of equivalence relations (e.g., Leader & Barnes-Holmes, 2001). Related to this, stimulus pairing has also been involved in research on the Stimulus Pairing Observation Procedure, where picture-word relations have been presented to participants and found to be functionally related to the development of listener responses (e.g., point to the "word"; Byrne et al., 2014). Other studies have also focused on pairing procedures to condition other responses, such as conditioning observing responses (e.g., Greer & Ross, 2008). We mention these areas here to acknowledge that stimulus-stimulus pairing is related to many areas of research in behavior analysis, including derived stimulus relations and the development of many important behavioral cusps.

We have provided a general overview of the stimulus-stimulus pairing procedure as it has been used to produce novel vocalizations among individuals with language delays. If there are any broad conclusions to make, it is that we have much more to learn regarding how and when the SSP procedure is likely to be more or less effective. Given the importance of developing early vocalizations as a foundation for subsequent language development, detailed analyses of variables we have discussed in this chapter seem warranted.

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Psychological Modeling and the Treatment of Obsessive-Compulsive and Related Disorders

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Psychological Modeling

Modeling was made popular as a psychological intervention in the latter part of the twentieth century by the psychologist Albert Bandura. Bandura (1969, 1971, 1977a) viewed modeling as an essential aspect of learning new behaviors. As he suggests, if we had to rely solely on learning from the consequences of our own individual actions, we would have died off as a species long ago (Bandura, 1971). We also learn through observational learning, i.e., through witnessing the consequences of other people's behavior (Bandura, 1971, 1977a). It is on this idea that the importance of modeling as a treatment technique is based. In this chapter we will explain psychological modeling and why it is beneficial in the treatment of anxiety and avoidant behavior in general. We will then discuss how it can be used specifically in the treatment of obsessive-compulsive and related disorders.

A study by Bandura et al. (1961) demonstrated the effectiveness of learning through the modeling process. In this study of 72 nursery school children, 24 children witnessed a model aggress toward a five foot Bobo doll, 24 children witnessed a subdued model who ignored the Bobo doll and did not display any aggressive behavior toward it, and 24 children were in a control group with no exposure to the model. The children were tested on the extent to which they would imitate the modeled behavior after the model was no longer present. Children who witnessed the aggressive model displayed similar aggressive behavior as was modeled toward the Bobo doll to a much greater extent than children in the other two groups. Further, children who witnessed the non-aggressive, subdued model displayed less aggression than the children in either of the other two groups.

Spiegler and Guevremont (2010) describe different aspects of modeling as follows. At a basic level, a model is simply someone who demonstrates a behavior to an observer; in other words, models the behavior. There are two parts to this. The first is that the observer witnesses the steps that are involved in performing the behavior. The second is that the observer witnesses the consequences of performing the behavior. These consequences are called vicarious consequences. Vicarious reinforcement is when the observer witnesses the modeled behavior being rewarded, which increases the likelihood that the behavior will be imitated. Vicarious punishment is when the observer witnesses the modeled behavior being punished, which decreases the likelihood the behavior will be imitated. If a person is afraid of negative consequences being the result of an

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_11

action, and then witnesses that action happening without the feared consequences occurring, there may be a reduction in the anxiety triggered by that event. If so, this process is called vicarious extinction. An observer can either witness something being modeled in-person through the use of a live model, or an observer can witness something being modeled symbolically through the use of mediums such as stories, films, or photographs.

Albert Bandura (1969, 1971, 1977a) broke modeling down into four basic components: attentional processes, retention processes, motor reproduction processes, and motivational processes. The first aspect, attentional processes, is based on the idea that behaviors cannot be imitated if the person does not pay attention to the behavior and the necessary ingredients of performing the behavior effectively. Features such as the frequency with which one is exposed to the modeled behavior, the value and consequences of the behavior, as well as the attractiveness and social power of the model will influence whose behavior will receive more attention (Bandura 1971, 1977a; Brewer & Wann, 1998).

The second process speaks to how, once a behavior has been attended to, it must be retained in order for it to be reproduced without the model being present, i.e., the behavior must be remembered. Once behaviors have been encoded in memory, rehearsal, either overt or covert, can work to enhance the retention process (Bandura, 1977a). This fact highlights the importance of therapists assigning homework when teaching patients new behaviors. If the patient is not able to practice the behavior overtly, then rehearsing it mentally can also work to enhance the learning process.

The motor reproduction processes component involves translating the behavior into specific actions. For modeled behaviors to be reproduced, the behavior must not only be cognitively processed, but the observing individual must have the skill set needed to perform the behavior. If this skill set is lacking, then the person needs to acquire it through practice (Bandura, 1977a). This again speaks to the importance of assigning homework when teaching new behaviors, so the individual can develop the necessary skill set through a process of trial and error.

Lastly, for the behavior to be imitated, motivation to perform the behavior must be enhanced through reinforcement. If there are no appropriate incentives to engage in a behavior, then there is less likelihood the behavior will be reproduced (Bandura, 1971). These consequences can either be directly experienced or observed. Witnessing models engage in behaviors which produce desired outcomes provides an incentive to imitate that behavior (Bandura, 1977a).

The likelihood of a task being initiated increases significantly if the person believes both in the benefits of doing the activity and in his or her ability to accomplish the activity (Bandura, 1977b). However, these two aspects are different. An individual can believe in the benefits of doing a task, without believing in his or her ability to do the task. Both need to be present for there to be the necessary motivation. This speaks of the importance of self-efficacy, meaning one's belief in one's ability to accomplish a task (Bandura, 1977b).

Bandura (1977b) speculated that the therapeutic value of psychological modeling is in it helping the patient to achieve a greater sense of self efficacy, which increases a sense of mastery, and as a result, decreases anxiety and avoidant behavior. The more a person believes in his or her ability to accomplish a task, the greater the likelihood that person will attempt the activity. If a patient experiences being able to master a task he or she previously believed to be impossible, then that person will grow in confidence as related to his or her abilities to do the activity. This will decrease the likelihood the person will avoid doing the activity and the anxiety associated with the activity. Along the same lines, if a patient can perform a task (or witnesses a task being performed) without the subjectively experienced feared consequences being realized, then that person will be less reluctant to do the activity. For these reasons, enhancing a sense of self-efficacy is a central mechanism in the interventions we will be exploring in this chapter.

There have been several studies demonstrating the effectiveness of modeling in reducing anxiety and avoidant behavior. Bandura (1967) studied the extent to which vicarious extinction occurred through the observation of modeled behavior toward a feared stimulus where the model did not experience any negative consequences. The study involved 24 boys and 24 girls aged 3–5 years, all of whom exhibited avoidant behavior toward dogs. The study found that observing a model engage in gradual exposures to more anxiety provoking situations involving a dog reduced avoidant behavior in the children. Studies have also found modeling to be effective in treating snake phobias in both children and adults (Blanchard, 1970; Murphy & Bootzin, 1973; Ritter, 1968) as well as injection phobias (Trijsburg et al., 1996). Modeling has also been found to be helpful in treating phobias in children with Autism Spectrum Disorder traits (Musket et al., 2020) and Development Delays (Davis et al., 2007).

Bandura and Menlove (1968) studied the effects of symbolic modeling through the use of films on children aged 3–5 who exhibited a fear of dogs. This study demonstrated that the children observing films of the models interacting with the feared stimulus without experiencing any negative consequences was an effective way of reducing fearful responses and avoidant behavior toward dogs. A study by Hill et al. (1968) also demonstrated the effectiveness of symbolic modeling in the forms of films in reducing avoidant behavior in children toward dogs. Fryrear and Werner (1970) used videotape modeling to successfully treat a college student's fear of animal dissection.

So far we have provided a description of psychological modeling as well as evidence supporting its effectiveness as a therapeutic intervention for anxiety and avoidant behavior in general. Modeling has also been demonstrated to be effective in the treatment of obsessive-compulsive and related disorders (Silverman, 1986; Thyer, 1985). We will now focus specifically on the use of this technique to treat these conditions.

The Treatment of Obsessive-Compulsive and Related Disorders

Prior to the Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (DSM-V), obsessive-compulsive disorder (OCD) was classified in the anxiety disorders section of the DSM. However, based on an expanding conceptualization it was determined that OCD be moved to its own DSM category. Furthermore, it was decided that additional disorders that were previously included in other sections of prior editions of the DSM be included in this newly formed section as well. These changes resulted in the new DSM-5 category of obsessive-compulsive and related disorders (OCRDs) (American Psychiatric Association, 2013).

The following disorders are included in the OCRDs DSM-5 category: obsessive-compulsive disorder (OCD); body dysmorphic disorder (BDD); hoarding disorder; trichotillomania (hair pulling disorder); and excoriation (skin picking) disorder. In addition, several other disorders are included in this category: substance/medication-induced obsessive-compulsive related disorder; obsessive-compulsive and related disorder due to another medical condition; other specified obsessive and compulsive and related disorders; and unspecified obsessive-compulsive and related disorders.

The rationalization for combining these disorders is not new. Indeed, research on the idea of an "OCD Spectrum" has been accruing over the last 40 years (Yaryura-Tobias & Neziroglu, 1983, 1997). The main premise underlying the OCD Spectrum is that several disorders share a high resemblance in various aspects, especially symptom similarity. One of the main similarities between the OCRDs is the persistent preoccupation with thoughts and repetitive behaviors. Moreover, research suggests that there is a high comorbidity rate among these disorders, which again underscores the rationale for grouping these disorders together.

Of special note is that although these disorders share similar overall categories of symptoms (i.e., obsessions/compulsive behavior), they have their own unique obsession content and compulsive behaviors, as well as additional features. For example, while OCD obsessions may vary among several different categories such as harm, sexual, and/or contamination, within body dysmorphic disorder (BDD), obsession content focus primarily on an "imagined and or slight defect" in one's appearance, while compulsive behavior usually manifests as mirror checking, camouflaging one's appearance, and severe avoidance.

Not surprisingly, based on the overlap between symptomatology, similar treatment inventions (i.e., exposure response prevention, skills training, etc.) are often used to treat these disorders and/or modified to address the unique features of each disorder. In addition, several other procedures are often used in conjunction with these more traditional interventions to enhance treatment outcomes.

Modeling is one such intervention. Subsequently, the remaining portion of this section of the chapter will focus on the incorporation of modeling in the treatment of OCRDs. Specific examples of different uses of modeling will be given for each of the main disorders within this category.

Modeling and OCRDs

As clinicians, whether we realize it or not, we are using the techniques of modeling in every exchange we have with our patients. Indeed, not only do patients learn from direct instruction, but also from what they see their therapists do. Moreover, not only can behaviors be modeled, but also thoughts, attitudes, and emotional responses. Subsequently, not only must therapists focus on the appropriate selection of interventions, but they must also be aware of how they themselves apply and come across during intervention implementation. By being aware of the concepts and procedures of modeling, therapists can purposefully incorporate them into their interactions with patients in order to increase the efficacy and efficiency of their treatment approach. This is especially relevant when it comes to the treatment of OCRDs.

Obsessive Compulsive Disorder

When it comes to the treatment of OCD, cognitive behavioral therapy (CBT) is a first-line treatment approach. Although a CBT package can contain many elements, a primary technique for treating OCRD is exposure/response prevention (EX/RP). Simply stated, EX/RP is a treatment intervention where individuals are assisted in confronting feared stimuli and/or situations, while simultaneously being coached to refrain from engaging in compulsive and/or safety behaviors. In therapy, EX/RP is applied in what has been referred to as either "therapist assigned" and/or "therapist assisted" exposure. In therapist assigned exposure, the therapist will often explain the rationale and instructions for EX/RP, as well as assist the patient in creating a hierarchy (i.e., a list of feared/avoided stimuli and situations that are in order from least fearful to most fearful). Once the hierarchy is complete, the therapist will assign the patient the task of carrying out the EX/RP assignment on their own between sessions.

In contrast, with therapist-assisted EX/RP, the therapist will actually assist the patient in carrying out the exposure exercises either by providing in-person support and corrective feedback in real time, and/or fully participating in the exposure alongside the patient. In comparing the two approaches, therapist-assisted EX/RP has the advantage of capitalizing on the therapist's ability to indirectly, or purposefully, incorporate modeling into the intervention. Research has demonstrated that therapist-assisted EX/RP can lead to enhanced treatment outcomes (Abramowitz, 1996). In addition to other factors (i.e., support/validation), it is hypothesized that part of this effect is directly related to the use of modeling during these exchanges.

To illustrate, we will focus on a scenario that often arises when working with an individual suffering from OCD that has contamination and hand washing rituals. It is often observed in clinical practice that patients with contamination fears will often engage in excessive/ritualistic hand washing behaviors. Although the patient may have some level of insight into the excessiveness of their behavior, they often do not possess a clear sense of what may be considered “reasonable” washing behavior. In this case, the therapist can serve as a live model of appropriate washing behavior, while the patient serves as an active observer (i.e., the key elements of modeling) (Spiegler & Guevremont, 2010).

In order to carry out modeling effectively and efficiently, the therapist would provide a rationale for why they will be serving as a model of an alternative behavior, as well as elicit the patient’s cooperation and agreement. It is important to first elicit agreement from the patient. Indeed, even seeing another person carry out a fearful behavior and/or not engage in a compulsion can be frightening to the patient and inadvertently sensitize and “turn them off” to EX/RP before they have even gotten the chance to participate and try it for themselves. Unfortunately, earlier on in the depiction of EX/RP, the therapist was presented as surprising the patient with feared situations or objects. Nothing is as far from the truth. Modeling is always with the consent of the patient.

Once agreement has been obtained, the therapist will first verbally go through the steps of what they are going to do and how they will do it. Next the therapist will actually demonstrate the goal behavior (i.e., in this case appropriate hand washing). The therapist will purposefully demonstrate every aspect of the desired behavior. For example, the therapist makes sure to demonstrate how to turn on the faucet with their full hand and to not use anything like a towel to avoid touching it (i.e., the opposite of which are often strategies used by individuals with OCD to avoid germs and/or recontamination).

Next the therapist would demonstrate the appropriate temperature of the water to be used (i.e., lukewarm as opposed to scolding hot, which is typically seen). The next steps would include demonstrating how to wet one’s hands and what is a reasonable amount of soap (i.e., one pump) to be used. The patient would then be taken through what would be considered appropriate lathering of their hands in a general sense (i.e., as opposed to specifically and methodically focusing on each individual finger and/or lathering not only the hands but wrists, arms, etc.). Finally, the therapist will demonstrate how long to rinse and dry their hands while simultaneously again focusing on shutting off the faucet and leaving the bathroom in a non-avoidant manner.

During this whole process, the therapist is cognizant of purposefully not only demonstrating overt behaviors accompanied by verbal prompts and explanations of their behavior, but also making sure to model appropriate emotional reactions to the task, as well as sharing their accompanying thoughts throughout the process (i.e., “I am comfortable with this level of cleaning” “This level of cleaning is reasonable,” etc.). Hopefully as a result of this approach, the patient will be willing to engage in similar behavior as the therapist. Patients may differ on their willingness to directly imitate the therapist’s behavior. However, hopefully the process will provide a model to strive toward, as well as assist in treatment engagement. Indeed, observing is not a guarantee that patients will accept the therapist’s behavior as a guide for their future behavior. Notwithstanding, by demonstrating realistic patterns of behavior and not suffering any harm, we hope to help reduce the patient’s initial anxiety (Spiegler & Guevremont, 2010).

In contrast, there are times when a therapist may purposefully model an exaggerated form of a behavior. Often in OCD treatment, the therapist and patient not only attempt to engage in “reasonable” behavior, but also in an exaggerated form of the patient’s disastrous consequences (i.e., the harm they believe will happen if they do not engage in their compulsions). For example, if a patient is afraid to eat food that “might” be contaminated in some way, the therapist may purposefully “contaminate” the food (i.e., by dropping on the floor, eating the food without washing their hands, etc.) and then eat it.

Although these may not be behaviors the therapist typically engages in everyday living, they are modeling that even a “risk” of that magnitude can be carried out and they will remain “safe.” Through the observation of this behavior, the patient can come to learn through vicarious learning that a feared consequence does not happen (Spiegler & Guevremont, 2010). Once the patient sees that this behavior did not result in anything bad happening, this will hopefully help to put their original fear in perspective and motivate them to take reasonable risks that were previously avoided. This also provides an additional opportunity for the therapist to model a different mindset and emotional reaction than the patient is accustomed to. It should be noted that when a therapist engages in an exposure exercise, it could be very motivating for the patient. Indeed, it can often motivate the patient to challenge him or herself and/or increase the therapeutic alliance since the therapist's behavior demonstrates a real investment in the patient's treatment and respect for their fears.

Imaginal Exposure

In the above examples so far, EX/RP has been carried out in vivo with the therapist serving as the live model for the patient. However, exposure can also be conducted imaginally. Similar to in vivo exposure, the patient confronts an avoided situation. However, instead of taking place in the actual environment, the event is encountered in the patient's mind. Imaginal exposure can be helpful for people who are not quite ready to enter into actual situations and/or situations that are hard to recreate (e.g., starting a fire). As with in vivo exposure, the goal is for the patient to experience a decrease in anxiety by continually confronting more difficult scenarios on their anxiety hierarchy.

Modeling procedures can be purposefully used in imaginal exposure. This type of modeling is called covert self-modeling. Covert modeling is when the patient imagines themselves (or the therapist) performing a desired behavior and/or entering a feared situation (Spiegler & Guevremont, 2010). This procedure can be carried out in alternative ways and across feared situations.

To start, the therapist would explain the rationale and procedure to the patient verbally. Next the therapist would physically demonstrate sitting comfortably in a chair with their eyes closed. The therapist would then inform the patient that they are selecting an anxiety-provoking situation that they will imagine. Like all exposures, the therapist would make sure that the selected image is challenging yet not overwhelming (Dryden, 2012).

Once selected, the therapist would then begin to imagine the scenario in their head while verbalizing exactly what they are imagining as to model the type of scenario the patient will be imagining in their head. For example, the therapist would begin by saying "I am walking in the park with my son and we are approaching the swings. There are four swings and no one is on them. My son is running up to the swing and jumping on. I see my son going back and forth on the swing. I feel my breathing getting fast but I am staying here and now he is getting off. I am walking out of the park." Once this is completed, the therapist would invite the patient to imitate what they just demonstrated, as well as provide feedback and reinforcement along the way. Initially, the therapist may ask the patient to repeat what they are imagining in their head to make sure they are following the procedure correctly. Eventually, the patient would be able to practice without verbalizing out loud what they are imagining.

At times, having the patient immediately picture themselves in a scenario may be anxiety producing itself. Therefore, as an alternative the patient can imagine the therapist entering the scenario instead of himself/herself. This serves two purposes. First, although the patient is not in the image, they are at least confronting the feared situation on some level. Second, the image of the therapist serves as a model for the patient just as in in vivo exposure. Alternatively, the patient can imagine the therapist entering the situation with them. This approach again capitalizes on modeling and the benefits of therapist-assisted exposure as described above.

Finally, patients often come in with the belief that "This is just the way I am" and the thought of acting with mastery in an anxiety producing situation is just too difficult to fathom. Subsequently, as a spin-off of the patient imagining the therapist in their mind, we ask the patient to imagine himself or herself as someone who is able to manage anxiety differently. Once they have this, they can imagine their "masterful" self, assisting their "anxious" self through the anxiety situation. This approach has the advantage of the patient serving as their own "mastery" model as opposed to the therapist, thus enhancing the patient's sense of self-efficacy and ownership of the reduced anxiety reaction (Spiegler & Guevremont, 2010).

Hoarding Disorder

Although multifaceted, the primary symptoms of hoarding disorder are the excessive acquisition of items (i.e., newspapers, books, jewelry, plastic bags, appliances, etc.) and an avoidance and/or refusal to discard items. These behaviors persist despite the significant distress and/or interference they may have for the person suffering from hoarding disorder, as well as in other important people in their life (Neziroglu et al., 2020). Often due to high overvalued ideation (Neziroglu et al., 2012) and/or poor insight, individuals with hoarding disorder are reluctant to engage in the treatment process. Subsequently, many individuals may come into treatment due to legal issues, strained living conditions, and/or the ultimatums from family members.

Not surprisingly, when it comes to treatment not only may these individuals be reluctant to engage in EX/RP, but efforts at modeling may even cause some to "counterimitate" a therapist's behavior (Spiegler & Guevremont, 2010). Therefore, in these cases it is important to focus on the functionality of the presenting issues and the therapist may even (i.e., at least initially) model behavior that is somewhat less than "reasonable" (e.g., be willing to throw away one newspaper as opposed to a stack). This approach is used to build trust and rapport with the patient, as well as keep them engaged.

Assuming the patient participates, again, traditional EX/RP and modeling procedures will be modified. To illustrate, one aspect of hoarding disorder treatment that patients find difficult is between session homework assignments of actually physically throwing away items. Indeed, it is one thing to determine with a therapist that certain items will be thrown away, while it's another thing to actually throw them away. It is not uncommon to work with a patient with hoarding disorder during a session and select items to be discarded only to return next session and find the items still there. Therefore, it is important not only to throw away items in session, but also to actually make sure the items are making it out of the home. This is where participant modeling can be an especially appropriate approach for this aspect of the treatment for hoarding disorder (Spiegler & Guevremont, 2010).

Participant modeling encompasses several steps often seen with traditional exposure therapy with certain purposefully added aspects to facilitate behavior change. For example, the therapist first models the behavior they would like the patient to perform. In the case of hoarding, this would include first selecting an item to discard. Next the therapist would demonstrate actually throwing away this item into a garbage bag. The therapist would then verbally prompt the patient to perform the same task they had just completed in an attempt to shape a desired behavioral sequence (i.e., the treatment goal of discarding items).

Once this sequence is established, the therapist would then model taking the garbage bag actually out of the patient's home and putting it on the street for garbage pick-up. Again just like any other step in a behavior sequence, the therapist is not only modeling behavior, but also the different thoughts and emotional reactions they may be having to throwing away an item. It is important to realize that the behaviors, thoughts, and feelings of the patient may be significantly different when throwing an item outside than when they are throwing away an item in a bag in their home. Therefore, it is important to not take this step of treatment for granted and instead apply the same exposure/modeling techniques used in the preceding steps. This would entail specifically walking with the patient and guiding/prompting them to put the garbage out and not take it back into their home.

Although therapists often can model putting discarded bags on the street for garbage pick-up, initially in treatment it is preferable to have the therapist actually take the bag away from the outside garbage. In the beginning of treatment, patients are likely to bring back the bag inside after the therapist leaves, therefore, to assist in dealing with the anxiety the therapist may take the bag away permanently. Gradually, the therapist can evaluate whether the patient can tolerate leaving the bag for garbage pick-up. Once this behavior sequence has been practiced repeatedly, the therapist may then consider implementing fading procedures where the patient becomes more responsible for implementing the different behaviors of the sequence on their own.

Group Treatment for Hoarding Disorder

Struggling with a disorder can often feel very isolating. This is why appropriate participation in treatment/support groups can be a welcomed adjunctive treatment modality. What is so important about such groups is not only can participants share their concerns and troubles, but they can also share their successes. What better way to benefit from modeling than to actually model your behavior off someone who intimately knows the same struggles you have dealt with and has come out on the other side. Indeed, research suggests that modeling gains can be increased when the model is more similar to ourselves (Spiegler & Guevremont, 2010).

Within the area of modeling, this is referred to as the coping model. This type of modeling is contrasted with mastery modeling where an expert (e.g., the therapist) serves as the model (Spiegler & Guevremont, 2010). Although the modeling of behavior by a therapist clearly has it merits as outlined thus far in the preceding sections, it is often observed that patients may feel other patients are easier to relate to when it comes to appreciating the difficulty of carrying out the tasks included in hoarding disorder treatment. By patients sharing their experiences of success, others not only learn strategies to help them engage in adaptive behavior, but more importantly through vicarious learning see that not only are the behaviors possible, but also they are "survivable."

Body Dysmorphic Disorder

Up until now, the focus on modeling and the OCRDs has been on exposure-based interventions. This makes sense given the symptom similarities among the OCRDs. However, another major component of modeling, especially relevant to these disorders, is skill-training. Indeed, the complete lack of important skills and/or the use of ineffective/maladaptive behaviors and strategies can lead to the maintenance of OCRDs. Therefore, teaching patients skills is an integral part of treatment. Not surprisingly, modeling is an important and efficient means for transferring skills to patients (Spiegler & Guevremont, 2010).

Body dysmorphic disorder (BDD) is an OCRD disorder where the modeling of different types of skills is just as important as exposure interventions. To illustrate, one of the maladaptive behaviors/compulsions seen in BDD is mirror checking. Typically, individuals suffering from BDD will not only check their defect in the mirror or reflective surfaces, but they will do so in a way that perceptually distorts or exaggerates their perceived defect. For example, by going close to a mirror, it gives the impression that the perceived/slight defect (e.g., pimple) is bigger than it actually is, thus reinforcing the already maladaptive beliefs/perceptions about the defect.

Similar to instruction in hand washing, instruction in how to look into a mirror is an important skill for treatment progress. More specifically, mirror retraining is a technique where the patient is instructed in how to look into the mirror in a functional manner while simultaneously learning how to describe their appearance more objectively (i.e., without using global labels or affect laden descriptions) (Wilhelm et al., 2013; Veale & Neziroglu, 2010).

For example, the therapist would first physically demonstrate how to stand in front of the mirror at an appropriate distance. Next the therapist would model how to describe each part of their body instead of just focusing on a specific area. These descriptions are based on objective language as opposed to labels (e.g., "I am looking at my hair, it is down to my ears, it is the color brown" as opposed to "I am looking at my hair, it looks too short, it makes me look ugly"). Throughout this process, not only is the therapist modeling the appropriate skill, but also modeling adaptive behaviors, thoughts, and feelings relating to their appearance. Slowly the therapist would then have the patient engage in the same behavioral sequence while simultaneously giving the patient corrective feedback and reinforcement along the way. Eventually, as in the above examples, the therapist would slowly reduce their assistance in helping the patient carry out the task in order to facilitate the "transference of the skills" needed for improvement.

In addition, in order to generalize these skills into other environments in the patients' life (e.g., home), symbolic, as opposed to live, modeling can be utilized (Spiegler & Guevremont, 2010). Although there are different forms of symbolic modeling, one technique often used for generalizing skills is some type of tape or recording on an individual's phone. Here, the therapist would verbally instruct the patient on times when to use this skill, how to use the skill, and key points to remember while carrying out the task (i.e., using objective vs. emotional laden descriptions when describing one's body parts).

Recordings can vary from complete scripts of how to complete the skills or recorded transcripts of the therapist carrying out the task to him or herself. Moreover, once the patient has achieved an adequate level of mastery, it is suggested that they create their own version of the skills instruction in order to utilize themselves as the model of new reasonable/functional behavior.

Hair Pulling (Trichotillomania) and Skin Picking (Excoriation) Disorder

Hair pulling and skin picking disorders are two separate disorders that share similar symptoms in that they both involve repetitive body focused behaviors. As their respective names suggest, the behavior may involve the pulling out of one's hair (i.e., often from scalp, but may occur in other areas) and picking of one's skin (i.e., cuticles, feet, mouth, etc.) These behaviors may be carried out either automatically and/or purposefully (Gupta & Dass Gargi, 2012). Moreover, the behaviors themselves may serve different "functions," such as self-soothing, the reduction of a preexisting urge, and/or negative affect reduction (Neziroglu et al., 2008).

Regarding treatment, for the final section we will combine hair pulling disorder and skin picking disorder together since not only do they share similar symptoms (i.e., repetitive body focused behaviors), but their treatment also relies heavily on the skills training modality known as habit reversal. Habit reversal is a multiple component treatment aimed at increasing the patient's awareness of their behavior, as well as providing instruction in alternative behaviors aimed at reducing/substituting pulling or picking behavior (Gupta & Dass Gargi, 2012). Habit reversal is often used in conjunction with EX/RP as is seen with the other OCDRs. A comprehensive explanation of all the components of habit reversal is beyond the scope of the current chapter; however, an explanation of "competing response" will be provided as it pertains to modeling.

After a period of self-monitoring of situations, as well as determining the behavioral components of the target behavior, patients are instructed in the process of competing response. To illustrate, suppose a patient is being treated for picking their cuticles. The therapist would first help the patient identify what specific behaviors are part of the picking behavior sequence (i.e., bringing their hands together, rubbing their cuticle with their index finger, bringing fingers together to lift loose skin, etc.). Behaviors will also be examined across different situations to determine if there are certain body positions that make the person more prone to engaging in the target behavior (e.g., a person who is bored with homework may begin to bring their hand to their other hand without realizing).

Once these behaviors are identified, the therapist will suggest a competing behavior response that is incompatible with the picking behavior. For example, if a person often brings their hands together while studying, they will be instructed to use alternative behaviors such as keeping their hands apart by holding the side of a desk, sitting on their hands, holding an object in their hand, etc. These changes in the environment make it more likely that their hands will not come together and start the picking sequence.

These same instructions can be used in pulling. Again the behaviors that make up the target behavior will be identified. In the case of pulling a typical behavior is flexing the arm at the elbow in order to raise the patient's hand to their head to pull. In contrast, the patient would be instructed to extend their arm when they feel an urge to pull, thus interfering with their ability to raise their hand to their head. Once a verbal explanation and rationale is given, the therapist will demonstrate the desired behaviors for the patient. Next the therapist will have the patient model the therapist's behavior simultaneously (i.e., while the therapist is actually performing the behavior). The therapist will then have the patient carry out the behavior himself or herself with the therapist providing feedback and reinforcement as possible.

Once this behavior sequence is rehearsed numerous times, the therapist and patient will try to practice the sequence in actual situations where picking and pulling are normally triggered and/or the therapist will attempt to trigger the urge in their office. Once triggered, the patient is instructed to use their competing response as practiced. Again the therapist can model the behavioral sequence exactly how the patient would carry it out if they were alone in a particular situation (i.e., doing homework).

As adjunctive instruction to the above description, therapists and patients can capitalize on smart phone technology and actually video record the patient and/or therapist carrying out the behavioral sequence. These recordings represent a form of "video modeling" (Spiegler & Guevremont, 2010) where the patient has a visual representation of the desired behavioral sequence that they can review between therapy sessions, during times of increased urges, and prior or during high picking/pulling situations (e.g., doing homework, watching TV, when distressed). Again, based on the principles of modeling, having a visual representation of the desired behavior that includes the patient themselves can be highly motivating and instructive.

Summary

In this chapter we have described how psychological modeling can be used to supplement cognitive behavioral therapy (CBT) and exposure response prevention therapy (EX/RP) in the treatment of anxiety and obsessive-compulsive and related disorders (OCRDs). Whereas CBT and EX/RP focus on the use of direct experience to reduce unhelpful cognitive, emotional, and behavioral responses and to develop the necessary skills to manage stressors, modeling expands this process by providing the opportunity to learn from other people's experience. As discussed, studies suggest the effectiveness of this modality in the treatment of anxiety and avoidant behaviors. In this chapter we reviewed specific modeling techniques that can be used in the treatment of obsessive-compulsive disorder, hoarding disorder, body dysmorphic disorder, trichotillomania, and excoriation. The ideas discussed in this chapter demonstrate ways psychological modeling can be incorporated when planning for, and engaging in, the treatment of these disorders.

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12 Conditional Discrimination: What's in a Name?

Joseph H. Cihon, Julia L. Ferguson, and Justin B. Leaf

It is not uncommon to overhear behavior analysts uttering phrases such as "behavior is selected by its consequences" or "behavior is a product of reinforcing contingencies." While this is absolutely true, it is also a bit of an oversimplification of the effect of consequences, particularly reinforcing consequences. Sure, reinforcement selects particular forms, or topographies, of behavior—that is, reinforcement increases the likelihood of future instances of similar behavior—but it also selects the environmental conditions that will set the occasion for similar responses in the future. When human and non-human animals respond differentially in two different conditions, it is commonly referred to as stimulus control, discriminated responding, or a discriminated operant (Catania, 1998).

Simple and Conditional Discriminations

With respect to discriminated responding, we generally distinguish between two basic types of discriminations: simple and conditional. A *simple discrimination* does not rely on contextual control of other conditions or stimuli. A simple discrimination describes a situation in which only one stimulus condition exerts control over a response (Axe, 2008; Green, 2001; Grow & LeBlanc, 2013). Simple discriminative responding is commonly developed by reinforcing responses in the presence of one stimulus and not in its absence. The left side of Fig. 12.1 provides an example of a simple discrimination. In this example, anytime the circle is selected, it results in access to a reinforcing consequence. Selecting another stimulus (e.g., the square) in the field will not result in reinforcement. Therefore, the circle becomes the only stimulus that exerts control over responding, regardless of the other stimuli that may be present.

Only a small portion of human behavior can be explained by simple discriminations. Much of human behavior depends on context, that is, conditional on other stimuli. *Conditional discriminations* describe situations in which behavior comes under the control of one stimulus when it is in the presence or context of another stimulus (Catania, 1998). Said differently, "the function of a discriminative stimulus (whether it is S+ or S–) changes based on the presence of another stimulus—the conditional stimulus" (Saunders & Williams, 1998, pp. 210–211). While simple discriminations are established by reinforcing a response in one stimulus condition or to one stimulus, conditional discriminations are "established by reinforcing responses to particular ante-

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_12

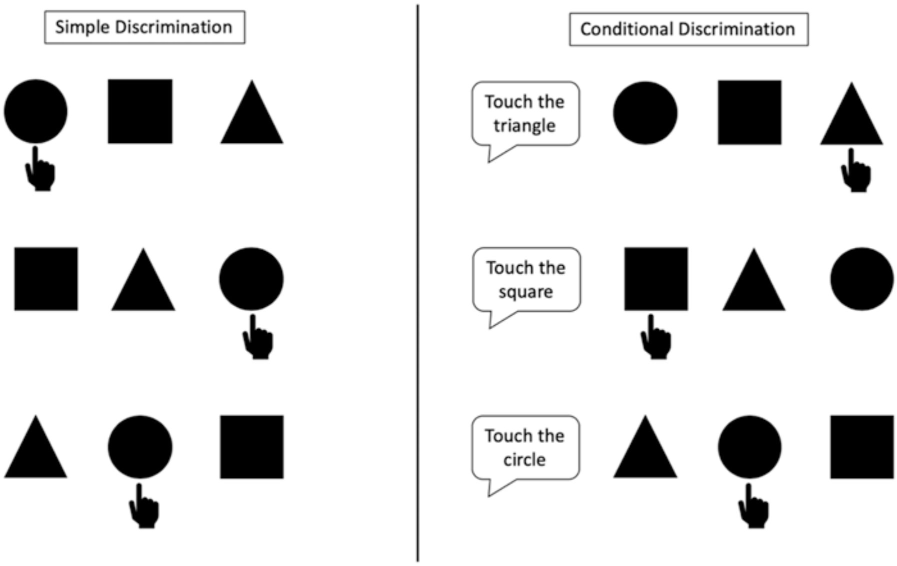

Fig. 12.1 An illustration of a simple and conditional discrimination

cedent stimuli *if and only if* they are preceded or accompanied by particular additional stimuli" (Green, 2001, p. 75). The right side of Fig. 12.1 provides an example of a conditional discrimination. In this example, selecting the stimulus that corresponds with the instruction results in reinforcement (e.g., touching the circle when a practitioner says "touch the circle"). Selecting another stimulus in the field (e.g., touching a square when a practitioner says "touch the circle") will not result in reinforcement. It is important to note that each stimulus in this example serves as a discriminative stimulus and a stimulus delta.

Conditional Discriminations and Relational Responding

Conditional discriminative responding is commonly confused with relational responding, and for good reason (Stewart & McElwee, 2009). Some definitions of relational responding used within the literature include "responding to one stimulus in terms of another stimulus" (Stewart & McElwee, 2009, p. 310). A definition such as this one would make it seem as though all conditional discriminative responding are examples of relational responding. For instance, in the conditional discrimination example in Fig. 12.1, the organism is responding to the comparison array (i.e., one stimulus) in terms of the instruction (i.e., another stimulus). To address this challenge, some have put forth an alternative definition to ensure that descriptions of relational responding involve responding that can be "generalized so that it involves responding in accordance with some type of pattern rather than on the basis of one or a limited number of associations" (Stewart & McElwee, 2009, p. 311). For example, telling a child "Lisa is faster than Tionne and Tionne is faster than Rozonda," and based on a previously established learning history, the child responds that Lisa is faster than Rozonda and that Tionne is slower than Lisa. Based on this stricter definition, the conditional discrimination example in Fig. 12.1 would no longer meet the definition for relational responding.

Confusion may be furthered by the commonalities found across preparations within the conditional discrimination, equivalence, and relational responding research (see Sidman & Tailby, 1982). One can find the use of procedures commonly referred to as "match-to-sample" across the literature in each of these areas (e.g., Iversen et al., 1986; Nissen et al., 1948; Pilgrim et al., 2000). It should, however, be noted that other procedures are in use within conditional discrimination research (e.g., go/no-go; Dube et al., 1993). Within match-to-sample procedures, the organism is presented with a stimulus (i.e., sample). The organism is commonly required to engage in what is referred to as an "observing response." Depending on the species of the organism and the procedure the observing response can be, but is not limited to, pointing to or pecking the sample, revealing the sample by lifting a flap, or vocally stating the name of the sample. Following an observing response, an array of stimuli is presented that includes the sample stimulus and other stimuli (i.e., the comparison array). The presentation of the array can occur with the sample remaining visible (e.g., if the sample stimulus is the middle key and the comparisons are outer keys, the middle key can remain illuminated when the outer keys are illuminated) or with the sample being removed (e.g., the center key is darkened when the comparison stimuli are illuminated). Upon selecting the correct comparison, access to reinforcement is provided while selecting the incorrect comparison results in a variety of different outcomes (e.g., ending the trial and starting an intertrial interval, representation of the trial until a correct match occurs). Even though match-to-sample or elements of match-to-sample procedures are used within the literature on conditional discrimination, equivalence, and relational responding, it is important to note that the subject of study is commonly different (e.g., trained versus untrained relations).

Misconceptions

From the outset, it is important to remind the reader that all organisms, human or otherwise, simply behave. That is, organisms engage in behavior (e.g., operant, respondent) based on a large variety of environmental variables (e.g., deprivation, the presence of absence of discriminative stimuli, a past history of reinforcement and punishment). Colloquially, we tend to categorize behavior in ways that make it easier to understand, describe, and communicate with others (e.g., discriminate, correct, incorrect, aberrant). While this vernacular may be convenient in everyday communication, it can set the occasion for terminological errors and other potential challenges. For instance, when discussing behaviorally based interventions for autistics and other individuals diagnosed with autism spectrum disorder (ASD)[1] it is not uncommon to hear phrases such as, "Sara can discriminate between green and red" (i.e., a conditional discrimination). While this statement is well intended, it is not entirely accurate with respect to a behavioral analysis of Sara's behavior. Remember, organisms simply behave, they do not discriminate. That is simply our convenient description of Sara's behavior in everyday language. Said more accurately with respect to a behavioral analysis, "Sara responds differentially in the presence or absence of green and red." This statement, although more accurate, is much more verbose and the use of the former statement makes sense, especially when conversing with those who may not be behavior analysts.

While this may seem like a simple semantic argument, the challenges it can create are nothing but simple. Imagine when the previous example, "Sara can discriminate between green and red," is changed to "Sara cannot discriminate between green and red" (i.e., the lack of the development of a conditional discriminative responding). This phrasing states that Sara is unable to discriminate between two colors and places the problem as a feature of Sara (i.e., an inability to discriminate). Intervention may now be more likely to focus on Sara having a discrimination problem rather than environmental variables contributing to the lack of conditional discriminative responding. However, Sara does not have a discrimination problem, she is simply behaving in accordance with the circumstances (i.e., organisms simply behave). The problem is Sara's behavior is not differentiated in the desired context; that is, she is not differentially responding in the presence of

[1]Terminology selected to adhere to the 7th edition of the American Psychological Association Publication Manual and to be inclusive of readers who prefer person-first as well as identity-first language.

green or red. This phrasing shifts the focus to the environmental variables that may be responsible for Sara's behavior (e.g., a lack of differential reinforcement) and what changes to the environment will be required to obtain the desired differential responding. In any event, the audience (e.g., other behavior analysts, non-behavior analysts) and the effect of our language on the audience should be the main deciding factor of the topography of our language (Becirevic et al., 2016).

Another misconception related to descriptions of conditional discriminative responding relates to stimulus control. As previously stated, stimulus control describes when behavior is more likely to ensue in the presence of a discriminative stimulus than in its absence. Sometimes when attempting to establish conditional discriminative responding in the clinical setting, behavior comes under the control of stimuli other than the desired instructional stimuli. For example, matching a red card to a red card may occur only when the interventionist is looking at the red card in the comparison array. This performance may also involve matching any sample to the comparison that the interventionist is directing their gaze at within the array. Situations like this are commonly referred to as "faulty" stimulus control (e.g., Green, 2001; Grow & LeBlanc, 2013). To describe stimulus control as faulty in these situations seems inappropriate and can lead to problems similar to those described in the preceding paragraph. Stimulus control, and a conditional discrimination at that, was developed in this example. The learner matches the sample conditional on where the interventionist is directing their gaze. To describe this as faulty negates the stimulus control that was established. A better way to describe this relationship would be *undesired* stimulus control. That is, the conditional discrimination that was established is not the desired conditional discrimination of the interventionist. Adopting this terminology may promote a better understanding of the lawfulness of environment–behavior relationships, especially with the growing number of minimally trained behavior analysts (Leaf et al., 2016b, 2017).

Conditional Discrimination Research

There is extensive research related specifically to the development and evaluation of conditional discriminative responding that some have suggested started all the way back in 1799 (Carter & Werner, 1978). When this research is paired with research that develops and evaluates conditional discriminative responding without explicitly stating it as the purpose (e.g., Keinz et al., 2011; Pérez-González, 1994), the literature base is immense. In fact, over 40 years ago in 1978, Carter and Werner stated, "the literature contains hundreds of conditional discrimination experiments" (p. 565) when reviewing the conditional learning literature with only pigeons! Research on conditional discriminative responding has also occurred with, but not limited to, rats (e.g., Lashley, 1938), non-human primates (e.g., Nissen et al., 1948), deaf children (e.g., Almeida-Verdu et al., 2008), neurotypical adults (e.g., Pérez-González & Alonso-Alvarez, 2008), Alzheimer's patients (e.g., Steingrimsdottir & Arntzen, 2011), and autistics and other individuals diagnosed with ASD (e.g., Fisher et al., 2007). What follows is a greatly abbreviated overview as well as descriptions of selected studies from this literature base organized across organisms commonly used within this literature (i.e., rat, pigeon, and human) as well other examples with lesser used organisms.

Basic Research

Rats In a classic and seminal paper in conditional discrimination learning, Lashley (1938) described several experiments in which conditional discriminations were developed with three rats. In the first set of experiments, the rats were trained through a series of steps to respond with few errors to two pairs of stimuli. A white erect triangle and a white inverted triangle on a solid black background served as one pair of stimuli, and the same triangles with a black background with horizontal white stripes served as the second pair of stimuli. Which stimulus functioned as the positive discriminative stimulus (S+) varied across training steps. To further evaluate if differential responding was controlled by the stimuli, Lashley evaluated responding across several more pairs of stimuli with triangles and various other patterns (e.g., a triangle with a circle around it, striped triangles). In the second set of experiments, Lashley evaluated if responding would generalize to figures other than triangles (e.g., cross vs. X, star vs. square) using a similar series of training steps. This performance was established with two of the three rats, while the third rat failed to reach the criterion. While Lashley was not the first to evaluate conditional discriminations, this study provided the first demonstrations of identifying and defining the physical properties of the controlling stimuli and laid the groundwork for later models of conceptualizing conditional discrimination learning (Carter & Werner, 1978).

North et al. (1958) replicated and extended Lashley (1938) with a larger number of rats and conditions. That is, North and colleagues included 17 rats and several pairs of stimuli that differed in terms of the background while keeping the form consistent. North et al. also included an additional test of patterning to evaluate if responding could be explained on the basis of the compound of the stimuli presented on each card (i.e., what the stimuli were painted on), independent of the other stimuli, or on the basis of the stimuli presented on both cards as a whole. The 17 rats were randomly divided into eight subgroups with two different problems, which referred to the combination of stimuli presented, and which stimulus resulted in access to reinforcement (i.e., the stimulus that resulted in reinforcement was reversed, making the second problem). North and colleagues' results aligned with Lashley's findings and demonstrated through the test of patterning that stimulus complexities can be evaluated based on form and background as functional units.

More recently, Bruce et al. (2018) examined conditional discriminative responding (i.e., matching-to-sample and non-matching-to-sample) with 15 rats using an automated olfactometer. Following an initial shaping phase to establish simple discriminations to four scents, conditional discrimination training began. Rats were randomly assigned to matching-to-sample and non-matching-to-sample conditions both of which used a successive go/no-go procedure. Following an observing response on each trial, a sample odor was presented and the first nose poke after 5 s terminated the sample and the comparison odors were presented. Responding was reinforced on a fixed-interval 5 s schedule on positive trials, and the comparison was presented for 5 s and then terminated on negative trials. Once a rat was responding with minimal errors, a new set of odors was presented using the same procedures as the previous odors. Bruce and colleagues also conducted a reversal phase once three sets of odors had been introduced in which the contingences were reversed (i.e., matching-to-sample rats were reversed to non-matching-to-sample and vice versa). Results revealed that most of the rats acquired conditional discriminative responding rapidly and maintained responding on the original contingencies with novel stimuli during the reversal phase.

Pigeons For an early review and summary on some of the founding literature on conditional discriminative responding with pigeons, we refer the reader to Carter and Werner (1978) (but also see Schrier & Thompson, 1980). The following articles were selected as examples of the establishment of conditional discriminative responding, and should not be taken as an exhaustive or comprehensive list. In Skinner's (1950) discussion of "Are theories of learning necessary?," he described and illustrated data on the maintenance of a chain of conditional discriminative responding (i.e., matching to sample) under intermittent reinforcement. Within this procedure, the center key was illuminated by one color for a minute which was changed with another color at random. When the pigeon responded (i.e., pecked) this center key the side keys illuminated with two different colors, one matching and one not matching the color of the pecked center key. Following a peck to one of the side keys, both side keys extinguished and the center key re-illuminated. Pecking the side key that matched the center key operated the food magazine. Not only was conditional discriminative responding established, but it was also maintained when reinforcement occurred no more often than once per minute on average.

A decade after Skinner's (1950) description, Cumming and Berryman (1961) trained three pigeons using a match-to-sample procedure almost identical to Skinner's procedure. To begin each trial, a center key on a three key display would illuminate red, green, or blue (i.e., the sample). Pecking the sample then illuminated the two side keys (i.e., the comparison array) while the center key remained illuminated. Pecking the comparison that matched the same resulted in 3 s of access to grain and pecking the other comparison resulted in all keys and the house light being turned off for 3 s. Following a 25 s intertrial interval, the next trial began. Conditional discriminative responding was established with all three pigeons. Cumming and Berryman also analyzed if responding was under the control of position (i.e., left or right) or color. The results of this analysis demonstrated that early during training position controlled the pigeons' behavior, and this gradually shifted to color (i.e., matching) by the 5th session.

In a more recent example, Mondragón and Hall (2015) evaluated the role of stimulus comparison on conditional discriminative responding across two experiment with 16 pigeons. In the first experiment, pigeons were presented with a color and a shape that signaled the availability of reinforcement for one response, and a different color and a different shape that signaled the availability of reinforcement for a different response. The pigeons were divided into two conditions: (a) comparison and (b) no comparison. Both conditions involved a successive, conditional, go-left/go-right task. In the comparison condition, sessions consisted of presenting both colors or both shapes. In the no comparison condition, sessions consisted of presenting one color and one shape or the other color and shape. Conditional discriminative responding was acquired more readily by the pigeons assigned to the no comparison condition. Differences between the pigeons in each condition were maintained in the second experiment which involved a successive go/no-go discrimination in which responding to one of the colors and one of the shapes resulted in access to reinforcement while responding to the other color and shape did not result in access to reinforcement. Mondragón and Hall concluded that the performance of the pigeons was suggestive of responses governed by the absolute properties of stimuli.

Non-human Primates/Monkeys For an early review and summary some of the founding literature on conditional discriminative responding with primates, we refer the reader to Spence (1937). The following articles were selected as examples of the establishment of conditional discriminative responding and should not be taken as an exhaustive or comprehensive list. Nissen et al. (1948) described an early evaluation of developing conditional discriminative responding with seven chimpanzees in a match-to-sample procedure. On each trial, three stimuli were presented (i.e., two cups and one box or two boxes and one cup) on a tray in a semi-randomized order in which the middle stimulus was the sample stimulus. A response to the sample stimulus (i.e., lifting the cup or box) revealed a small piece of food. The side stimuli served as the comparison stimuli. Responding to the correct comparison stimulus also revealed a small piece of food while selecting the incorrect comparison resulted in removing, resetting, and representing the same trial again (i.e., a correction trial). Correction trials were not counted as new trials. Although variability was observed across the seven chimpanzees, all developed conditional discriminative responding. Generalization of matching was also evaluated immediately following completion of the training across a variety of objects and colors. The results demonstrated that the chimpanzees did not just learn matching in specific arrangements, but their responding generalized to matching based on sameness.

Riopelle and Copelan (1954) evaluated the development of simple discriminative responding while minimizing unreinforced responses (i.e., errors) with five rhesus monkeys. Prior to this study many simple discrimination preparations involved shifting from one stimulus to the other without warning (i.e., the S+ becoming the S−). In an attempt to solve this problem, the five rhesus monkeys actually developed conditional discriminative responding. In Riopelle and Copelan's preparation, any time a stimulus change occurred the stimuli were presented on a different colored tray. Conditional discriminative responding was demonstrated when the monkeys changed the stimulus they selected without error. Following continued training, all five monkeys changed their responding based upon a change in the color of the tray and this responding generalized to new color sequences.

Leal et al. (2020) provided a great, recent example of an approach to translational research to develop non-verbal memory testing procedures for those with limited verbal repertoires. Across two experiments Leal and colleagues evaluated the development of delayed matching-to-sample with long delays and manipulation of intertrial intervals with three tufted capuchin monkeys. In Experiment 1, the monkeys were trained to respond on a delayed match-to-sample preparation across three different sets of stimuli. Depending on the monkeys' performance, the researchers either increased of delay (i.e., if the performance criterion was met) or the intertrial interval (i.e., if the performance criterion was not met) from session to session. Results of Experiment 1 demonstrated that gradual increases in delay and intertrial interval generated high accuracy on the delayed matching-to-sample preparation. However, with varying delay and intertrial interval values, Experiment 1 provided no data on the effect of intertrial interval changes for any given delay value. As such, Experiment 2 involved only one delay value and different intertrial interval values. The results of Experiment 2 demonstrated that all three monkeys displayed fairly high accuracy regardless of the ratio of intertrial interval to delay value.

Humans As previously stated, much of human behavior is contextual or conditional, so it is not surprising that the development of and variables affecting conditional discriminative responding has been examined with humans. North and Leedy (1952) hypothesized that marked interference is likely in the development of conditional discriminative responding as a result of generalization along incorrect stimulus dimensions (e.g., shape instead of color) or common stimulus elements (e.g., color instead of shape). To evaluate this hypothesis, North and Leedy evaluated the responding of 51 adult women to stimuli that had two critical components, one of which varied more than the other. There was a total of nine stimuli, which were differentiated by three based on shared outer or inner components. That is, three stimuli may have the same outer component (e.g., flower petals) while having differing inner components (e.g., different color inner circle) or three stimuli may have the same inner component (e.g., solid inner circle) while having differing outer components (e.g., different shaped flower petals). Initial teaching occurred across two conditions: (a) the outer component remained consistent, but the inner component varied and (b) the inner component remained consistent, but the outer component varied. Following initial teaching a test condition occurring in which the two components varied with equal frequency. The results indicated that the stimulus component that varied the most frequently in training resulted in better discriminated responding.

Gollin and Liss (1962) explored the development of discriminated responding with 35 young children across two experiments. Experiment 1 first evaluated the establishment of a simple discrimination, and, of most interest to the topic of this chapter, Experiment 2 evaluated conditional discriminated responding using methods similar to Lashley (1938). Following the development of simple discriminations in Experiment 1, an alternation and random condition were used to evaluate conditional discriminated responding across three different age groups (i.e., 3.5–4, 4.5–5, and 5.5–6 years). In the alternation condition, trials alternated between stimuli from the original training in Experiment 1 and stimuli from reversal training. In the random condition, stimuli from the reversal training were randomized. To engage in conditional discriminative responding, "help" was required for all but one, two, and seven members of the 3.5- to 4-, 4.5- to 5-, and 5.5- to 6-year-old groups, respectively (i.e., the younger the child the more likely help was required to acquire the conditional discrimination). Help consisted of identifying a mutually agreed upon name for the stimuli and naming the background prior to each trial. Taken together, Gollin and Liss's results indicated that age played an important role in the development of conditional discriminations within their preparation.

In an interesting recent study, Pérez and Polín (2016) evaluated conditional discriminative responding when 109 college students were exposed to three different conditions: (a) sample and comparisons presented at the same time and requiring sample observation (i.e., simultaneous discrimination); (b) comparisons presented when the sample disappeared and

Requiring sample observation (i.e., successive discrimination); and (c) simultaneous discrimination without requiring sample observation. Across all three conditions, two training blocks occurred and were counterbalanced (i.e., half the participants were exposed to Block A then Block B, and the other half to Block B then Block A). Block A consisted of a match-to-sample procedure with one sample and three comparisons. Block B consisted of trials that were superficially identical to Block A, but reinforcement contingencies involved a simple discrimination across 75% of trials a conditional discrimination across 25% of trials. While simple discrimination trials resembled conditional discrimination trials in Block B, the sample stimulus remained constant and did not affect the reinforcement contingencies associated with the comparison stimuli. The results indicated no differences in acquisition between Blocks A and B, which led Pérez and Polín to conclude that the participants responded as if exposed to a conditional discrimination even though reinforcement was not dependent on the relation between the sample and the comparison stimulus chosen.

Other In a unique example of conditional discriminative responding, Roitblat et al. (1990) evaluated matching-to-sample via echolocation with a dolphin. With some engineering ingenuity, a floating apparatus was designed that controlled when echolocating could and could not occur with the sample and comparison stimuli. Additionally, vision occluders were placed over the dolphin's eyes to prevent the possibility that any matching performance could be due to seeing the stimuli. Sample stimuli were placed in the water and remained until the dolphin failed to emit echolocation clicks for 5 s. The comparison stimuli were presented in the same manner as the sample, and the dolphin could select a comparison by making contact with one of three response wands (i.e., one for each comparison stimulus). While design and procedural limitations prevented Roitblat and colleagues from demonstrating a functional relationship, the dolphin responded with high accuracy as demonstrated in the final 48 sessions (i.e., averaged 94.5% correct matches). Roitblat et al. noted that echolocation allowed more precision in the determination of attending to the sample and comparison stimuli that is sometimes lacking or difficult in other preparations.

Tokuda et al. (2015) were interested in evaluating if successive discrimination training would be effective at developing conditional discriminative responding with 11 octopuses (Octopus vulgaris). The octopuses were divided into two groups. One group accessed reinforcement for responses to a barrel-shaped white object when the when the tank was aerated. The other group accessed reinforcement for responses to a barrel-shaped white object when the aeration was switched off. Following initial training, testing for the development of conditional discriminative responding consisted of alternating aeration on and off during each trial. Tokuda and colleagues evaluated the number of trials and the latency the octopuses responded to the barrel-shaped white object. The results demonstrated that both groups responded in accordance with the conditionality of the aeration being on or off.

Dürckheim et al. (2018) evaluated conditional discriminative responding (i.e., match-to-sample) with three elephants using human scents (all obtained from unspecified body parts of a diverse group of 26 humans). The elephants were first trained to detect a single scent by presenting a cloth with the target scent, placing that cloth in one of nine jars, and requiring the elephants to find the matching cloth. Training gradually changed based on the elephants' performance to include blank cloths without scents and, eventually, cloths with varied non-matching scents. The elephants were randomly provided with trials that involved all non-matching scents throughout training and testing phases in which reinforcement was contingent upon not selecting any of the comparison stimuli. Dürckheim and colleagues' results demonstrated that all three elephants were efficient and accurate in matching human scents, which extended findings of previous research demonstrating the same effects with dogs (e.g., Marchal et al., 2016).

Applied Research

In addition to the extensive basic research literature base on conditional discriminations, there are numerous studies on conditional discriminations that would be considered "applied" (Baer et al., 1968). Given the expansive literature base, only a small sample of this literature will be described here and does not represent a comprehensive or exhaustive list. The articles were selected with an acknowledged bias of the authors' behavioral histories and are meant to provide a wide sampling of applications. It should also be noted that while the literature on the development of equivalence classes is applicable here, it was excluded based on the purpose of the chapter.

Saunders and Spradlin (1989) noted that matching in a match-to-sample preparation requires two component discriminations: (a) a successive discrimination between samples and (b) a simultaneous discrimination between the comparisons. Their hypothesis was that for learners for whom conditional discriminative responding is commonly difficult to establish (e.g., individuals diagnosed with intellectual disabilities), it may be advantageous if training procedures directly established a successive discrimination between samples and a simultaneous discrimination between the comparisons. Their participants included two individuals diagnosed with intellectual disabilities each of whom had previous histories of difficulties in establishing arbitrary matching (i.e., conditional discriminations). Saunders and Spradlin first trained the participants to respond to two different sample stimuli based on two different schedules of reinforcement then conducted conditional discrimination training (i.e., match-to-sample) in which the reinforcement schedule requirement for the sample had to be met prior to exposing the comparison array. Despite the prior schedule training with the sample stimuli, both participants continued to respond at chance levels during conditional discrimination training. This responding continued even after directly training a comparison discrimination. However, both participants acquired conditional discriminative responding when trials were presented in blocks as opposed to alternating randomly which also maintained after the schedule requirement the for the sample was removed.

Pérez-González and Williams (2002) extended the research related to blocking procedures when evaluating the efficacy of a combination of two blocking procedures when teaching conditional discriminative responding with five children diagnosed with autism who did not learn with previously attempted conventional procedures. Conditional discriminative responses consisted of matching objects in response to spoken names and amounts to numbers. Procedures for both responses occurred across several stages and consisted of presenting sample until 10 consecutive correct responses occurred and leaving the location comparisons constant. Following 10 consecutive correct responses, the requirement for changing sample was reduced. Finally, the samples were presented randomly, and, in the final stage, the position of the comparison stimuli was randomized. Pérez-González and Williams' results indicated that all five participants acquired the targeted conditional discriminative responses with minimal errors.

Fisher et al. (2007) further evaluated the development of conditional discriminative responding for individuals whom have had previous histories of difficulties learning in match-to-sample procedures. Using a multi-element design, Fisher and colleagues compared the use of two variations of least-to-most prompting to develop conditional discriminative responding with two individuals diagnosed with autism. In one condition, least-to-most prompting, prompts consisted of a model prompt and a model prompt plus physical guidance. The other condition, identity matching, was identical in all aspects but replaced the model prompt with presenting an identical comparison stimulus, stating the sample stimulus again, and pointing to the correct comparison stimulus. The results indicated that least-to-most prompting with identity matching as one of the prompting hierarchies was more effective for the two participants.

Implications

Research on conditional discriminations has opened the door for a wide variety of interventions, behavioral discoveries, and additional research. The doors conditional discrimination research has opened have several implications for behavior analysts conducting research and applying behavior analytic principles in practice. As such, there are undoubtably numerous clinical implications and areas for future research. What is presented here are examples in light of the authors' repertoires and current and past research and are not meant to be exhaustive by any means.

Future Research

Much of the research involving conditional discrimination has evolved into examining higher order operant behavior (e.g., Almeida-Verdu et al., 2008; Green et al., 1993; Stewart & McElwee, 2009), the emergence of untrained relations (e.g. Keintz et al., 2011), and verbal behavior (e.g., Axe, 2008), to name a few. There is no doubt this research should and will continue to yield fruitful data, interventions, and additional research endeavors. For instance, Axe (2008) reviewed previous researchers' examination of conditional discriminations in the intraverbal relation and provided recommendations for future directions for research. Among Axe's findings were that there was little research on training individuals to engage in conditional discriminative responding for intraverbal relations and that conditional discriminative responding is often lacking for individuals diagnosed with developmental disabilities. Axe recommended that individuals diagnosed with developmental disabilities may benefit from direct training to develop conditional discriminative repertoires, future research examining prerequisite skills, stimulus arrangements, and teaching procedures, and informing research from previous research on auditory conditional discriminations and matrix training. As evident from Axe's review and recommendations, there is clearly room left for continued research related to conditional discrimination and the development of conditional discriminative responding.

Research should continue to evaluate teaching procedures common within practice, especially those for individuals with whom they have documented challenges in the development of conditional discrimination repertoires (e.g., individuals diagnosed with ASD). In addition to Axe's (2008) recommendations (i.e., transfer of stimulus control, errorless learning, and stimulus arrangements), research is needed which evaluates the use of various prompt types (e.g., within conditional discrimination teaching procedures. Prompting adds additional stimuli into the teaching environment, and the effect of the addition of these stimuli on the development of the desired conditional discriminative responding is warranted. This research should examine specific prompt types (e.g., response-prompts) and fading procedures (e.g., constant time delay; see Walker, 2008 for a review) in isolation and combination as well as across varied stimulus arrangements. This research could inform practice as to methods to evaluate the conditions under which (e.g., certain combinations of prompt fading procedures and stimulus arrangements) are more likely to develop undesired stimulus control (e.g., simple rather than conditional discriminations).

Future research should also continue examining prerequisite skills related to conditional discriminative responding. This would include prerequisite skills for acquiring various conditional discriminative responding (e.g., intraverbal relations, matching) and the skills for which conditional discriminative responding serves as a prerequisite. While the data are scarce on prerequisite skills for acquiring various conditional discriminative responding (Axe, 2008) it is likely that skills commonly referred to as "learning how to learn" skills are necessary. These commonly include repertoires related, but not limited to, attending, matching, imitation, and responding to the language of others (Lovaas, 2003; Smith, 2001). Research evaluating the presence, absence, or amount of development of each of these repertoires and the effect on teaching procedures for developing conditional discriminative responding will provide useful data to inform clinical practice. Furthermore, the development of a conditional discriminative repertoire may also serve as a prerequisite for other skills (e.g., more complex intraverbal relations, social interactions). Research that evaluates the effects of the presence, absence, or amount of development of conditional discriminative responding on various other skills could also help inform the scope and sequence of curricula within the clinical setting.

Clinical

The implications of conditional discriminative learning and research for the clinical setting are numerous. As previously discussed, the majority of human behavior is context dependent, or conditional. As such, the majority of clinical applications of the science and principles of behavior analysis related closely to conditional discriminative responding. The application for which these implications are most visible is perhaps within behavioral interventions for autistics and other individuals diagnosed with ASD. This is particularly the case given the common use of discrete trial teaching (DTT; Lovaas, 1987, but also see Leaf & McEachin, 2016) within these interventions. DTT is a systematic approach to instruction involving three primary components: (a) an instruction from the interventionist, (b) the learner's response, and (c) a consequence provided by the interventionist based on the learner's response (e.g., access to reinforcement following a correct response). Additional procedures used within DTT, and relevant to the current chapter, include providing a prompt to increase the likelihood of the desired learner response (MacDuff et al., 2001). The commonalities in the description of DTT here and previous descriptions of the match-to-sample approach used within conditional discrimination research highlights why implications of this research are exceptionally relevant to behavioral interventions for autistics and other individuals diagnosed with ASD.

There have been several discussions within the literature related to the use of prompts while using DTT (e.g., Green, 2001; Grow & LeBlanc, 2013; Leaf et al., 2016a). Some of which directly discussed conditional discrimination teaching methods and how some arrangements can result in undesired stimulus control (i.e., Green, 2001; Grow & LeBlanc, 2013). One of these arrangements involves presenting the same sample stimulus and only one (correct) comparison stimulus across numerous subsequent trials. If this arrangement develops discriminative responding, it is likely to be a simple, rather than a conditional, discrimination. If this instructional arrangement is in use, the interventionist could test for the development of a simple discrimination by giving the learner different samples while keeping the comparison stimulus the same or vice versa. The interventionist could also test which type of discrimination was developed by expanding the comparison array. If the learner matches the sample to the comparisons seemingly at random, it is likely that a simple discrimination has been developed. As Saunders and Spradlin (1989) demonstrated, it may be important to ensure blocks of trials are alternated with other relations to prevent the development of undesired stimulus control such as a simple discrimination when targeting a conditional discrimination.

Clinical application could also benefit from the research identifying and defining the properties of the controlling stimuli within conditional discriminative responding. As previously discussed, the development of undesired stimulus control is common within practice. Using the techniques within the research on conditional discriminative responding may help clinicians identify the stimuli and/or properties of stimuli that have acquired control. If an interventionist identifies patterns responding that is suggestive of undesired stimulus control, methods similar to Lashley (1938) and Saunders and Spradlin (1989) could be employed. For example, the interventionist could alter one component of a sample stimulus and conduct matching trials with just the sample or do the same with the comparison stimuli. Ultimately this may require some level of clinical judgement on the part of the interventionist (Leaf et al., 2016b). That is, changes to intervention would be informed by research, clinical experience, and current environmental variables (e.g., client responding; Redelmeier et al., 2001). In fact, some have provided data and suggested that interventions that involve flexibility and clinical judgement from the interventionists may yield better results (e.g., Cihon et al., 2020; Leaf et al., 2016a, b), and this may be extended to the development of conditional discriminative responding.

Conclusion

The behavior of human and non-human animals is discriminative. A distinction is commonly made between two general types of discriminative responding: simple and conditional. Though useful, only a small portion of human behavior can be accounted for by simple discriminations given much of human behavior is conditional. As a result, conditional discriminative responding has a rich history within research and practice within the field of behavior analysis. This chapter distinguished between simple and conditional discriminative responding, discussed the difference between conditional discriminative and relational responding, described selected samples of historical and current research related to conditional discriminative responding, highlighted misconceptions related to conditional discriminative responding, and outlined implications for future research and clinical practice. Much of the current literature related to conditional discriminative responding involves relational responding and emergent relations, and, as such, was outside the scope of this chapter. The reader is encouraged to seek out the vast literature and resources related to those topics.

Given the remarkable growth in the number of practicing behavior analysts (Behavior Analyst Certification Board, n.d.), it is possible that many of the misconceptions related to conditional discriminative responding could be avoided with a full adaption of the scientist-practitioner model (see Malott, 1992; Reid, 1992) and a focus on increasing standards with respect to training of behavior analysts (see Leaf et al., 2016b, 2017, 2020; Schlinger, 2015). Within the scientist-practitioner model behavior analysts would receive thorough training in conducting and interpreting research, even if they plan on working within clinical settings and not academic or research settings. This training would also focus on developing a thorough conceptual understanding of behavior analysis. That is, training on concepts and principles rather than tools and procedures. Perhaps this training would provide all practitioner's the research and conceptual understanding to avoid these mishaps as well as others.

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13 Auditory–Visual Discriminations: Stimulus Control, Teaching Procedures, and Considerations

Samantha Bergmann and Tiffany Kodak

Every day, nearly every behavior of an individual involves stimulus control (Saunders & Williams, 1998). Without stimulus control, the world “would be chaotic” (Skinner, 1953, p. 108). Thankfully, stimulus control makes it so that behaviors previously reinforced in the presence of certain stimuli are more likely to occur when the stimuli are present again. Stimuli—events to which an organism can attend—become correlated with reinforcement. When our behavior comes to be controlled by stimuli in our environment, we can behave more effectively and efficiently. An example of stimulus control occurs in the kitchen when you reach into the fridge to grab a bottle of a new type of mineral water. You find that attempts to twist the cap do not produce an open bottle but using a bottle opener does. The next time you grab a bottle of the new mineral water, you are much more likely to use a bottle opener and unlikely to twist the cap. The change in response probability is due to a history of differential reinforcement wherein one response (prying cap off with an opener) produced an open bottle, but another response (twisting cap with your hand) did not. Whether you are likely to use the bottle opener or twist the cap depends on which brand of water is in your hand. The result is that you spend less time trying to twist caps that need a bottle opener.

All behavior analysts should know the prevalence and power of stimulus control. Stimulus discrimination training, whether that training occurs incidentally in one’s life or is programmed in a structured learning environment like an early intensive behavioral intervention program, creates the conditions for stimulus control. Behavior analysts serving individuals with autism spectrum disorder (ASD) should be well-versed in stimulus discrimination training because some of the most common treatment goals are related to stimulus-control excesses and deficits (Pilgrim, 2015). Behavior analysts should be familiar with discrimination training with auditory and visual stimuli, which are prevalent in many interactions and instructional programs.

Stimulus Discrimination

Most operant behavior involves interaction with antecedent stimuli in the environment (Dinsmoor, 1995a; Saunders & Williams, 1998). Behavior that occurs more often in the presence of a stimulus than in its absence is a discriminated operant (Catania, 2013). Skinner’s early laboratory work (1933) demonstrated that discriminated operants

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_13

result from discrimination training. Discrimination training involves reinforcing a behavior in the presence of one stimulus—the discriminative stimulus (S^D or positive stimulus, S+ [hereafter, we will use S+])—and extinguishing (i.e., withholding a reinforcer) the same behavior in its absence (i.e., S-delta, S^Δ, negative stimulus, S− [hereafter, we will use S−]). The S− can include the absence of the S+ (e.g., the absence of light in the operant chamber; i.e., presence vs. absence discrimination) or the presence of stimulus conditions other than the S+ (e.g., red light when the S+ light is green; i.e., quality discrimination). Research on discrimination training has shown that whether one trains a response in the presence of the S+ only or both an S+ and an S− influences training outcomes (Dinsmoor, 1995a). With repeated stimulus discrimination training, the effects of stimulus control should be a narrowing of the effects of reinforcement (Catania, 2013). That is, behavior becomes highly probable in the S+ condition and improbable under conditions that do not resemble the S+.

To illustrate discrimination training outside of the laboratory, consider a young child who learns to sign *square* (i.e., drawing both index fingers to meet at the center and outlining the shape of a square by bringing both fingers out, down, and in to meet in the middle) when shown a drawing of a square. When the parent shows the square, the child forms and moves her hands correctly, and the parent smiles and nods. If the parent's smiles and nods are reinforcers, then the child will emit the same sign when shown the square in the future. The parent may be surprised to see the child sign *square* when the picture is a circle, triangle, or diamond. The child signs *square* because the child's sign was reinforced only in the presence of the square and not extinguished in the presence of other shapes. Therefore, it is unlikely the sign *square* is under the control of the specific shape; instead, it is controlled by the presence of any shape drawing. A parent can remediate this control by showing the child multiple shapes in training. When the child signs *square* in the presence of a circle, the parent neither smiles nor nods. That is, the same response does not contact reinforcement in the presence of the new antecedent stimulus. With experience, this differential reinforcement contingency should strengthen signing *square* in the presence of the square (S+) and weaken signing *square* in the presence of the circle (S−). Due to differential reinforcement, the emission of the response becomes more probable under conditions that resemble the S+ (i.e., other square-like forms) and less probable under conditions that resemble the S− (i.e., other circle-like forms). Observing more responses in the presence of S+ than in its absence suggests discriminative control by the S+, which is stimulus control (Saunders & Williams, 1998).

Types of Discriminations

Simple Discrimination

The basic form of stimulus control is the three-term contingency that includes an antecedent stimulus, response, and reinforcer (Saunders & Williams, 1998). In a three-term contingency, a response is reinforced in the presence of an S+, and the same response is not reinforced in the presence of an S−. The three-term contingency is a simple discrimination. The everyday environment abounds with simple discriminations. However, one observation is insufficient to say that a response is under stimulus control; instead, we require repeated observations to determine that the response indeed occurs more often in the presence of the S+ than the S− (Dinsmoor, 1995a).

In a simple discrimination, the response is reinforced in the presence of one stimulus (i.e., S+) across opportunities. In other words, there is never a situation wherein emitting the response in the presence of the S+ is not reinforced (although one can use different reinforcement schedules). There is an extensive literature base on the acquisition of simple discrimination with nonhuman subjects and human participants with and without intellectual, developmental, or physical disabilities (cf. Saunders & Williams, 1998).

Successive Simple Discrimination When the S+ and the S− are shown separately across trials, intervals, or opportunities, this is an arrangement for a successive discrimination. The learner can observe either the S+ or the S− but never the S+ and S− at the same time. If the S+ is present, the response is reinforced. If the S− is present, the response is not reinforced. The presentations are separated by time: the intertrial interval (ITI). Successive discriminations can be acquired more slowly than simultaneous discriminations (Carter & Eckerman, 1975). An example of a successive simple discrimination is reinforcing the sign *square* when a parent shows a child a square but not when a parent shows a circle.

Simultaneous Simple Discrimination When the S+ and S− are shown together within a trial, interval, or opportunity, this is an arrangement for simultaneous discrimination. That is, the learner can observe both the S+ and S−. Although both stimuli are present in a simultaneous discrimination, only responses to the S+ will be reinforced. An example of a simultaneous simple discrimination is providing a reinforcer for touching the picture of the square in the presence of both the square and the circle picture.

Conditional Discrimination

In a conditional discrimination, reinforcer delivery for responding in the presence of an antecedent stimulus depends on whether an additional antecedent stimulus is present. This additional antecedent stimulus is called a conditional stimulus (also referred to as a sample stimulus) and creates a four-term contingency. To illustrate this, let us consider a child who is learning shapes. Imagine that her parent shows both a picture of the square and the circle, and her parent begins the learning opportunity by signing *square*. When the child touches the picture of the square, the parent smiles and nods. The sign for square determines that the S+ is the picture of the square, and the S− is the picture of the circle. If the parent signs *circle,* then smiles and nods follow the child touching the circle. The sign for the circle determines that the S+ is the picture of the circle, and the S− is the picture of the square. Nothing about the physical properties of the square and circle changed in this example, but the correlation with reinforcement changed because of the parent's sign—the conditional stimulus. The conditional stimulus can also be the context in which the behavior occurs. For example, a child listens to a teacher's instruction, "Get your materials out." The child extracts different materials from his desk depending on whether the teacher just started a math or reading lesson.

Antecedent Stimuli

Any stimulus to which a learner can attend may come to control behavior if the learner's behavior is more likely to be reinforced in the presence of the stimulus than its absence. Thus, behavior can be controlled by isolated or combined auditory, gustatory, olfactory, proprioceptive, tactile, and visual stimuli. Given their prevalence in the everyday environment, auditory and visual stimuli, the foci of the present chapter, are likely to serve as discriminative and conditional stimuli for individuals with intact hearing and sight.

Auditory Stimuli

Auditory stimulus control involves differential behavior in the presence of auditory stimuli. Auditory stimuli may be spoken words, environmental sounds, pure tones, etc. The acquisition of a discriminated operant requires that a learner tells the difference between two or more sounds in their environment, which is observed via differential behavior in the presence of auditory stimuli. An example from a hearing screening test involves a child raising his hand when the tone is present and not raising his hand when the tone is not present.

There are many examples of auditory stimulus control in our daily lives (Saunders & Williams, 1998), and some auditory discriminations may be more important than others. For example, seeking shelter when one hears a tornado siren instead of running outside is an auditory discrimination. Auditory discrimination is important because this stimulus control allows a learner to act on the sounds they hear and is part of many instructional tasks (Serna, 2016). Many children with hearing within normal limits can acquire auditory discrimination of speech sounds through naturally occurring learning opportunities and in a relatively rapid fashion, but these discriminations can be challenging for individuals with intellectual or developmental disabilities (ID and DD, respectively; Serna, 2016). Difficulties acquiring auditory discriminations can render interventions to address social communication skills and verbal behavior less effective (Serna, 2016).

Dimensions and Parameters of Auditory Stimuli Auditory stimuli can be complicated and include multiple dimensions that necessary for discrimination, such as frequency, amplitude, and sound patterns (Serna, 2016). The dimensions of auditory stimuli may be overlooked when behavior analysts design applied-behavior-analytic programs to assess and teach this repertoire. For example, the discrimination of speech sounds, perhaps the most ubiquitous of all auditory stimuli for individuals with hearing within normal limits, requires the learner to differentiate between the individual phonemes that make up a word (Serna, 2016). For example, the difference between the words *van* and *fan* is the voiced or voiceless initial consonant. However, the learner must be able to differentiate between more than the phonetics; a learner must also attend to differences in pitch (i.e., rise and fall), amplitude (i.e., loudness), duration, content (e.g., tense of verbs), and intonation (Schreibman, 1975; Serna, 2016). For example, a caregiver may say a child's name—a stimulus with the same phonemes—with various pitches, amplitude, duration, or intonation. Each variation may be under the control of different stimuli in the caregiver's environment (e.g., a messy room, a low score on a test, beautiful artwork) and suggest reinforcers will follow different behaviors (e.g., cleaning room, studying the course content, creating more artwork). Variations in auditory stimuli create a challenge when one attempts to ensure behavior has come under the control of the relevant stimulus properties instead of irrelevant properties (Halbur et al., 2021).

Visual Stimuli

Visual stimulus control involves differential behavior in the presence of visual stimuli. Visual stimuli can be anything that we can see in our environment like pictures, text (textual stimuli; Skinner, 1957), objects, patterns, and textures. An example from the Ishihara test for colorblindness ("Ishihara Test", 2020) involves individuals saying the numbers in color combinations that they can see and remaining quiet when numbers are in color combinations that they cannot see. There are many examples of visual stimulus control in our daily lives (Saunders & Williams, 1998), and some visual discriminations may be more important than others. For example, stopping at a red light at a busy intersection instead of pressing down on the gas pedal is a visual discrimination. Many individuals of typical development can learn visual discriminations from trial-and-error experiences, whereas individuals with ID or DD may have difficulty acquiring visual discriminations and require intervention (Serna et al., 1997).

Dimensions and Parameters of Visual Stimuli Visual stimuli are reflections of light on an object (Harrison, 1991) and include wavelength (i.e., color), intensity (e.g., brightness, thickness), geometric (e.g., shapes, forms), spatial (e.g., position, orientation), and temporal properties (Balsam, 1988, p. 124). Many basic studies use light sources (e.g., colored keys), quantified with specialized tools (i.e., photometers that can measure the light of any wavelength; Harrison, 1991). The stimuli used in applied discrimination training are not so easily quantifiable, and it can be challenging to define the boundaries which separate the S+ and S−. The visual stimuli may be 2-D or 3-D stimuli that are multidimensional and range from simple (e.g., a card of a single hue) to complex (e.g., a scene of people and animals in a park).

Stimulus Disparity and Stimulus Salience

Two parameters of stimuli used in discrimination training that can affect acquisition are stimulus disparity and stimulus salience (Dinsmoor, 1995b). Although some authors believe that disparity and salience are undifferentiated in applied research (e.g., McIlvane & Dube, 2003), a behavior analyst should consider both, separately and jointly, when selecting antecedent stimuli and analyzing responding for sources of stimulus control (see Halbur et al., 2021, for a discussion of disparity and salience in research and practice).

Disparity of Auditory and Visual Stimuli Stimulus disparity is the degree of physical difference between the S+ and the S− (Dinsmoor, 1995b). When stimuli used in discrimination training are minimally different from one another, then stimulus discrimination acquisition is likely to occur more slowly than when stimuli differ to a greater degree (Dinsmoor, 1995b). There are examples of assessments and interventions which recommend altering auditory stimuli to create more disparate stimuli. One example is the Assessment of Basic Learning Abilities (ABLA-R, Martin et al., 2014) wherein assessors present spoken stimuli "red box" and "yellow can" with different pitches and tempos (e.g., "red box" with low pitch and staccato tempo). In another example, the sequence recommended in an auditory-matching procedure decreases stimulus disparity as a learner moves through the phases: environmental sound vs. no sound, environmental sound vs. white noise, environmental sounds vs. environmental sound, word vs. environmental sound, word vs. nonsense word, word vs. phonetically dissimilar word, and word vs. phonetically similar word (e.g., Du et al., 2017). Research has not evaluated whether each phase in the auditory-matching procedure is necessary; however, programming highly disparate stimuli for the S+ and S− at the beginning of training could promote faster acquisition (Halbur et al., 2021).

Disparity is important to consider with visual stimuli, too. The degree of difference between visual stimuli can affect acquisition speed (e.g., Hannula et al., 2020). Hannula et al. (2020) manipulated the stimulus disparity between the sample (Experiment 1) and comparison stimuli (Experiment 2) in conditional discrimination training. The experimenters manipulated the disparity by increasing and decreasing the red saturation (i.e., from light pink to dark red). The three participants in Experiment 1 responded with lower accuracy when the sample stimuli were similar in red saturation (i.e., low disparity) compared to their responses when the sample stimuli were dissimilar (i.e., high disparity). The three participants in Experiment 2 responded with lower accuracy when the comparison stimuli were similar in red saturation (i.e., low disparity) compared to their responses when the comparison stimuli were dissimilar (i.e., high disparity). Therefore, instructors should consider initiating training with highly disparate stimuli and gradually transitioning to just barely disparate stimuli; this process is a progressive discrimination (Dinsmoor, 1995b).

In addition to quantifiable differences in intensity or wavelength, the disparity of visual stimuli may include parts or elements of a stimulus that come to control responding (Balsam, 1988). The critical features are those components of a stimulus class that define or differentiate stimuli that fall within the boundaries of the class (i.e., "must have" attributes; Layng, 2019). The noncritical or variable features are the components of stimuli that do not define class membership but can occur in one or more exemplars (i.e., "can have" attributes; Layng, 2019). Learners acquire discriminations within and between stimulus classes because of differential reinforcement in the presence and absence of critical features. For example, the critical feature of a bowl is its concave shape with edges and bottom creating a curve without seams ("Bowl", 2020). Bowls can vary in their size, color, material, design, and depth. To acquire the stimulus class of "bowl," a learner's behavior must be reinforced in the presence of stimuli that retain the critical feature and include different variable features. The same behavior should not be reinforced in the presence of stimuli that lack the critical feature. Varying noncritical features across members and nonmembers of a stimulus class can lead to faster acquisition and generalization to untrained exemplars (Song et al., 2021).

Salience of Auditory and Visual Stimuli Stimulus salience refers to the difference between the S+ and the surrounding environment (Dinsmoor, 1995b). If the S+ is easily discriminable from stimulation in the background—in intensity or identifiable features—it will be more likely to occasion responding (cf. Halbur et al., 2021). Pierrel et al. (1970) evaluated the effects of the salience of auditory stimuli in discrimination training with rats. The disparity between the S+ and S− was held constant at 10 dB, but the salience was manipulated by selecting dB levels that were either more or less intense based on their loudness against the background (i.e., 90–100 dB and 60–70 dB). Pierrel et al. found that the rats assigned to the conditions with stimuli with higher dB levels acquired the discrimination more quickly. The salience (i.e., loudness) of auditory stimuli has been included in investigations on vocal imitation (Risley & Reynolds, 1970) and listener discriminations (e.g., following spoken instructions; Smeets & Striefel, 1980). The use of a differential observing response (described below) when teaching discriminations of auditory stimuli could make the relevant auditory stimuli stand out from the background stimulation (i.e., increase their salience).

The importance of stimulus salience in visual discrimination was discovered in research designed to study selective control and stimulus disparity on observing (Dinsmoor, 1995b). For example, Johnson (1970) found that pigeons learned the discrimination between a horizontal and vertical line at different rates due to the brightness of the line (i.e., how much the line stood out from the background of the response key). In general, the more that a visual stimulus or a component of the visual stimulus stands out from the background, the greater control the stimulus will come to have over responding (Balsam, 1988).

Importance of Stimulus Disparity and Salience when Teaching Discriminations The selection of auditory and visual stimuli should be considered carefully when teaching discriminations. Programs that aim to teach listener discriminations (i.e., auditory discrimination; e.g., instruction following, AVCD) recommend that auditory stimuli do not include additional words (e.g., "Show me;" Grow & LeBlanc, 2013) nor overlapping actions in the beginning of training (Lovaas, 2003). As the learner acquires some discriminated operants, additional words and overlapping actions should be added to verify conditional control of the S+. Programs to teach visual–visual or auditory–visual discriminations should consider how visual similarities can affect acquisition. When beginning instruction, selecting visual stimuli with few overlapping or common features will likely result in more rapid acquisition (Grow & LeBlanc, 2013; Halbur et al., 2021). The program can progress from easy discriminations (i.e., high disparity and salience) to more difficult discriminations (i.e., low disparity and salience).

When conducting comparative analyses on procedures to teach discriminations, it is important to consider how stimuli are assigned to different conditions to equate disparity and salience (Wolery et al., 2018). For auditory stimuli, it is recommended that one avoids assigning stimuli with the same phonemes or rhymes within the same condition because this could increase the difficulty of the condition and influence internal validity (Cariveau et al., 2021). Unlike the relatively strong recommendations for identifying and assigning auditory stimuli using a logical analysis procedure (Cariveau et al., 2021; Grow & LeBlanc, 2013), there are fewer recommended practices for visual stimuli. Cariveau et al. (2021) recommended we consider features such as background and shape. It may also be important to consider the number of overlapping variables or noncritical features (Halbur et al., 2021).

Assessing and Teaching Stimulus Discriminations

Auditory, visual, and auditory–visual simple and conditional discriminations can be arranged in various ways and taught with several empirically validated procedures. However, the conditions under which procedures are implemented should be considered when selecting interventions. Furthermore, intervention components may be added during training to increase the salience of the sample and comparison stimuli, provide additional opportunities to respond to the stimuli following an error, and arrange different consequences for independent and prompted correct responses.

Procedural Arrangements

Several procedural arrangements have been employed to assess and teach simple and conditional auditory and visual discriminations. The procedures include at least one antecedent stimulus, the S+ or the S−, and may include additional antecedent stimuli like a conditional stimulus (referred to as a sample stimulus in match-to-sample [MTS] procedures). Some procedures present two or more stimuli in an array, and these stimuli are referred to as comparison (i.e., choice) stimuli (Green, 2001). One of the comparisons is correct (S+), and the other(s) is incorrect (S−). The learner's selection behavior (e.g., pointing to, picking up, handing to the instructor, tacting [i.e., labeling]) toward the S+ is reinforced. Whether antecedents serve as only the S+ or S− or both the S+ and S− determines whether the discrimination is simple or conditional, respectively. The number of antecedent stimuli present at one time determine whether the discrimination is successive or simultaneous, respectively.

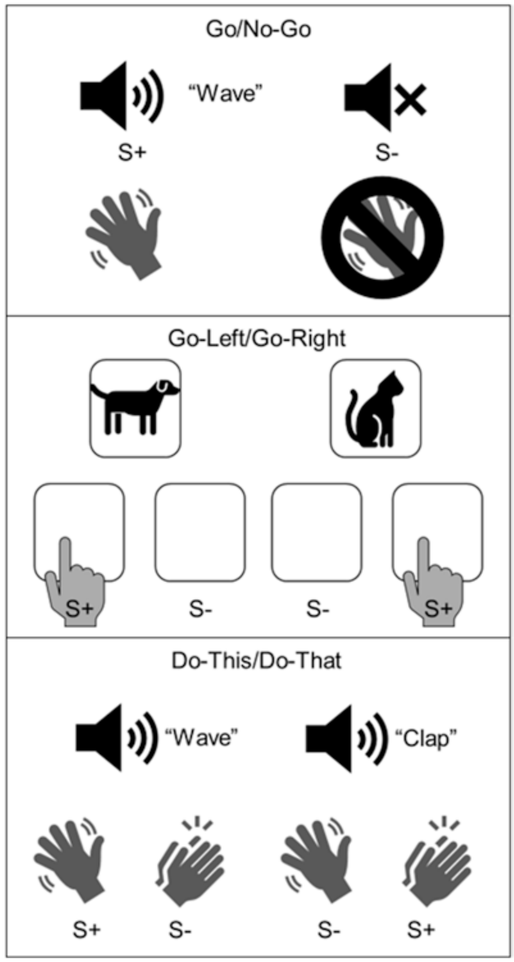

Fig. 13.1 Example trials of Go/No-Go, Go-Left/Go-Right, and Do-This/Do-That procedures. *Note.* In Go/No-Go (top), waving is reinforced when the auditory stimulus "Wave" is present and is not reinforced in its absence. In Go-Left/Go-Right (middle), touching the left stimulus is reinforced when the dog is present, and touching the right stimulus is reinforced when the cat is present. The comparison stimuli can be blank, as shown, or may have arbitrary forms or figures. The location remains static throughout all Go-Left/Go-Right trials. In Do-This/Do-That (bottom), waving is reinforced when "Wave" is present, and clapping is reinforced when "Clap" is present

Go/No-Go Procedures

In go/no-go procedures (Fig. 13.1, top panel), emitting the target behavior in the presence of the S+ is reinforced, and emitting the target behavior in the presence of the S− is extinguished. Typically, the two stimuli are presented for a specific duration or until a response occurs. Emitting the response in the presence of the S+ and not emitting the response in the presence of the S− is correct, and the opposite patterns are incorrect (Saunders & Williams, 1998). A go/no-go procedure includes reinforcing the target response during the S+ interval. It may include the presentation of a reinforcer if the learner does not emit the response during the S− interval (Saunders & Williams, 1998). The go/no-go procedure is a simple successive discrimination (see Saunders & Williams, 1998, for a discussion about conditionality).

Some go/no-go procedures use a presence vs. absence discrimination, whereas others use two different stimuli in a quality discrimination (Serna, 2016). An example of a quality discrimination is presenting the instructions “Clap hands” and “Touch tummy” and reinforcing hand clapping only in the presence of the former. The go/no-go procedure would not teach the touch tummy action, as the function of including another instruction would be to verify that “Clap hands” rather than any vocal stimulus evokes hand clapping. Serna et al. (1992) used go/no-go to teach two women with ID to touch a screen only when the computer said “Touch.”

Serna (2016) highlights a potential issue when using go/no-go procedures with individuals with ID or DD, especially if the individual has a history of reinforcement for touching stimuli in the past. Serna described a predisposition to “go” (i.e., emit the target response) regardless of the presentation of the S+ or S−. Serna (2016, p. 244) reported that go/no-go “yielded less successful results” when it was used with additional adults with ID following the success of the Serna et al. (1992) study. Bergmann et al. (2021) reported that three of the five child participants, two of whom were diagnosed with ASD and one of whom was typically developing, touched the card on 100% of trials regardless of which auditory stimulus was present. A predisposition to “go” is a potential limitation of the go/no-go procedure that behavior analysts should consider before using it in a learner’s intervention programming.

Go-Left/Go-Right or Yes/No Procedures

An alternative to the go/no-go procedure that requires a response on each trial is referred to as a go-left/go-right or yes/no procedure (Fig. 13.1, middle panel). In this procedure, there are two visual stimuli in an array. The visual stimuli may be blank or have figures or words written on top. One stimulus is positioned to one side of the response field, and the other stimulus is positioned on the other side; the stimuli may be arranged on the left and right or top and bottom, but their positions remain fixed from trial to trial. The conditional stimulus is presented, and a selection response is directed toward the comparison in the left or right position depending on which stimulus is present. Because the comparison stimulus on the left is either the S+ or S− depending on which antecedent stimulus is presented, this is a simultaneous conditional discrimination procedure. Schlund (2000) used a go-left/go-right procedure with one adult participant with a traumatic brain injury. The participant picked up a red poker chip when he could hear the tone and picked up a white poker chip when he could not hear it. The topography (i.e., form) of the response looked the same across trials, and the tone’s presence or absence determined which poker chip was the S+.

Do-This/Do-That Procedures

In contrast to the topographically similar responses in go-left/go-right procedures, the do-this/do-that procedure (Fig. 13.1, bottom panel) involves emitting topographically distinct responses in the presence of two or more stimuli. When one stimulus is present, “doing this” is reinforced, and when another stimulus is present, “doing that” is reinforced. For example, in the presence of “Clap your hands,” clapping is reinforced, and in the presence of “Stomp your feet,” stomping is reinforced. More than one stimulus and response should be included in training from the outset to increase the likelihood that the auditory or visual stimulus controls behavior. No comparison array is used with do-this/do-that, so it is a simple successive discrimination.

Schlund (2000) taught one adult male with a traumatic brain injury to engage in two different behaviors to complete a hearing screening assessment. The participant learned to wave his arms above his head and nod when he could hear the tone and shake his head when he could not hear the tone. Bergmann et al. (2021) included do-this/do-that in an auditory discrimination assessment. For example, participants knocked on the table in the presence of the word "foam" and waved in the presence of the word "gift." The do-this/do-that procedure was the arrangement that led to mastery in 90% of the evaluations conducted by Bergmann et al.

Matching-to-Sample (MTS) Procedures

A robust literature base has investigated MTS in basic, translational, and applied studies with a variety of nonhuman subjects and human participants. Although the MTS procedure can be used with stimuli across an organism's senses (e.g., see Dass et al., 2018 for an example of MTS with olfactory stimuli), this chapter will focus on preparations with auditory and visual (2-D and 3-D) stimuli. The MTS procedure (Fig. 13.2) includes presenting a sample stimulus and comparison array, and it is a conditional discrimination procedure. In MTS, the learner must observe the sample stimulus, discriminate the sample stimulus from other sample stimuli presented on successive opportunities, discriminate the sample stimulus from the comparison stimuli, and discriminate each comparison stimulus from one another (Green, 2001). Therefore, this procedure involves successive simple discrimination and simultaneous conditional discrimination. The MTS procedure can be either simultaneous—the sample stimulus remains in the environment when the comparison stimuli are available—or delayed—the sample stimulus is removed from the environment before the comparison stimuli are available (Pilgrim, 2015). Time to acquisition increases with the duration of delay (Mackay, 1991).

Identity In identity MTS (Fig. 13.2, top left panel), at least three stimuli are presented, including one sample and two or more comparison stimuli. The sample and S+ comparison stimuli are identical physically. Stimuli could include the same auditory stimuli (e.g., "Cat" and "Cat") or visual stimuli (e.g., two pictures of a cat). A reinforcer is provided when the learner selects the identical S+ in the presence of the sample stimulus. Kodak et al. (2015) included an identity MTS procedure. Participants with ASD touched the comparison stimulus that matched the 2-D sample stimulus, and all nine participants passed the identity MTS subtest. Some behavior analysts reserve the term "identity matching" for a conditional discrimination repertoire that extends beyond matching with a limited stimulus set and should only be used when a learner can match novel samples and comparisons (Catania, 2013, p. 158).

Oddity The oddity MTS procedure (Fig. 13.2, top right panel) is arranged like the identity MTS procedure with one sample stimulus and at least two comparison stimuli. In the oddity procedure, there will be at least one comparison stimulus physically identical to the sample stimulus and one stimulus that is physically different (Pilgrim, 2015). The difference between the identity and oddity MTS procedures is that the physically identical comparison stimulus is the S− and the physically different stimulus is the S+. Therefore, a reinforcer is provided when the learner selects the comparison stimulus that does not match the sample stimulus. Soraci et al. (1987) evaluated the performance of five preschool children who were at risk for ID on an oddity task. The participants acquired the oddity relation only after the experimenters increased the number of non-odd stimuli (S−) in the array. In Soraci et al., accurate performance was maintained as they faded the modification. The authors reported that this outcome was significant because children with ID and DD routinely perform below peers in oddity procedures, perhaps due to insensitivity to the relations between stimuli.

Arbitrary In an arbitrary MTS procedure (Fig. 13.2, bottom left panel), the samples and comparison stimuli are all physically different. The sameness relation of the sample stimulus and the S+ comparison stimulus is based on something other than identity. For example, an arbitrary MTS procedure could include the number 8 and a grouping of eight items or the word "eight." There may be other relations included in an arbitrary MTS procedure like similarities based on category or class (e.g., sample is a coat and the

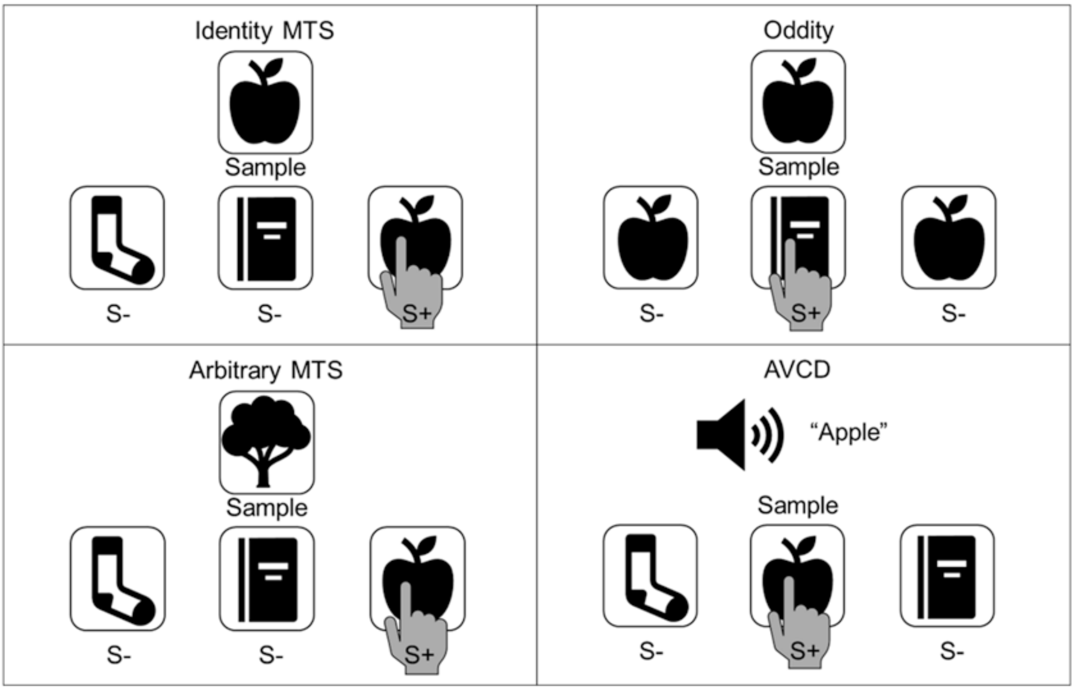

Fig. 13.2 Example trials of MTS procedural arrangements. *Note.* In identity MTS (top left), the sample and S+ are physically identical stimuli. In oddity (top right), the sample and S+ are not physically identical. In arbitrary MTS (bottom left), the sample stimulus and S+ are not physically similar, and the instructor determines the relation. In this figure, the apple is the S+ because it grows on a tree. In AVCD (bottom right), a type of arbitrary MTS, the sample and S+ are not physically similar, and the auditory sample determines which visual stimulus in the array is the S+

S+ is a pair of pants because they are clothing), function (e.g., sample is an oven and the S+ is a microwave because they heat food), or feature (e.g., sample is a horse and S+ is a cat because they have tails). Arbitrary relations can be used with an oddity MTS procedure, too.

An arbitrary MTS procedure may include control by a spoken sample and visual comparison stimuli. For example, the sample stimulus "Red" is spoken in the presence of a red card (S+) and a green card (S−); touching the red card would be selected. This type of discrimination is an auditory–visual conditional discrimination (AVCD; Fig. 13.2, bottom right panel). There are many examples of AVCDs in our day-to-day interactions. For example, if a parent asked a child to get her spelling list from her bedroom, the child would scan the visual stimuli in her room. The auditory stimulus "spelling list" would evoke picking up the spelling list instead of other items like a soccer ball or sweatshirt. Many individuals acquire an AVCD repertoire through these everyday experiences, yet some individuals, including children with ASD, require an intervention.

Teaching Procedures

Simple Discriminations

Trial-and-error procedures, which reinforce correct responses and move to an ITI following an error, can teach stimulus discriminations. Trial-and-error procedures are not recommended for individuals with ID, DD, ASD, or other learning difficulties (Saunders & Williams, 1998). An errorless procedure that can be used to teach a successive simple discrimination involves gradually modifying the duration of the S+ and S− intervals. The training begins with the S+ present, and the target response is reinforced. For very brief periods, the S+ is replaced by the S−. Brief presentations decrease the probability that the learner will emit a response in the presence of the S−. If the learner does not respond in the presence of the S−, the instructor presents the reinforcer or switches to the S+; emitting the response in the presence of the S− delays the presentation of the S+ (i.e., changeover delay). Terrace (1963) trained pigeons to peck only in the presence of a red light (S+) and not peck in the presence of an unlit key (S−) by gradually increasing the duration of the S−.

Conditional Discriminations: Simple-Conditional and Conditional-Only

Several early intervention curricula recommend a simple-conditional method for AVCD training (e.g., Lovaas, 1981). In initial steps of the simple-conditional method, simple discrimination is taught in isolation in a massed-trial format (e.g., the spoken word “apple” and only the picture of the apple). Only after several steps does training target a conditional discrimination among the three stimuli wherein the sample stimulus varies, and each stimulus serves as an S+ and S− across trials. Refer to Grow et al. (2011) for a diagram of the nine steps of the simple-to-conditional method. In comparison, AVCD may be taught with a conditional-only method in which the discriminations of multiple samples and comparison stimuli are targeted from the outset. Throughout all trials in conditional-only, a learner must attend to the auditory sample (e.g., the spoken word “apple,” “book,” or “sock”), scan the array of comparison stimuli (pictures of the apple, book, and sock), and select the comparison that matches the sample.

Research comparing the simple-conditional and conditional-only method supports the use of the conditional-only method with learners with DD. Grow et al. (2011) compared these two methods of AVCD training with three participants with ASD; they replicated the comparison several times with each participant. The conditional-only method was effective in seven of the eight comparisons, whereas the simple-conditional method was effective in four of eight comparisons. The conditional-only method often required fewer training trials, too. In addition, participants required modified intervention in the simple-conditional method to reduce biases and error patterns (i.e., faulty control; see below) in four of the eight comparisons.

Researchers have proposed that the simple-conditional method may be unnecessarily lengthy and more likely to establish biased responding due to the inclusion of isolation training (Grow et al., 2011; see Grow & Van Der Hijde, 2017, for a replication which omitted isolation training; see Fisher et al., 2019 and Lin & Zhu, 2020 for a potential relationship between novice and experienced learners and the simple-conditional method). When stimuli are presented in isolation (e.g., there is only one picture in an array), the learner is not required to attend to the auditory sample stimulus (e.g., the spoken word “apple”). Instead, the learner can touch one picture in the array across trials, and this pattern of responding produces reinforcers consistently. Thus, responding may come under the restricted stimulus control of one picture rather than the combination of the picture in the comparison array and the auditory sample stimulus. Furthermore, Green (2001) recommended careful arrangement of instruction to promote the development of relevant sources of stimulus control, which includes training conditionally and avoiding training in isolation or with distractors (Table 13.1).

Procedural Components and Arrangements

Trial-Initiation Response Before an instructor begins a learning trial, the learner emits a specific response (e.g., places hands in lap, raises hand) to initiate the trial (see Campanaro et al., 2020, for an example teaching procedure). The use of a trial-initiation response can increase the likelihood that the learner attends to the conditional stimulus, which could be especially beneficial when the conditional stimulus is not repeated (e.g., a non-repeated auditory stimulus, delayed MTS; Saunders & Williams, 1998).

Table 13.1 Arrangements to promote appropriate stimulus control in conditional discrimination training

Arrangement	Description	Purpose
Counterbalance S+, S− presentations and positions	Present each S+ the same number of times but never more than two times in a row. Arrange S+ and S− in each position an equal number of times.	Decrease the likelihood that discrimination comes to be controlled by position or location.
Number of comparison stimuli	Include at least three comparison stimuli in an array.	Reduce the likelihood of stimulus or position biases because reinforcement schedule is thinned.
Same comparison stimuli	Include the same comparison stimuli on every trial. Do not include novel S−.	Learners can come to respond away from novel stimuli. Functions like an array of one or two.
No distractor stimuli	Include comparison stimuli that are both S+ and S−. Do not include stimuli that are always S−.	Learners can come to respond away from stimuli that are only S−. Functions like an array of one or two.
Comparison stimuli out of view	Arrange comparison stimuli out of the learner's view (e.g., hook-and-loop tape on board, use barrier).	Avoid providing extraneous, inadvertent prompts (e.g., straightening S+) that can control responding.
Observing response	Program an observing response for sample stimuli before the comparison stimuli are available.	Increase the likelihood a learner attends to the sample stimulus. Without attending to the sample, other stimuli likely to control the response.
Auditory sample stimulus	Provide only auditory stimuli necessary to determine the S+. Do not add additional like "give me."	Increase the likelihood a learner attends to the relevant auditory stimulus. Increase disparity.
Teach pointing	Teach the learner to point to the stimulus instead of handing the S+ or placing the sample atop the S+.	Pointing is a functional response, applicable regardless of S+ size. Placing the sample could teach the learner to attend to identical features only.
Prompts and prompt fading	Use prompts and prompt fading rather than trial-and-error (differential reinforcement alone).	Prompt the response and reinforce. Differential reinforcement without prompts can create error patterns.

Note. The arrangements to promote appropriate stimulus control do not guarantee that instructor-defined stimulus control will develop. These recommendations are from Green (2001), Grow and LeBlanc (2013), and Saunders and Williams (1998)

Stimulus-Presentation Order When conducting discrimination training with multiple antecedent stimuli (e.g., AVCD, AMTS), the instructor can present the conditional stimulus before, after, or at the same time as the comparison stimuli. Green (2001) recommended presenting the conditional stimulus before the comparison stimuli, whereas McIlvane et al. (1990) recommended presenting the comparison stimuli first. Several studies have compared acquisition with different stimulus-presentation orders (e.g., Cubicciotti et al., 2019) with either a relative advantage of sample-first presentations or learner-specific outcomes.

Observing Response and Differential Observing Response (DOR) Learners must observe all relevant features of stimuli arranged in discrimination training to acquire the targeted discrimination. If the relevant features are not observed, the discrimination will not be established or may come under the control of one or more irrelevant features (i.e., faulty, restricted stimulus control). For example, if a child attends only to the first letter of words while reading, the child's behavior is under restricted stimulus control. Until this child attends to all letters in written text, she will not become a fluent reader nor comprehend written text.

Observing responses are emitted in the presence of a sample stimulus and must occur before the comparison stimuli are presented. When using an observing response, the learner emits the same response in the presence of each sample stimulus. Observing responses can increase the likelihood that a learner has observed the sample stimulus (Green, 2001). A DOR also occurs in the presence of the sample stimulus, but it requires a distinct response to each sample stimulus (or each component of a sample stimulus) included in discrimination training. A DOR provides an overt response to indicate attending to each sample and may prevent or remediate restricted stimulus control.

Researchers have programmed different topographies of DORs in training, such as requiring an echoic response (e.g., Fisher et al., 2019) and motor responses (e.g., sign; Elias & Goyos, 2013). Walpole et al. (2007) had a participant with ASD match unique letters in words with overlapping components (e.g., matched n and t for *man* and *mat*, respectively) before matching whole words. The inclusion of a DOR in training increased levels of correct matching, and accurate responding maintained following the removal of the DOR.

Nevertheless, other researchers found that removing the DOR from training resulted in a return to low or intermediate levels of accuracy (e.g., Farber et al., 2017). Thus, Farber et al. evaluated a gradual reduction in the frequency of DORs during conditional discrimination training and found this approach resulted in maintained accuracy and overall improvements in observing behavior during training. Therefore, it is recommended that practitioners who include DORs in discrimination training carefully review the effects of removing the DOR on discriminated responding and consider gradually thinning the frequency of DORs during training if highly accurate responding does not maintain without the DOR.

Prompts Prompts are used to occasion a correct response in the presence of one or more programmed stimuli—either a visual stimulus, auditory stimulus, or both—during the initial stages of discrimination training. Prompts are a type of assistance or modification made to instruction that increases the likelihood of a correct response, which produces a reinforcer, and increases the future likelihood of the response under similar stimulus conditions.

Extra-Stimulus Prompts An extra-stimulus prompt involves adding a stimulus to the environment to occasion a correct response to the target stimulus. For example, an instructor points to an apple in an array of visual comparison stimuli immediately after saying, "apple." The instructor's point is an extra-stimulus prompt, and it should result in the learner imitating the instructor by pointing to the picture of the apple, which produces a reinforcer.

Early research on extra-stimulus prompts showed they might be challenging to fade because learners made errors as the prompts were removed and failed to acquire the stimulus discrimination (e.g., Schreibman, 1975). For example, Schreibman et al. (1982) used a point prompt as an extra-stimulus prompt to teach four children with ASD to point to a visual S+ in an array of three visual stimuli. This training targeted a simple visual discrimination, because one stimulus remained the S+ across all trials. Training began with the point prompt positioned immediately in front of the stimulus, and this prompt was faded by increasing the distance between the point prompt and the S+. The fading procedure was terminated and considered unsuccessful for all participants due to frequent errors.

Based on the results of Schreibman et al. (1982) and others (e.g., Koegel & Rincover, 1976), researchers hypothesized that early studies on extra-stimulus prompts were unsuccessful in teaching simple and conditional discrimination to children with ASD due to restricted attending to the point prompt rather than the aspects of the stimulus necessary to acquire the discrimination. However, research that followed showed that extra-stimulus prompts could be successful when combined with prompt-fading procedures, such as a prompt delay (Wolery et al., 1988). Wolery et al. (1988) combined an extra-stimulus prompt with a progressive-prompt delay in which the authors gradually increased the latency from the presentation of the visual stimulus to the extra-stimulus prompt. All three participants learned the targeted simple discriminations, and the extra-stimulus prompt was faded successfully. Thereafter, researchers have combined extra-stimulus prompts and prompt-fading procedures to teach simple and conditional discrimination to children with ASD (e.g., Kodak et al., 2011; McGhan & Lerman, 2013). Based on empirical support for extra-stimulus prompts combined with prompt-fading procedures over the past 30 years, these prompts are commonly used in early intervention services for children with ASD and other DD (Love et al., 2009).

Within-Stimulus Prompts A within-stimulus prompt involves manipulating one or more features of the S+ or S− to assist the learner in responding to the correct comparison stimulus. Once consistent responding to the stimulus is achieved, aspects of the manipulation are removed gradually to return stimuli to their original forms. Within-stimulus prompts can be arranged in several ways, including superimposition (e.g., Birkan et al., 2007), size (e.g., Zawlocki & Walls, 1983), and intensity (e.g., Schreibman, 1975). For example, Zawlocki and Walls (1983) used within-stimulus prompts of size fading to teach visual discriminations to 13 individuals with ID. The S+ circles were initially increased in size to occasion responding to them, and then the size was faded gradually across trials as the size of the S− circle remained consistent. Participants acquired the targeted discriminations with fewer errors when compared to a no-fading condition. Fading is a crucial component of transferring control from the within-stimulus prompt to the relevant features of the S+. It is recommended that instructors modify the S+ rather than the S− to facilitate the transfer of stimulus control (Dinsmoor, 1995b). In addition, Fields (1978) suggested inserting terminal-probe trials into fading to determine whether all fading steps are necessary and to detect transfer of control.

Despite the efficacy of within-stimulus prompts, there are drawbacks to using this type of prompt fading during instruction. Several features may be critical to the targeted discrimination among stimuli, making it difficult for the instructor to select the feature(s) to manipulate. Material preparation can be time-consuming due to the production of stimuli that contain small variations among many fading steps (Green, 2001). Furthermore, materials management can be cumbersome for an instructor who must organize these materials and present the stimuli related to the current fading level. The use of technology (e.g., slideshows of stimuli presented on tablets) may alleviate the burden of managing printed materials, although empirical evidence for this recommendation is needed. Practitioners should consider the costs and benefits of within-stimulus prompts when selecting prompts in discrimination training.

Error Correction When a learner errs during discrimination training, an instructor has several options for correcting the error. In early discrimination training studies, instructors said “no” following an error and moved to the next trial (e.g., Schreibman, 1975). However, other—more effective strategies—have replaced this practice, such as providing one or more active response opportunities to the learner following an error (McGhan & Lerman, 2013). For example, following a response to the S− on a trial, an instructor repeats the auditory sample stimulus (e.g., says, “apple”) while pointing to the S+ (the picture of the apple in the array) and provides a learner with an opportunity to imitate pointing to the S+. After that, an instructor could move on to the next instructional trial or repeat the erred trial until the learner engages in an independent correct response to the S+ one time (a procedure called re-present until independent; Carroll et al., 2015) or multiple times (a procedure called directed rehearsal; McGhan & Lerman, 2013). The most effective and efficient error-correction procedure to include in discrimination training may be specific to the learner, suggesting that an assessment could inform intervention (e.g., Carroll et al., 2015; McGhan & Lerman, 2013).

Differential Reinforcement Differential reinforcement is a treatment component that is commonly combined with other interventions, such as a prompt delay (Vladescu & Kodak, 2010). Differential reinforcement is a critical component of discrimination training because responses to the S+ are reinforced, whereas responses to the S− are not reinforced (referred to as trial-and-error; Saunders & Williams, 1998). However, differential reinforcement is commonly arranged for independent and prompted correct responses as well (Love et al., 2009). For example, Hausman et al. (2014) arranged varying reinforcement schedules for prompted responses during discrimination training for three participants with ID. Independent correct responses produced reinforcement on a fixed-ratio 1 (FR 1) schedule, whereas the reinforcement schedule for prompted responses varied across three conditions (FR 1, FR 3, and extinction). Two participants had higher levels of independent correct responding when prompted correct responses were never reinforced.

Several types of differential reinforcement may be arranged during discrimination training. In addition to different reinforcement schedules described above, researchers and practitioners may arrange differential qualities and magnitudes of reinforcers for independent and prompted responses. During intervention, independent correct responses produce higher quality or larger magnitude reinforcers, whereas prompted correct responses produce lower quality or smaller magnitude reinforcers (e.g., Johnson et al., 2017). The most effective and efficient differential reinforcement arrangement may be learner-specific; an assessment may help select an arrangement for discrimination training for a learner (Boudreau et al., 2015).

Furthermore, differential reinforcement has often been implemented at varying times during instruction, such as being implemented from the onset of instruction (e.g., Karsten & Carr, 2009) or after independent correct responding meets a criterion (e.g., Carroll et al., 2015). One study that assessed the onset of differential reinforcement found immediate onset resulted in the most efficient mastery of skills in six of the seven comparisons (Campanaro et al., 2020).

Differential Outcomes Effect Conditional discriminations may be more readily acquired if a different consequence is provided following responses emitted in the presence of different antecedent stimuli—this is the differential outcomes effect (DOE; McCormack et al., 2019). When arranging instruction for a conditional discrimination, the instructor provides different reinforcers following responses to each conditional stimulus. For example, an instructor provides an airplane toy when the child waves his hand after the instruction "Wave" and a superhero action figure when the child stomps his feet after the instruction "Stomp." McIlvane and Dube (2003) posited that differential consequences increase the discriminability between antecedent and response relations and may promote the acquisition of the instructor-defined discriminations rather than faulty stimulus control. Basic research with humans and nonhumans and applied research with adults and children with and without disabilities supports DOE to enhance acquisition of conditional discrimination, especially in MTS arrangements (see McCormack et al., 2019, for a review). For example, Estévez et al. (2003) found that arranging differential outcomes in conditional discrimination training led to better accuracy and faster learning for 19 of 24 children and adults with Down syndrome.

Over 40 studies on the DOE have been published, and a meta-analysis found medium-to-large effect sizes (McCormack et al., 2019). Still, it is unknown how frequently the DOE is used in applied-behavior-analytic intervention. To incorporate the DOE into practice, an instructor must identify many reinforcing stimuli and pair these reinforcers with specific antecedents and responses. If the learner's reinforcers are limited, there will be insufficient variation for programming. Thus, the instructor may need to provide exposure to various items, activities, and edibles to expand available reinforcers before using the DOE. Technology may permit incorporating the DOE in practice if a variety of pictures, games, and video clips increase a learner's behavior; however, this needs to be evaluated empirically.

Issues and Modifications to Consider when Establishing Stimulus Control

Whether one is establishing simple or conditional discriminations, there are recommended arrangements to reduce unwanted sources of stimulus control (Table 13.1).

Identifying Unwanted Sources of Control

Identifying the source of control when a learner fails to acquire conditional discriminations could inform manipulations of antecedent- and consequence-based interventions to resolve problematic response patterns (Hannula et al., 2020). An analysis of stimulus control topography coherence (McIlvane & Dube, 2003) with a kernel analysis (Fields et al., 2010) could inform decisions regarding stimulus control in conditional discrimination training. A component analysis can be used to detect the stimulus component controlling responding, which may be pertinent when concerned about stimulus overselectivity (i.e., restricted control by one or subset of stimulus components, Lovaas et al., 1979). Additionally, an instructor can use error analyses to determine if the learner is emitting molecular (i.e., controlled by the previous trial) or molar (i.e., controlled by previous training conditions) error patterns that suggest faulty sources of control (Grow et al., 2011; Hannula et al., 2020).

Error analyses conducted within conditional discrimination training can reveal patterns of responding like win-stay, lose-shift, win-shift, and position biases (Fig. 13.3). Sometimes these response patterns are beneficial (e.g., shifting responding away from an S− is a hallmark pattern of rapid acquisition in learning sets; McIlvane, 2013), but these response patterns can be problematic. Win-stay errors (Fig. 13.3, top left panel) occur when a learner engages in the same response or selects the same comparison stimulus that was reinforced in a previous trial(s) or training condition (Grow et al., 2011; Lovaas, 2003). A win-stay response pattern is more likely to occur when one stimulus is presented as the S+ in successive trials (Lovaas, 2003). Lose-shift errors (Fig. 13.3, top right panel) occur when a learner engages in a response or selects a stimulus other than the response or stimulus, respectively, that was not reinforced in the previous trial or training condition (Grow et al., 2011; Lovaas, 2003). Lose-shift errors are more likely to occur when the instructor alternates between two stimuli in a non-random fashion (Lovaas, 2003). Win-shift errors (Fig. 13.3, bottom left panel) occur when a learner emits the other response or selects the other stimulus when a response or stimulus produced reinforcement in the previous trial (Lovaas, 2003). Win-shift responses are more likely to occur when the instructor alternates between two stimuli (Lovaas, 2003). A position bias (Fig. 13.3, bottom right panel) occurs when the learner continues to select the stimulus in a specific position in the array regardless of which conditional stimulus is presented (Hannula et al., 2020). A position bias may be more likely when the location of the S+ is not counterbalanced across trials and samples and when there are fewer than three comparison stimuli (Green, 2001).

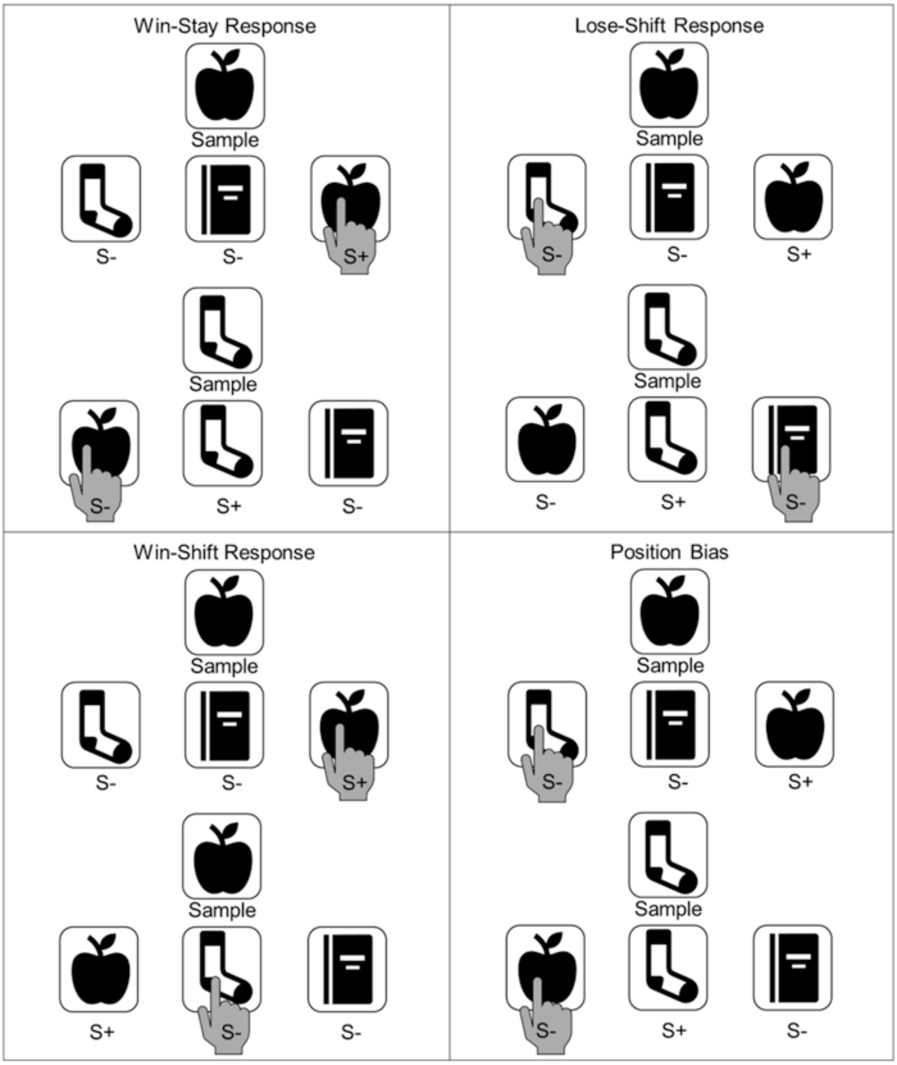

Fig. 13.3 Examples of potential problematic sources of control. *Note.* Each panel represents a possible series of trials showing molecular error patterns

Because stimulus control topography and error analyses require effortful data collection and expertise, it is recommended that instructors avoid using strategies that may promote faulty stimulus control from the outset (Grow et al., 2011; Table 13.1). Therefore, instructors should begin with conditional-only training, which is less likely to lead to problematic response patterns than simple-to-conditional training (Grow et al., 2011), after the learner can engage in skills like pointing to stimuli and scanning an array (Green, 2001).

Strategies to Mitigate Unwanted Sources of Stimulus Control

Differential Observing Responses (DOR) A DOR can reduce restricted stimulus control by ensuring the participant observes the relevant features of the sample stimulus. Dube and McIlvane (1999) resovled restricted stimulus control by arranging a DOR that required participants to match the compound sample (e.g., AB) to an identical compound sample in an array that also contained comparisons with an irrelevant form in each component (e.g., array contained AC, CB, AB). Only after participants correctly matched the compound sample to the identical comparison (i.e., matched AB to AB) were they permitted to advance to the second portion of the trial in which they matched one of the two components of the compound sample. Engaging in the DOR increased the salience of the second component of the compound stimulus, which resulted in highly accurate matching of each component in subsequent trials.

Blocking Some learners may not respond to conditional discrimination training procedures even when they incorporate the recommended components in Table 13.1. For example, Kodak et al. (2015) found 44% of children with ASD may not benefit from conditional discrimination training with common prompt-delay procedures. Individuals for whom conditional discrimination training is ineffective may benefit from a procedure called blocking. Blocking is a more intensive intervention that has demonstrated success in establishing conditional discrimination in learners with ASD and ID (e.g., Saunders & Spradlin, 1989).

Blocking involves training each sample-comparison relation in session blocks and then gradually reducing the number of consecutive trials in which each sample-comparison relation is targeted until samples are randomly rotated. For example, when conducting blocking of AVCDs, all training trials in a session (e.g., 16 trials) would include one auditory sample (e.g., the spoken word "apple") and responses to the S+ (e.g., picture of the apple) are reinforced in different positions in the two-comparison array. Once the child consistently responds to the picture of the apple in the presence of the sample "apple," the second sample-comparison relation is targeted by presenting "sock" on all 16 training trials and reinforcing responses to the picture of the sock. The targeted sample-comparison relation is alternated across blocks of sessions until learners respond correctly when reinforcement shifts to the other targeted comparison stimulus occurs on nearly all trials in the block (e.g., 90% or more of trials). Thereafter, the size of the trial blocks is reduced (Fig. 13.4). The goal of this reduction in block size is to produce a rapid shift in responding from one comparison to the other after a shift in the targeted sample-comparison relation. Trial blocks continue to decrease (e.g., blocks of 4 trials, blocks of 2 trials) as responding continues to shift rapidly from one sample-comparison relation to the other with each new block of trials. Blocking concludes with random alternation of the sample stimulus across trials and continued correct responding to both sample-comparison relations across several consecutive training sessions.

Researchers have successfully used blocking to teach targeted sample-comparison relations of visual–visual and auditory–visual conditional discriminations to individuals with ASD and ID (e.g., Kodak et al., 2011; Saunders & Spradlin, 1989). Nevertheless, blocking may take considerable time to conduct and should not be used with learners who might benefit from other conditional discrimination training methods.

Assessing and Teaching Prerequisite Skills for Discrimination Training Learners may be unlikely to benefit from discrimination training until they acquire putative prerequisite skills. Conducting discrimination training when learners cannot engage in the putative prerequisite skills could increase the likelihood that control by sources other than those defined by the instructor (e.g., instructor's eye gaze, the last stimulus touched when setting up) will develop. Green (2001) recommended teaching learners "learning to learn" skills like scanning materials, waiting for the sample stimulus before responding, and emitting observing responses. Researchers have examined putative prerequisite skills for conditional discrimination (e.g., Kodak et al., 2015; Saunders & Spradlin, 1989).

To engage in a correct discrimination during AVCD—arbitrary MTS—training, a learner must respond differentially to pictures associated with varying auditory stimuli; therefore, it is likely that they will need to acquire several skills before

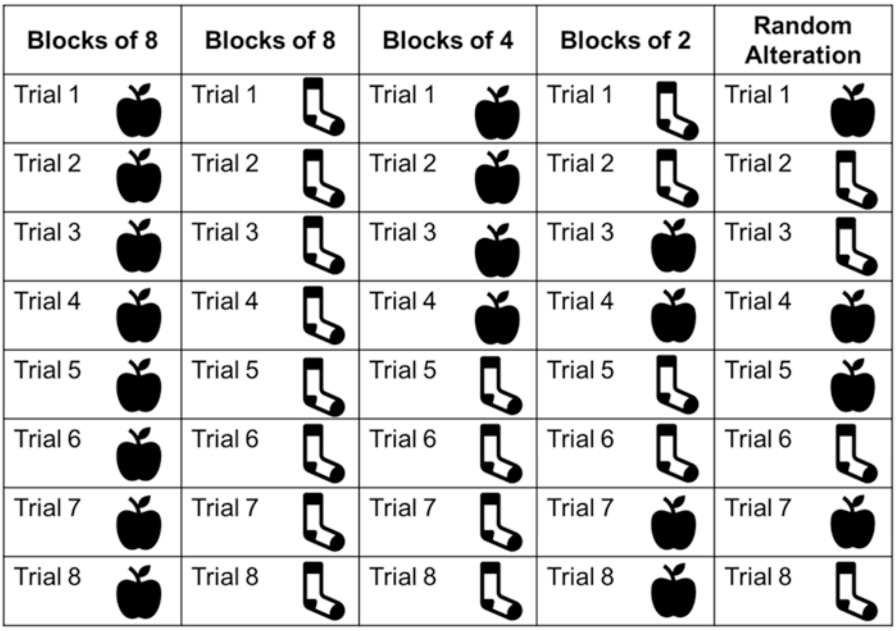

Fig. 13.4 Example distribution of S+ trials in blocking. *Note*. The order of each stimulus in the blocks can be randomized. That is, the sock might be the S+ for the first four trials in a blocks-of-four session. Both stimuli are present on each trial, but only one stimulus is the S+ for a specific number of trials in the block. The position of the S+ changes across trials within a block

AVCD training is successful. The skills include successive discrimination of auditory samples (e.g., discriminate the sound of a cow mooing from a baby crying), simultaneous discrimination of visual stimuli in the comparison array (e.g., touch the picture of the baby [S+] and do not touch the picture of the cow [S−]), matching identical stimuli (e.g., identical pictures of cows or identical sounds of mooing), and observing the visual comparisons in the array (e.g., looking at the pictures of the cow and baby).

Kodak et al. (2015) evaluated the correlation between an assessment of putative prerequisite skills for AVCD and the results of AVCD training. In addition to the skills described above, Kodak et al. measured how participants responded to a common extra-stimulus prompt (i.e., pointing). Kodak et al. showed four of nine participants with ASD did not display mastery-level responding to one or more skills included in the assessment. Subsequent outcomes of AVCD training were correlated with the assessment results for seven of the nine participants. Four participants who mastered all putative prerequisite skills also mastered AVCDs, and three of the four participants who did not master all putative prerequisite skills also failed to master AVCDs. Nevertheless, the skills assessment did not examine a functional relationship between mastery of prerequisite skills and successful AVCD training; future research should teach missing skills and evaluate whether subsequent AVCD training is successful.

Conclusion

Simple and conditional discriminations with auditory and visual stimuli are ubiquitous. Control of our behavior by stimuli in the environment promotes a more efficient and organized world (Skinner, 1953). When teaching auditory, visual, or auditory–visual discriminations, an instructor must consider the controlling relations, procedural arrangement, teaching strategies, and sources of stimulus control. Behavior analysis has amassed extensive literature on discrimination training parameters and procedures beyond the current chapter's scope. The interested reader is referred to several excellent chapters on basic, translational, and applied stimulus control (see Dinsmoor, 1995a, b; Harrison, 1991; Mackay, 1991; McIlvane, 2013; Pilgrim, 2015; Saunders & Williams, 1998; Spradlin & Simon, 2011).

Although the focus of this chapter was stimulus discrimination, we would be remiss if we did not acknowledge the importance of stimulus generalization. Stimulus discrimination and stimulus generalization are like opposite sides of a continuum of stimulus control, and both emerge from the same process—differential reinforcement (Dinsmoor, 1995a). Whereas stimulus discrimination training produces the highest levels of a previously reinforced response in the presence of the S+—thereby narrowing the effects of reinforcement—stimulus generalization can be observed when the behavior reinforced in the presence of the S+ occurs in the presence of stimuli similar to but different from the S+—thereby broadening the effects of reinforcement (Dinsmoor, 1995a; Saunders & Williams, 1998). Extending stimulus control outside the boundaries of the school, clinic, or home is essential for learners to navigate a world full of auditory, visual, and auditory–visual simple and conditional discriminations—many of which they will never contact directly in a formal training program.

Conflicts of Interest The authors have no conflicts of interest to disclose.

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14 Instructive Feedback: Applications in Applied Behavior Analysis

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Instructors, in general education and special education settings, are often required to teach a wide variety of skills and maximize instructional time. Effective and efficient teaching procedures not only produce positive outcomes but may do so in less time (Caldwell et al., 1996). The efficiency of a procedure can be assessed in a variety of ways, including, but not limited to, the number of trials to meet mastery, the number of learner errors, preparation time prior to implementation for a procedure, or the total amount of teaching time for a learner to reach a mastery criterion (Campbell & Mechling, 2009). A procedure for increasing the number of acquired responses in the same or less instructional time is instructive feedback. Instructive feedback is a procedure that involves providing supplemental non-target stimuli in the consequent or antecedent portion of trials (Werts et al., 2003). For example, when teaching a learner to expressively label pictures (e.g., Superman) using discrete trial teaching, the instructor may provide additional information during the consequence (e.g., the instructor saying, "Yeah! He can fly."). This instructional strategy has been shown to increase the efficiency of effective programming (Caroll & Kodak, 2015; Reichow & Wolery, 2011). Although instructive feedback requires the instructor to deliver extra stimuli during a teaching trial, the learner is not required to respond in any way, and the instructor does not provide programmed reinforcement if the learner does respond. Research spanning over 30 years has demonstrated the effectiveness of this instructional technique (Albarran & Sandbank, 2019; Werts et al., 1995). Researchers have found that learners acquire at least some of the non-target stimuli provided during the instructive feedback portion of the trial (Ross & Stevens, 2003; Tullis et al., 2017; Wall & Gast, 1999). Additionally, the acquisition of the non-target stimuli does not interfere with the learning rate of the target stimuli (Holcombe et al., 1993). This is an important finding as it suggests that adding extra information to the learning trial does not interrupt learning the target skill.

Instructive feedback can be used with a variety of learners and instructors. Studies have shown instructive feedback to be an effective procedure for learners diagnosed with autism spectrum disorder (ASD; Ledford et al., 2008; Werts et al., 2011), learners with intellectual disabilities (Caldwell et al., 1996; Colyer & Collins, 1996; Fetko et al., 2013; Werts et al. 2011), learners with speech and language impairments (Werts

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et al., 2011), and typically developing learners (Griffen et al., 1998; Whalen et al., 1996). This has positive implications for use in behavioral intervention, special education, general education, and inclusive settings. Due to the fact that there is no requirement for the learner to respond to the instructive feedback and no requirement for the instructor to provide reinforcement for responding to the instructive feedback, it is a relatively simple procedure to implement. Instructive feedback can also be used in one-to-one or group teaching environments (Doyle et al., 1990a; Lane et al., 2015; Tullis et al., 2019). In a group environment, learners in the group may acquire additional targets through observational learning (e.g., Lane et al., 2015; Leaf et al., 2017). Instructive feedback has been used to teach skills related to daily living (e.g., Cromer et al. 1998; Griffen et al., 1998; Jones & Collins, 1997; Parrot et al., 2000), academic skills (e.g., Appleman et al., 2014; Fetko et al., 2013; Ross & Stevens, 2003), and social skills (e.g., Colozzi et al., 2008; Grow et al., 2017; Lane et al., 2015). Additionally, targets selected for instructive feedback can be related or unrelated to the target stimuli, which provides endless options for additional skills to be taught with minimal additional effort. The purpose of this chapter is to explore the use of instructive feedback in various treatment packages, highlight the benefits of using instructive feedback, and provide a review of the current literature on instructive feedback.

Variations of Procedure

Instructive feedback has been used to expose clients to non-target, or secondary, stimuli in a variety of ways. It can be provided as part of the antecedent or consequence portion of a trial. The secondary targets presented may or may not be related to the primary targets of an acquisition program. Additionally, the schedule of presentation of instructive feedback can be provided on a continuous schedule or on an intermittent schedule throughout teaching trials.

Antecedent Versus Consequence

When instructive feedback is provided as part of the antecedent portion of a trial, secondary target information is provided in addition to a discriminative stimulus or prompt and occurs prior to a response from the student (Haq et al., 2017; Jones & Collins, 1997; Nottingham et al., 2017; Vladescu & Kodak, 2013; Wolery et al., 2000). For example, Jones and Collins (1997) taught microwave skills to three adults with disabilities. The primary target skill was safely using a microwave and was taught using a task analysis. The secondary targets were nutritional information related to the cooking task. The secondary target information during this procedure was provided in the antecedent condition along with a prompt if the target skill was not performed. For example, when preparing food, if the participant did not initiate the step of adding water, the instructor provided the prompt, "You will need water" along with the instructive feedback "You should be drinking six cups of water each day to stay healthy." Instructors also provided instructive feedback in the consequent portion of each trial paired with praise if the participant performed the step correctly. Similarly, this consisted of nutritional information related to the task. Nottingham et al. (2017) also provided instructive feedback as part of the antecedent condition and consequence portion of learning trials to two children diagnosed with ASD. The instructor provided the secondary target information in the antecedent portion of the trial prior to presenting the antecedent stimuli relevant to the primary task. In another condition, two secondary targets were presented at the end of each trial. The participants in the study acquired the secondary targets that were presented in the antecedent and consequence condition. Nottingham and colleagues found that by providing the secondary feedback in both portions of the trial, the participants have more opportunities to be exposed to the non-target information and potentially leads to more efficient teaching. While these studies provided some evidence of the effectiveness of instructive feedback used in the antecedent portion of a trial, the majority of studies evaluating instructive feedback have used instructive feedback solely in the consequence portion of a teaching trial.

In a review of 54 studies using instructive feedback for people with disabilities, 49 used instructive feedback only in the consequence portion of a trial (Albarran & Sandbank, 2019). Instructive feedback delivered in the consequence portion of the trial presents somewhat differently in discrete learning trials versus task analysis procedures. During discrete trial teaching, instructive feedback is presented at the end of every trial in addition to programmed consequences of the primary target (e.g., Appelman et al., 2014; Gursel et al., 2006; Loughrey et al., 2014). When used in task analysis procedures, the instructive feedback is provided after each step is performed in the chain (e.g., Collins et al., 2017; Fiscus et al., 2002).

Appelman et al. (2014) targeted English sight words for four children with mild delays in a discrete trial format. For each trial, the instructors provided the child with an English written word. Following a prompted or unprompted response, the instructor provided praise and instructive feedback (e.g., "Great job saying padre. Padre is dad in Spanish.") after being presented with the English word (e.g., "Dad") on each trial. Similar procedures have been used while targeting letters of the alphabet and providing instructive feedback in the form of the corresponding letter sound in the consequent portion of the trial (Campbell & Mechling, 2009).

A common area of focus for adolescents and young adults with disabilities is vocational and job-related skills. It is often important for educational settings to teach these skills to prepare students for the future while adhering to a core academic curriculum. Research has used instructive feedback to target these skills when teaching using task analyses. Collins et al. (2017) embedded non-target information in the form of science content while learners performed the task of taking care of a plant. After the participants performed each step of the task, the researchers provided non-target information about photosynthesis as a rationale for the step being performed. In this way, instructive feedback facilitates acquisition of skills in more than one content area that increases instructional efficiency.

Classification of Targets

Information provided as instructive feedback can be classified into three different categories: parallel, expansion, and novel. Parallel stimuli refer to stimuli that target the same type of skill in a different form (e.g., target information is written numbers, parallel information is the roman numeral of that number). Werts et al. (1995) provided parallel information by targeting coin values as the primary target (e.g., $0.25) and the corresponding value as words as the secondary target (e.g., "twenty-five cents"). Expansion stimuli extend the concept of the primary target (Albarran & Sandbank, 2019). Ferguson et al. (2020) provided expansion targets by targeting superhero names as the primary target (e.g., Storm) and the corresponding superhero's power as the secondary target (e.g., "she can control the weather"). Novel stimuli are used in instructive feedback by providing information that is unrelated to the acquisition targets (Albarran & Sandbank, 2019). For example, Whalen et al. (1996) directly taught single-digit addition math facts (e.g., 3 + 2, 4 + 4) while targeting sight words (e.g., cheese, enter) using instructive feedback. When instructors use novel stimuli in instructive feedback, educators are able to target multiple goal areas and decrease time spent directly teaching each skill. While expansion targets are most commonly used in the instructive feedback research (Albarran & Sandbank, 2019), using novel targets in instructive feedback has been shown to be effective as well. Targeting different types of stimuli in instructive feedback procedures allows instructors flexibility when creating teaching programs because the information provided in the instructive feedback can be acquired regardless of its relationship to the targeted topic or skill (Fetko et al., 2013; Grow et al., 2017; Haq et al., 2017).

Schedule of Delivery

Another way that instructive feedback allows for flexibility in teaching is the schedule of delivery. Instructive feedback can be provided on every teaching trial or every few trials (e.g., Cromer et al., 1998; Griffen et al., 1998; Nottingham et al., 2020). For example, Griffen et al. (1998) compared two schedules of delivery to determine the efficiency of each schedule of instructive feedback. Two sets of target words were selected for acquisition. Two instructive feedback stimuli were selected for each target behavior, presented on two different schedules: (a) one on a continuous schedule (i.e., presented on every trial), and (b) the other on an intermittent schedule (i.e., presented every fourth trial). Acquisition of secondary targets provided during instructive feedback was assessed prior to teaching and following the participants reaching the mastery criterion for the primary targets. The researchers examined efficiency measures including the number of probe sessions required to meet the mastery criterion number of errors during probe sessions and the duration of instructional time. Griffen et al. found that, on average, there were fewer probe sessions per student required to meet the mastery criterion with a continuous schedule (i.e., 17.2) compared to the intermittent schedule (i.e., 18.8), more frequent errors with the continuous schedule (i.e., 25) compared to the intermittent schedule (i.e., 24.2), and more instructional time with the continuous schedule (i.e., 4 h 19 min) compared to the intermittent schedule (i.e., 3 h 33 min). Based on these results, there are no substantial differences in the efficiency of using a continuous schedule versus an intermittent schedule. In a replication and extension of Griffen et al. (1998), Nottingham et al. (2020) compared a continuous schedule of instructive feedback to two different intermittent schedules in which instructive feedback regarding the secondary targets was presented on every fourth trial or every other trial. The results of their evaluation found that the intermittent schedules of instructive feedback led to the lowest mean training time per target and to the more efficient acquisition of the secondary targets (Nottingham et al., 2020).

Taken together, the aforementioned studies suggest that instructors may choose a schedule for instructive feedback based on preference for the teaching procedures and other relevant variables in their educational setting, and learners are still likely to acquire the secondary targets at similar rates. For example, if an instructor would like to spend less instructional time teaching a skill, they could choose an intermittent schedule. This schedule may require more response effort on the part of the instructor. Their behavior would have to change throughout the session and between trials instead of a consistent presentation on every trial, so skill level and final educational objectives still need to be considered when choosing a schedule of presentation for instructive feedback.

Modalities

Instructive feedback can vary by modality as well. It can be provided vocally (e.g., Delmolino et al., 2013; Gursel et al., 2006; Jones & Collins, 1997), visually (e.g., Ledford et al., 2008; Wolery et al. 2000), through modeling (e.g., Grow et al., 2017; Parrott et al., 2000), or a combination of modalities (e.g., Falkenstine et al., 2009; Grow et al., 2017). Ledford et al. (2008) provided instructive feedback visually with community signs. In this study, expressive identification of words related to community signs was targeted for acquisition. The visual stimuli provided as instructive feedback was a picture of the community sign. Wolery et al. (2000) used sight words as a primary target and additional, unrelated sight words as the visual instructive feedback. Other studies have provided secondary targets vocally. For example, Delmolino et al. (2013) targeted labeling animals, school supplies, and kitchen utensils as the primary targets. Following the student's response, instructors provided praise and vocal instructive feedback by verbally providing a feature or function of the original target. These modalities of presentation have been used alone, in conjunction with each other, or in conjunction with modeling. When presented together, the visual stimulus is paired with a verbal label or description that can be related or unrelated to the primary targets. For example, Tullis et al. (2017) provided visual and vocal stimuli during instructive feedback. In their study, students were required to receptively identify a social dilemma as depicted in a picture when presented with the cue, “Where is the problem?” or something similar. Following the selection of a picture, the instructor held up the picture and described the problem that was represented (e.g., “This is a problem because her shoes are missing so she will get cold”). A few studies have presented instructive feedback by modeling a response, usually in conjunction with another modality. In one example of these studies, Grow et al. (2017) targeted labeling common features of animals, food, or objects as their primary response. Using instructive feedback, the instructor modeled a play behavior with a toy and measured play behaviors as their secondary targets. When the instructor modeled the play response, they also provided a verbal narrative or statement of the play behavior as the response was occurring (e.g., place a toy pizza on a tray, put the tray in the oven, and say, “I’m hungry”).

Populations

Instructive feedback has been shown to be effective with a variety of populations that span across diagnoses and age groups. Most commonly, the procedure is used with individuals diagnosed with ASD or intellectual disabilities (Albarran & Sandback, 2019). However, there is some research to support its use with disabilities such as attention deficit hyperactivity disorder (e.g., Caldwell et al., 1996; Fetko et al., 2013), Down syndrome (e.g., Fetko et al., 2013; Griffen et al. 1998; Singleton et al., 1995), emotional behavioral disorders (e.g., Fetko et al., 2013), as well as individuals with speech and language impairments (e.g., Colyer & Collins, 1996; Ledford et al., 2008). Instructive feedback has also been used with typically developing individuals in educational environments (e.g., Parker & Schuster 2002; Werts et al., 1996; Whalen et al., 1996).

Research has shown that using instructive feedback may be beneficial for teaching aspects of verbal behavior including tact relations and intraverbals, as well as play behavior for children diagnosed with ASD. Instructive feedback during skill acquisition programs related to tact training with children with ASD has led to the acquisition of secondary targets in the absence of direct teaching (e.g., Leaf et al., 2017) in which all participants in the study not only acquired the primary targets but also acquired the secondary targets through the use of instructive feedback. Individuals diagnosed with ASD often engage in rote responding and may be inflexible to adjust topics of conversation as necessary when engaging in social interactions with others (Lee et al., 2020). This can lead to a lack of variability when responding to others, unnatural interactions with others, and exclusion from peer groups (Stauch et al., 2017). Carrol and Kodak (2015) examined the use of instructive feedback to increase variability in intraverbal responses for two individuals diagnosed with ASD. When providing instructive feedback during the consequent event of a learning trial, the interventionist modeled response variability. For example, if the instructor asked, “Tell me three shapes,” and the participant responded with three shapes, the instructor provided praise for their response and said three additional shapes. This procedure resulted in increased response variability in the absence of programmed reinforcement. Another interesting use of instructive feedback for individuals diagnosed with ASD is the incorporation of unrelated targets when providing instructive feedback. As described previously, Grow et al. (2017) provided instructive feedback during tact training, but instead of providing instructive feedback in the form of a tact, they provided feedback in the form of play behavior. They found that tact training with instructive feedback resulted in fewer sessions for acquisition, and the play behavior provided during instructive feedback was acquired as well. These studies demonstrate the usefulness of instructive feedback to increase the efficiency of targeted skill acquisition as well as the acquisition of additional targets not directly reinforced for individuals diagnosed with ASD.

Similarly, this technique has been successful to teach aspects of functional life skills with individuals diagnosed with intellectual disabilities. Cromer et al. (1998) provided instructive feedback regarding prescription information in the consequence portion of teaching trials for middle school students diagnosed with an intellectual disability. Probe sessions were conducted prior to training trials and following training trials to determine the acquisition of instructive feedback stimuli. They found that the students' percentage of correct responses to questions about prescription details provided with instructive feedback was higher following the training trials. Many individuals with disabilities take daily medications, and using instructive feedback could increase efficiency in acquiring this type of life skill and lead to greater independence in adulthood. Taylor et al. (2002) used a task analysis to teach laundry skills to young adults with intellectual disabilities. They also presented words related to the laundry routine (e.g., delicates, temperature, cycle) on index cards throughout the task analysis as instructive feedback targets. Prior to instructive feedback, participants did not identify any of the related words. Following the intervention, the participants identified an average of 81.3% of the laundry-related words. Again, using instructive feedback was beneficial in teaching complex functional targets that contribute to a greater level of independence for individuals diagnosed with an intellectual disability.

Some studies have examined the use of instructive feedback for participants with varying diagnoses. For instance, Werts et al. (2011) included high school students diagnosed with ASD, Down syndrome, speech and language impairments, and seizure disorder. Three of the four participants acquired vocabulary related to civics information that was presented as instructive feedback. Parrott et al. (2000) also included participants with Down syndrome, ASD, Tuberous Sclerosis, and seizures. Instructive feedback was provided while the participants completed a hand-washing task. All participants increased the percentage of correct responses when responding to questions about the instructive feedback targets following training. The success of instructive feedback in acquisition with multiple disabilities provides a solid foundation for its use across varying populations.

Instructive feedback also has the potential to be used in inclusive settings with positive outcomes for students with disabilities and their typically developing peers. In a small group setting, Parker and Schuster (2002) examined the acquisition of instructive feedback and observational learning stimuli for two students with intellectual disabilities and two typically developing students between the ages of 15 and 19. Target stimuli and instructive feedback stimuli were presented to students in a group setting. Specific target stimuli were assigned to each student (e.g., cooking sight words, job-related sight words, prefixes, and chemical element abbreviations) and were presented on index cards. The instructor called the student's name, presented the index card with the target stimuli, and then provided the instructive feedback stimuli after the student's response. Instructive feedback information was related to the target stimuli (e.g., element abbreviations and type of element). The observational learning stimuli were the primary and secondary instructive feedback targets presented to other students in the group. Results showed that instructive feedback stimuli for target skills were acquired for three of the four students (range: 25–83%), observational learning of other student's target stimuli occurred for three of the four students (range: 9–38%), and some of the instructive feedback stimuli provided for other students' target stimuli were acquired for all participants (range: 13–59%). While there was some level of acquisition of instructive feedback for target stimuli, peers' target stimuli, and peers' instructive feedback stimuli, the complexity of the target skills and instructional feedback varied based on the cognitive functioning level of the participants. It is possible that some of the targets were more difficult to acquire because of the increased complexity, and this should be considered when choosing peer groups and future targets for observational learning stimuli.

Effects of instructive feedback have been demonstrated across multiple age groups as well. Research has demonstrated skill acquisition of primary targets and secondary information with participants as young as 3 years old and participants as old as 45 years old. Vladescu and Kodak (2013) provided secondary targets in the antecedent and consequence portion of the learning trials to teach tacting to four children with ASD. Their youngest participant was 3 years old and mastered all primary and secondary targets. Additionally, Vladescu and Kodak found that the conditions involving secondary targets for this participant required the least amount of training time per target. Jones and Collins (1997) evaluated the effectiveness of instructive feedback while teaching adults with intellectual disabilities microwave skills. Their oldest participant was 45 years old. This participant mastered all three microwave cooking skills and demonstrated acquisition of secondary targets (nutrition and safety facts) when assessed during post-tests. The participant also demonstrated maintenance and generalization of the primary targets.

Instructional Contexts

Instructive feedback has been demonstrated to be effective across many instructional contexts including one-to-one instructional formats and small and large group settings. Instructive feedback has also been successfully used in school, clinical, home, and telehealth settings. Across these varying instructional contexts, researchers, teachers, behavior interventionists, and peers have successfully implemented instructive feedback.

Groupings

Research on instructive feedback procedures has been commonly implemented in a one-to-one format in which there is one instructor and one learner (Albarran & Sandbank, 2019). One of the earliest studies published using instructive feedback occurred in a one-to-one format (i.e., Doyle et al., 1990b). Doyle et al. (1990b) used a constant time-delay procedure to teach sight words to three children diagnosed with developmental delays in a one-to-one format. Instructive feedback was provided regarding the action/function of the corresponding sight word (e.g., ball is something you throw). The results demonstrated the children learned the targeted sight words and the action/function of the targeted word provided as instructive feedback. In a more recent study, Tullis et al. (2017) used instructive feedback to teach a child diagnosed with ASD in a one-to-one format to identify a problem (e.g., batteries missing from a toy) and why it was a problem (e.g., the toy cannot work). Tullis and colleagues found that the use of instructive feedback resulted in the child learning nine out of ten of the secondary targets without direct teaching. This study was also unique in that the child participant used an augmentative or alternative communication device.

Research on instructive feedback has also been commonly implemented in small and large group settings. When instructive feedback is used in a group setting, there are additional opportunities for observational learning of primary and secondary targets for other members of the group. Research using instructive feedback in group settings has occurred with dyads (e.g., Appelman et al., 2014; Ferguson et al., 2020; Lane et al., 2015; Ledford et al., 2008; Singleton et al. 1995; Wall & Gast, 1999; Werts et al., 2003), groups as small as three (e.g., Campbell & Metchling, 2009; Falkenstine et al., 2009; Holcombe et al., 1993; Jones & Collins, 1997; Keel & Gast, 1992; Leaf et al., 2017; Ross & Stevens, 2003), and as large as an entire classroom of students (e.g., Werts et al., 1996). In a recent example, Leaf et al. (2017) evaluated the use of instructive feedback in a group of three learners diagnosed with ASD to teach superhero names (i.e., primary targets) and the corresponding superhero's power (i.e., secondary targets). The results demonstrated that all participants learned their designated primary and secondary targets and their peer's primary and secondary targets through observational learning. Leaf and colleagues demonstrated that when instructive feedback was used in a group setting, the participants acquired six targets in the same amount of time it took to master one target. This study is just one example of how targeted skills can be acquired effectively and efficiently when observational learning opportunities are coupled with the information acquired through instructive feedback.

Settings

Instructive feedback procedures have occurred in a variety of settings including special education classrooms (e.g., Anthony et al., 1996), self-contained or resource classrooms (e.g., Olszewski et al., 2017), general education classrooms (e.g., Whalen et al., 1996), clinical settings (e.g., Tekin-Iftar et al., 2008), community settings (e.g., Fiscus et al., 2002), preschool (e.g., Doyle et al. 1990b), and home settings (e.g., Ferguson et al., 2020). School classroom settings have been used most frequently in the instructive feedback literature, followed by clinic settings and then community and home settings (Albarran & Sandbank, 2019). No differences have been demonstrated in the acquisition of instructive feedback targets across settings, but some variables should be taken into account when considering the use of instructive feedback within various settings. One consideration is the selection of primary and secondary targets. For example, if the target skills are related to self-help or vocational skills, then a community setting may be more beneficial in which to teach the targeted skill. If the target skills are academic, a classroom or school setting may be more beneficial. If the target skills are social, teaching in a setting in which you have access to other learners would be beneficial. These examples of target skills and corresponding settings highlight the importance of teaching in settings that have the relevant stimuli desired to obtain control over responding. Another consideration is the desired number of targeted skills. A one-to-one setting may be sufficient when teaching a limited number of skills. However, a school setting, or settings in which multiple learners are present, may permit more observational learning opportunities without increasing instructional time when targeting a large number of skills. Another consideration is access to in-person settings. In-person behavioral intervention is not always accessible for individuals diagnosed with disabilities for a variety of reasons (e.g., rural locations, health guidelines). When this is the case, direct instruction via telehealth may be a viable option. Ferguson et al. (2020) evaluated the use of instructive feedback in dyads with instruction delivered directly via telehealth. This modality of instruction was found to be effective, and participants learned their respective primary targets, secondary targets, and their peer's targets through observational learning.

Instructors

Instructive feedback procedures have also been used by a variety of instructors, including researchers (e.g., Johnson et al., 1996), paraprofessionals (e.g., Colozzi et al., 2008), therapists (e.g., Vladescu & Kodak, 2013), special education teachers (e.g., Tekin-Iftar et al., 2003), speech-language pathologists (e.g., Shelton et al., 1991), and peers (e.g., Collins et al., 1995). In a recent review of the instructive feedback literature, Albarran and Sandbank (2019) found researchers to most commonly implement instructive feedback procedures, followed by teachers, paraprofessionals, behavior therapists, and then peers. This stands in contrast with an early review of the instructive feedback literature that found teachers to most commonly implement instructive feedback procedures (Werts et al., 1995). It is not surprising that so many different types of teaching professionals have implemented instructive feedback procedures due to the ease of their implementation. When peers have been used to implement instructive feedback procedures, the results have been similar (e.g., Collins et al., 1995; Fetko et al., 2013). For instance, Fetko et al. (2013) used peer tutors to provide science facts as instructive feedback while the participants learned to play UNO. Results showed that two out of the three participants acquired the secondary targets provided as instructive feedback by their typically developing peers. Notably, missing from the list of instructors that have implemented instructive feedback is parents and caregivers. The potential benefits of instructive feedback provided by parents outside of therapeutic and educational settings are currently unknown.

Future research evaluating instructive feedback procedures should evaluate parent and caregiver use of instructive feedback procedures. Future research should also evaluate methods of training parents and caregivers to implement instructive feedback procedures into teaching and learning opportunities that naturally occur in the child and parent's home and community settings.

Other General Research Findings

Skill Acquisition

The research evaluating instructive feedback has demonstrated the procedure to be effective and efficient to teach additional non-target stimuli, but the rates of acquisition for secondary targets have varied across studies. In a review of 23 studies using instructive feedback between the years of 1989 and 1994, Werts et al. (1995) found the net gain to be 58.2% of targets acquired through instructive feedback across all participants and studies reviewed. More recently, Albarran and Sandbank (2019) reviewed 54 studies that evaluated instructive feedback procedures and found that an average of 64% (range, 0–100%) of participants learned their instructive feedback targets. More research evaluating the conditions under which participants learn all instructive feedback targets, some instructional feedback targets, or none of the instructional feedback targets is warranted, but it is important to note that learner acquisition of the primary targets never affected the instructive feedback provided. Relevant prerequisite skills, such as attending and an echoic repertoire, should also be documented in future studies to assess which prerequisite skills are necessary for learners to acquire the instructive feedback targets.

Albarran and Sandbank (2019) also evaluated the overall participant gain of their peer's primary targets and secondary targets when instructive feedback procedures were evaluated in a group or dyad arrangement. Across 15 studies, Albarran and Sandbank found that acquisition of peer's primary targets averaged 59% (range, 16–95%) and acquisition of peer's instructive feedback targets averaged 55% (range, 19–99%). That is, the overall percentage of acquisition of observational learning targets was only 4% lower than the overall percentage of acquisition for participant's instructive feedback targets. This may be the case because learners in a dyad or group may already engage in behaviors that are likely to lead to successful learning in a group setting (e.g., attending for longer durations, active responding, generalized imitative repertoire). These prerequisite skills likely facilitate observational learning in the absence of direct teaching. Similar to the acquisition of instructive feedback targets, future research should focus on determining the conditions under which learners acquire their peer's primary and secondary targets and specific prerequisite skills that may increase the likelihood of target acquisition through observational learning.

Maintenance

Werts et al. (1995) found maintenance data to be reported in eight of the 23 studies (i.e., 34.8%) and Albarran and Sandbank (2019) found maintenance data to be reported in 13 out of 54 (i.e., 24.1%) studies reviewed. Taken together, maintenance data has rarely been reported in the instructive feedback research. When maintenance data has been reported, the results have varied with some participants maintaining their behavior from intervention to maintenance, some responding at lower rates compared to intervention, and some participants responding at higher rates compared to intervention (Albarran & Sandbank, 2019; Werts et al., 1995). More maintenance data is needed in the instructive feedback research. If instructive feedback targets are acquired by a learner but data on the maintenance of the targets learned is not collected, then the effectiveness of the instructive feedback procedure is unknown when it comes to maintaining the responses learned over time. It will also be important to assess the maintenance of the instructive feedback targets learned and targets acquired through observational learning in a group setting. It may be the case that targets learned through instructive feedback or observational learning do not maintain as long as targets learned through direct teaching. If this is the case, then more formal teaching may be required for the learned responses to maintain in a learner's repertoire.

Generalization

Albarran and Sandbank (2019) found generalization measures of instructive feedback targets to be reported in 9 out of 54 studies (i.e., 16.7%). When generalization measures were reported, they averaged 66% (range, 38–86%) across settings and instructors. This is another area in the instructive feedback literature that requires more research. The generality of behavior change is a hallmark of applied behavior analysis (Baer et al., 1968), and it is important to assess if the learned behaviors occur in other settings, with other people, with other related similar behaviors, and in the terminal environment. If reported generalization measures in the instructive feedback literature are consistently low, instructors would then need to develop generalization training procedures in order to ensure the learned behaviors generalize (Stokes & Baer, 1977).

Social Validity

Measures of social validity in the instructive feedback literature were not analyzed in the previous literature reviews (i.e., Albarran & Sandbank, 2019; Werts et al., 1995), but the assessment of social validity is present in some of the research on instructive feedback. Social validity is defined as the assessment of the social significance of a treatment's goals, outcomes, and procedures (Wolf, 1978) and is commonly underreported in behavior analytic journals (e.g., Carr et al., 1999; Ferguson et al., 2019; Kennedy, 1992). The percentage of instructive feedback studies including social validity measures remains unknown, but several research groups have reported measures of social validity. Appelman et al. (2014) assessed social validity by providing a questionnaire to teachers and students regarding the success of the instructional procedures. The results of the questionnaire were positive, indicating that teachers agreed that the goals of the study were important (i.e., teaching English and Spanish sight words), found the small group arrangement to be appropriate, and agreed that the children learned the target words. Students also responded positively to the questionnaire and indicated that they enjoyed learning new sight words and enjoyed working with their partner and the instructor. Collins et al. (2017) assessed social validity by asking three questions to the students participating in the study. Students' responses to the questions indicated that the students enjoyed the community setting of the study (i.e., greenhouse), agreed that they learned information about photosynthesis, and three out of four students found that learning about plant care would be useful in the future. Colozzi et al. (2008) also used a questionnaire to assess social validity. They asked parents, preschool teachers, and paraprofessionals questions regarding the effectiveness of the procedures and the importance of the targeted skills. The majority of parents rated the methods and goals to be moderately important, and the majority of staff found the methods and goals to be very important. Overall, when social validity has been assessed in the instructive feedback literature, surveys and questionnaires to parents, instructors, and student participants have been used most frequently. Other instructive feedback studies that have used questionnaires to assess social validity include Ledford et al. (2008), Pennington et al. (2014), and Shepley et al. (2016). Future instructive feedback research should continue to assess the social validity of the procedures to ensure instructors find the procedures to be helpful and easy to implement throughout their sessions. Future studies could also evaluate the learner's preference for this procedure compared to other teaching procedures using a concurrent chain arrangement (Hanley, 2010).

Behavioral Mechanisms

Although the research evaluating instructive feedback has demonstrated the procedure to be effective and efficient in teaching additional non-target stimuli, the behavioral mechanisms as to why instructive feedback works are still unknown since programmed reinforcement or prompting of the response(s) never occurs. Possible explanations and variables that could explain the effectiveness of instructive feedback include observational and incidental learning (e.g., Werts et al., 2003), the presence of a naming repertoire (e.g., Nottingham et al., 2020), echoic repertoire (e.g., Leaf et al., 2017), attending skills (e.g., Nottingham et al., 2020), motivating operations (e.g., Ferguson et al., 2020), indiscriminable contingencies in the instructional environment (e.g., Werts et al., 2003), and an association between the primary and secondary targets (e.g., Werts et al., 2003).

Some researchers have discussed the possibility of indiscriminable contingencies in the teaching and probe environments and the link between the primary and secondary targets (e.g., Werts et al., 2003; Wolery et al., 1993). This may come about due to the research designs implemented that continually probe and assess for the acquisition of the secondary responses throughout baseline and intervention. Since the participants in the studies are exposed to the secondary target stimuli in the baseline, this may function as a cue that the targets are important and increase attending when the stimuli are presented in future trials. When using instructive feedback procedures, the instructive feedback is assigned to a primary target or behavior and the instructive feedback is either presented on every trial or intermittently during trials when the primary target is being taught through reinforcement procedures. This may form an association between the primary target and the secondary targets due to the secondary stimuli being inadvertently paired with reinforcement that is delivered contingent on correct responses to primary targets (Werts et al., 1995, 2003). These potential variables explaining the effectiveness of instructive feedback have been evaluated, and Werts et al. (2003) found that participants still learned instructive feedback targets even when they were not directly assigned to primary target behavior. Werts et al. (2003) also evaluated the potential confounding effects of daily probes on the acquisition of instructive feedback targets and found that daily probes did not affect participants' acquisition of the instructive feedback targets. Overall, Werts et al. (2003) concluded that these factors did not explain the effectiveness of instructive feedback procedures.

More recently, researchers have noted participants emitting echoic behavior following the presentation of instructive feedback (e.g., Dass et al., 2018; Ferguson et al., 2020; Nottingham et al., 2017, 2020; Vladescu & Kodak, 2013). Attending behaviors such as orienting toward stimuli, looking at stimuli, and commenting have been shown to accompany echoic behaviors (e.g., Ferguson et al., 2020; Nottingham et al., 2020). These behaviors have led researchers to suggest that a naming repertoire (Horne & Lowe, 1996; Miguel, 2016) is relevant to the acquisition of targets through instructive feedback. A bidirectional naming repertoire is a higher-order operant in which there is a two-way relationship between listener and speaker behaviors, and teaching one of those behaviors (e.g., listener behavior) is enough to establish both repertoires (i.e., speaker and listener behaviors) in the absence of direct teaching (Horne & Lowe, 1996; Miguel, 2016). The demonstration of a naming repertoire could explain why some learners acquire the targets presented during instructive feedback without directly teaching the responses. Currently, no research has evaluated the aforementioned possible behavioral mechanisms responsible for the acquisition of secondary targets. Future research could help fill this gap by designing research to specifically evaluate the effects of the presence or absence of various repertoires (e.g., assessing participant's naming repertoire prior to intervention and evaluating if the demonstration of a naming repertoire correlates with the acquisition of secondary responses targeted through instructive feedback).

Future Directions

Clinical

Due to the flexibility of the types of learners, types of instructors, instructional arrangements, and target skills for which instructional feedback procedures can be used, the clinical implications are vast. Currently, it is unknown how frequently instructive feedback procedures are programmed into general education, special education, or clinical settings. It is possible that instructive feedback procedures are used incidentally by instructors in these settings without realizing the benefits of this instructional practice. Clinically, instructive feedback procedures could be implemented throughout almost all programming. Instructive feedback procedures are simple to implement and can be embedded into the consequence of any trial. Additionally, research has demonstrated that instructive feedback procedures do not need to be implemented on a continuous schedule, meaning that if instructors do not provide instructive feedback after every trial in a clinical setting, the learners will still acquire the secondary targets at similar rates.

By using instructive feedback procedures in clinical practice, instructors could cut down on instruction time by strategically planning the instructive feedback targets. For example, in a special education classroom, a teacher could be conducting a science lesson while providing instructive feedback on relevant math goals for the learners in the class. Similarly, general education classrooms could benefit from implementing this behavior analytic strategy by maximizing instructional time in the same way. Multiple subjects in general education settings can be taught together such as math and science targets or reading and vocabulary. This could help teachers and paraprofessionals cover multiple goals in the same amount of instructional time.

Research

Although the instructive feedback literature is substantial, there are still many areas for potential future research. First, to the authors' knowledge, there have been no training studies conducted on how to train instructors or caregivers on the implementation of instructive feedback. Since instructive feedback procedures can be embedded throughout and across programs, this is an important skill for instructors to be trained on that will lead to more efficient and effective teaching. Second, future research should evaluate instructive feedback procedures with parents or caregivers implementing the procedure. Social validity measures should be taken when parents or caregivers are implementing instructive procedures to ensure the procedures are acceptable to their family and are a procedure that can be easily implemented in their everyday lives.

Another area of future research for instructive feedback would be manipulating the treatment integrity of the procedure. Similar to other behavior analytic research that has evaluated errors of commission during discrete trial teaching (e.g., DiGennero Reed et al., 2011), conditions could be arranged in which instructors systematically engage in treatment fidelity errors when providing instructive feedback to assess how important following a particular schedule of instructive feedback is to learner acquisition of secondary targets. This type of research would be helpful for determining how important it is to adhere to a specific schedule of instructive feedback delivery. This information would be especially helpful when it comes to having teachers, behavior therapists, and parents use instructive feedback procedures in more natural settings in which they may not be able to adhere to strict schedules of when to provide instructive feedback.

Future research should also explicitly evaluate the role of naming repertoire in the acquisition of instructive feedback targets. The results of which may help shed light on possible behavioral mechanism(s) at work when learners acquire these targets in the absence of direct teaching. Another area of future research would be to evaluate for which participants and under what conditions instructive feedback is the most appropriate. Doing so would help inform instructors of the most and least optimal conditions to implement instructive feedback. Finally, future instructional feedback research should prioritize examining measures of maintenance, generalization, and social validity. As it stands currently, these additional measures are only appearing at low rates in the literature. More measures of maintenance, generalization, and social validity are needed so that clinicians and researchers have more information regarding the maintenance of targets acquired through instructive feedback, the generalization of those targets learned, and the social validity of the procedures used.

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15 Generalization

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Definitions and Historical Background

Generalization is a broad term that has been described as an individual's responding to novel stimuli, their novel responding topographies, or responding that is maintained across time. The concept of generalization was introduced by B.F. Skinner (1965) in *Science and Human Behavior*, in which he described generalization as (a) the effect that stimulus control has on responses to stimuli that share similar qualities (i.e., responding can come under stimulus control for directly trained stimuli and for stimuli that share similar qualities), and (b) the effect reinforcement has on directly trained responses and untrained responses (i.e., an increase of non-targeted responses can occur when reinforcement is provided for a specific behavior).

Baer et al. (1968) described generalization as part of the seven dimensions of applied behavior analysis as *generality*. When describing generality, Baer et al. noted that behavior change must be "durable over time… appear in a wide variety of possible environments, or… spreads to a wide variety of related behaviors" (p. 96) to be considered as generalized. That is, generalization describes the occurrence of behaviors that (a) are sustained across time (i.e., response maintenance); (b) occur across various untrained materials, places, people, and contexts (i.e., stimulus generalization); or (c) are emitted as untrained responses (i.e., response generalization). Stokes and Baer (1977) later expanded upon the definition of generalization by noting that for one to claim the occurrence of generalized behavior change, such behaviors must occur with no "extratraining changes" or when some "extra manipulations" are necessary, but less costly than direct training (p. 350). Stokes and Baer described seven strategies used to promote generalization of behaviors, including (a) train and hope, (b) sequential modification, (c) introduction of natural maintaining contingencies, (d) training sufficient exemplars, (e) training loosely, (f) use of indiscriminable contingencies, and (g) programming for common stimuli. Stokes and Osnes (1989) further refined the strategies presented by Stokes and Baer by focusing solely on programming tactics for generalization changes. Specifically, whereas Stokes and Baer presented a combination of assessment tactics (e.g., train and hope) and programming tactics (e.g., train loosely), Stokes and Osnes described 12 programming tactics organized in terms of 3 generalization principles, which will be discussed in greater detail later in this chapter.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_15

Types of Generalization

Response Maintenance Response maintenance, often referred to simply as maintenance, is the term that describes sustained responding across time when training components are removed. For example, if an individual is taught to request water and the request continues to occur days, weeks, and/or months after the request was directly trained, such responding can be considered maintained. This is so because the response continued to occur without assistance following the initial training (i.e., maintenance is demonstrated). When efforts are made to produce behavior change, it is imperative to consider how environmental variables will maintain favorable behaviors (e.g., functional communication) or unfavorable behaviors (e.g., aggression) across time; because behavior change outcomes should be practical and applicable. Conversely, if one does not consider environmental variables, adaptive behaviors may not be sustained and maladaptive behaviors suppressed for long periods of time. Such considerations might require the identification of naturally occurring contingencies, creating necessary schedules of reinforcement, and/or determining how reinforcement will be recruited, among other potential strategies.

Stimulus Generalization Stimulus generalization is the term that describes responding to untrained stimuli that share similar characteristics (e.g., materials, places, people, contexts). For instance, if an individual is taught to request water at their home, and the individual emits the same request for water at his school, such an occurrence can be considered stimulus generalization because the previously taught response was emitted in a new, untrained setting. The same would be true if the request occurred with novel people or with novel examples of water. Stimulus generalization is important for a variety of reasons. For example, it is not feasible for one to directly teach an individual to respond in a particular way to every single potential stimulus with which responding is desired, but instead responding must be generated without direct training across a variety of places, peoples, and materials. When planning for stimulus generalization, some have emphasized the importance of focusing on (a) developing *stimulus classes* and (b) developing *stimulus discriminations* between stimuli (e.g., Cuvo, 2003).

Stimulus Class A stimulus class is a group of stimuli that share common physical, temporal, or functional characteristics. For instance, a bottle of Dasani® water, Aquafina® water, and Evian® water can all be grouped under the same stimulus class of water because they share common characteristics (e.g., bottled, clear, consumable, liquid, water). If an individual is taught to request a bottle of Dasani® water by pointing to it, and untrained requests via pointing for other brands of water are subsequently emitted, then it can be said that stimulus generalization has occurred. Thus, the emergence of stimulus generalization can also be described as the emergence of untrained responding across stimuli within the same stimulus class. Cuvo (2003) recommended that the development of stimulus classes is strongly considered when producing stimulus generalization, because it may result in the emergence of generalization across other stimuli within their respective classes.

Stimulus Discrimination It is also important to take into consideration teaching stimulus discriminations when producing generalized behavior change to ensure responding occurs in appropriate contexts (and does not occur in inappropriate contexts). That is, if stimulus discriminations are not taught, it is possible for stimuli to exert excessive control over a response (this is sometimes referred to as *stimulus overselectivity*; Lovaas et al., 1971). A study by Horner et al. (1986) demonstrated how one could program to avoid overselectivity. Four participants with intellectual disability diagnoses were taught to bus tables by teaching appropriate and inappropriate times to clean the tables at a university cafeteria. The participants had to attend to (a) whether people were present, (b) whether food was eaten, (c) whether the dishes were empty, (d) whether garbage was present, and (e) the position of the stimuli on the table. Generalization probes across novel cafeterias demonstrated that the four participants generalized their responses to new settings and maintained discriminations between tables that should and should not be bussed. This study by Horner et al. demonstrated how stimuli class membership (i.e., to-be-bussed tables and not-to-be-bussed tables) can be "appropriately expanded and delimited" (Cuvo, 2003, pg. 81) through the development of stimulus classes and by teaching stimulus discriminations.

Response Generalization Response generalization is the term that describes the occurrence of novel, untrained responses. For example, if a child is taught to request water by reaching their arm out and making a "grabbing" motion, and the child later emits requests by pointing, then such occurrence can be considered response generalization because the individual emitted a topographically different response relative to the original response. Many scholars have noted that topographically similar, but different responses (e.g., pointing instead of reaching/grabbing) can be considered a form of response generalization (e.g., Kazdin, 1994; Mayer et al., 2011), whereas others have noted that responses may be physically dissimilar (e.g., saying, "Wah" instead of reaching/grabbing; Partington & Sundberg, 1998).

Response Class Some have noted that functionally equivalent consequences are an important part of response generalization (e.g., Carr, 1988). Based on this classification, response generalization can also be considered as the emergence of novel responses within the same response class (i.e., within the same group of functionally equivalent responses). Let us consider the example of the child requesting water again. If a child engaged in novel requests (e.g., pointing) for the same consequence (e.g., water being provided), then both the previously taught response and the novel response would be members of the same response class (i.e., they both resulted in the same consequence whereby water was provided).

Other Generalization Outcomes

Several other generalization outcomes have been observed and described in behavior-analytic literature, that do not classify seamlessly within the concepts described in the preceding sections. We provide a brief overview of them for clarity's sake.

Generative Responding Generalization is referred to as generalized behavior change, generality, or even induction in some cases. Although similar, these terms should not be confused with *generative responding* (i.e., generative verbal behavior, language generativity), which is a term that is typically used to describe novel responses that are used for other functions. One way this term is used is for describing novel responses that operate under joint stimulus control (Holth, 2017), such as the emergence of untaught tacts during direct mand training (e.g., Greer & Ross, 2008; Nuzzolo-Gomez & Greer, 2004). That is, if an individual is taught to request an item by stating its name, and then the individual uses the name of the item for another purpose (e.g., label it spontaneously to engage in a social interaction), then such occurrence would be considered generative responding. This term has also been used to describe novel language, typically referring to the capacity one has to produce and understand sentences that have never been seen, spoken, or heard (Hayes et al., 2001; Stewart et al., 2013).

Recombinative Generalization This term is used to describe "differential responding to novel combinations of stimulus components that have been included previously in other stimulus contexts" (Goldstein, 1983, pg. 280). For example, if a student is directly taught to select a "blue car" or "red airplane" and the student then is able to select "red car" or "blue airplane" without direct training, then such an occurrence could be considered a form of recombinative generalization. This kind of generalization is favorable because responding in the natural environment often requires the capacity to "combine" stimuli in various ways to produce a desired consequence. One clear example of this is an individual's ability to combine letters to create words, phrases, and paragraphs with different meanings without direct instruction for each word-letter combination. This kind of generalization outcome can be programmed and produced through *matrix training* (Pauwels et al., 2015).

Response Variability Sometimes referred to as *behavioral variability* or *operant variability*, response variability describes the extent to which responses sequentially vary from one another within a response class (Neuringer, 2002). This skill is valuable because it may help individuals come in contact with reinforcement more effectively when any one topography from the same response class contacts extinction (e.g., Adami et al., 2017). For example, an individual traveling in a country where his/her language is not spoken may exhibit practical variable responding. After a long day of touring, the individual walks into a shop, approaches the clerk, and asks for water by saying, "water?" The clerk looks at the individual and shrugs his shoulders. The individual then walks to the fridge and points to the water. The clerk says, "oh!" and proceeds to sell the individual a bottle of water. In this scenario, it is clear that response variability (e.g., varying from vocally stating "water" to pointing) was beneficial in that it increased the likelihood of producing reinforcement when one response, within the same class, was not reinforced. Teaching response variability can also be useful for preventing the resurgence of problem behaviors; an individual who has been taught behavioral variability is more likely to refrain from engaging in problem behaviors (e.g., aggression), and vary between socially appropriate alternative behaviors (e.g., requesting), when any one response experiences extinction (e.g., Adami et al., 2017; Falcomata et al., 2018; Hoffman & Falcomata, 2014).

Emergent Relations Emergent relations, sometimes called *derived relations* or *emergence of stimulus relations*, originated from equivalence-based instruction (EBI) literature and are used to describe the emergence of untrained relationships between stimuli (Sidman, 1971). Essentially, a derived relation occurs when an individual shows that one class of stimuli (e.g., the written word CAR) is the same as another thematically similar class of stimuli (e.g., the image of a car) without direct training. If an individual is able to show further associations with three or more thematically similar stimuli (e.g., the vocalization "car"), then that is considered *stimulus equivalence* (i.e., if CAR = image of a car, and the image of a car = "car", then CAR = "car"). Although research has shown that EBI has the capacity to promote substantial generativity, further explanation of this intervention on derived relations is outside the scope of this chapter. For more information, see Pilgrim (2020) or Fienup and Brodsky (2020).

Programming Tactics for Generalized Behavior Change

Exploitation of Current Functional Contingencies

The term "natural communities of reinforcement" has been used to refer to the natural contingencies that exist in individuals' environments (Stokes & Baer, 1977). Stokes and Baer (1977) asserted that increasing the chances that individuals' communities of reinforcement will come to control target responding (i.e., adaptive; maladaptive) promotes generalization. Subsequently, Stokes and Osnes (1989) discussed the strategy of *Exploitation of Current Functional Contingencies* as one strategy for programming for generalization. Specifically, Stokes and Osnes described several tactics that rely on the exploitation of environment-based functional contingencies, including (a) *recruitment of natural consequences,* (b) *contacting natural consequences,* (c) *modification of maladaptive consequences*, and (d) *reinforcement of occurrences of generalization*. Each of the tactics that comprise the strategy of *Exploitation of Current Functional*

Contingencies is similar in that they incorporate the systematic promotion of contact by target behaviors with environmental sources of reinforcement or punishment through the reliance on pre-existing (i.e., *contacting natural consequences)* or actively programmed (i.e., *modification of natural consequences*; *reinforcement of occurrences of generalization)* contingencies in the environment; or the intentional designation of target behaviors that are more likely to be reinforced and maintained in the natural environment resulting in generalization (i.e., *recruitment of natural consequences*).

Recruit Natural Consequences Stokes and Osnes (1989) described situations in which target behaviors may not be occurring in such a way to allow for naturally occurring contingencies to develop control and produce generalization. Perhaps the behavior is occurring below rates that are necessary for existing naturally occurring contingencies that do not have an opportunity to effectively maintain it. Or, in some situations, the form of the target behavior itself may be a hindrance to the effects of natural contingencies. In such cases, the targeting and training of behaviors that actively access natural contingencies may be necessary to promote generalization. This tactic, referred to as *recruitment of natural consequences*, is intended to facilitate contact of the behavior with environment contingencies that exist in the individual's natural environment. Said another way, the tactic utilizes an approach in which the individual is provided with the means to actively solicit reinforcement in the natural environment through systematic teaching and training to facilitate generalization.

Numerous examples exist in the behavioral literature that demonstrate the effectiveness of the tactic of recruitment of natural consequences. For example, Chambers and Rehfeldt (2003) conducted a study in which they evaluated the relative effects of teaching manual signs and Picture Exchange Communication System (PECS; Bondy & Frost, 1994) in terms of generalization of mands (i.e., a verbal response that specifies its reinforcer; Catania, 1992) across settings exhibited by four individuals with diagnoses of severe/profound mental retardation and intellectual disability. The authors first trained the participants to utilize the respective mands to request reinforcers. The results of the training phase suggested that three of the participants acquired PECS-based mands; two of the participants who acquired PECS-based mands also acquired manual signs. Next, the authors conducted across-setting generalization probes of the respective mands with each of the participants. The results showed that (a) all three of the participants who had acquired the PECS-based mands via direct training demonstrated generalization with the PECS-based mands, (b) the two participants who had acquired the manual signs via direct training demonstrated generalization with the manual signs, and (c) the two participants who had acquired both mand modalities utilized the PECS-based mands more often than manual signs to request preferred items that were not present in the individuals' environment. The overall results of Chambers and Rehfeldt demonstrated that specific behaviors (i.e., mands) could be trained that would allow individuals with moderate/profound disabilities to recruit reinforcement in their respective environments which resulted in the generalization of the behaviors.

Functional Communication Training (FCT; Carr & Durand, 1985) is one of the most common reinforcement-based treatments for problem behavior (Tiger et al., 2008). FCT consists of the teaching of functional communicative responses (FCRs; mands) that are intended to replace problem behavior in an individual's repertoire. Specifically, following an antecedent (e.g., Carr & Durand, 1985) or functional (e.g., Iwata et al. 1982/1994; Northup et al., 1991) analysis that systematically demonstrates the function(s) of problem behavior, a functionally equivalent mand is targeted and trained that allows the individual to contact the reinforcers that previously maintained problem behavior. Thus, the tactic of recruiting natural consequences is a central aspect of FCT and is inherent to the treatment (Falcomata & Wacker, 2012). Several studies (e.g., Durand & Carr, 1992; Moes & Frea, 2002) have evaluated the effects of FCT in terms of generalization with a specific reliance on the recruitment of natural contingencies component (i.e., in the absence of other tactics for programming for generalization). For example, Durand and Carr (1992) conducted a three-study experiment in which they (a) identified the functions via functional analyses of problem behavior exhibited by 12 children with a variety of diagnoses (e.g., autism; attention deficit disorder; developmental language disorder; i.e., Study 1), (b) evaluated and compared the effects of FCT and a time-out procedure within and across two groups of children (i.e., Study 2), and (c) evaluated and compared the extent to which the positive treatment findings in the second experiment would maintain and generalize to trainers who were unaware of the participants' treatment history (i.e., Study 3). The results of Study 2 showed that both FCT and the time-out procedure were effective at decreasing problem behavior. In contrast, the results of Study 3 showed that the children in the FCT group demonstrated generalization by emitting functional communicative responses with novel individuals and their problem behavior remained low during the generalization evaluation. Thus, the tactic of recruiting natural consequence may be said to have been active within the procedures implemented by Durand and Carr as the children in the FCT group exhibited functional communicative responses with novel adults and the positive treatment effects generalized. The results of Durand and Carr also showed that the effects of the time-out procedure were not replicated with the novel trainers; thus, generalization was not demonstrated with the time-out procedure. The results of Durand and Carr are interesting in that the generalization comparison (i.e., Study 3) may be characterized as a comparison between the effects of recruiting natural consequences (i.e., FCT) and what was essentially a train and hope approach (i.e., the time-out procedure); with recruitment of natural consequences clearly shown to be the effective tactic in the study.

Contact Natural Consequences Natural consequences are those that exist in the environment that are not specifically programmed in an artificial way (Stokes & Osnes, 1989). When skills are taught that subsequently contact naturally occurring reinforcers that exist in the individual's environment, lasting generalization and maintenance is more likely. Stokes and Osnes (1989) described the tactic of "contacting natural consequences" as "the most fundamental guideline of behavior programming, as well as generalization programming" (p. 341). The power of this tactic lies in its economic and efficiency features (i.e., behavior change agents and/or therapists do not need to explicitly identify, program, and embed artificial reinforcers in the natural environment for desired behavior to be strengthened and maintained in the natural environment; instances of generalized behaviors may be more likely to be reinforced consistently when the reinforcement exists naturally in the participant's environment).

In addition to utilizing the recruitment of natural consequence tactic, Durand and Carr (1992) also provided an example of the systematic use of the tactic of contacting naturally occurring reinforcers. As described above, following functional analysis of problem behavior and the assignment of participants to two treatment groups (i.e., FCT and time-out), both FCT and time-out were demonstrated to be effective. However, only the group that received the FCT treatment demonstrated generalization and maintenance in the presence of novel and naïve therapists. As the novel therapists were naïve to the procedures, they represented naturally occurring sources of reinforcement. In addition to recruitment of natural consequences and contact with naturally occurring reinforcers, additional tactics for programming for generalization were implicit within the procedures used by Carr and Durand (e.g., use of sufficient stimulus exemplars; use of sufficient response exemplars). Thus, the study also provides an example of how tactics can be combined and enhance the probability that target skills and behaviors will contact naturally occurring reinforcement.

Modify Maladaptive Consequences Stokes and Osnes (1989) discussed situations in which problem behaviors are under the control of powerful consequences. Subsequently, Stokes and Osnes conceptualized and characterized those consequences that maintain inappropriate behaviors as "maladaptive." Therefore, they asserted, the modification of such maladaptive consequences may be a necessary tactic in some situations to promote generalization. Specifically, Stokes and Osnes discussed the "termination of reinforcer delivery" for maladaptive behavior so that "more appropriate behaviors can be developed and maintained through natural or temporarily artificial consequences" (p. 343). This tactic, referred to as *modify maladaptive consequence*, is intended to facilitate contact of appropriate/adaptive behaviors with naturally occurring environment contingencies by decreasing "maladaptive" behaviors that have been previously functioning to produce those same environmental contingencies. In such cases, if maladaptive consequences are not modified, the appropriate behaviors intended for generalization may not sufficiently contact naturally occurring environment contingencies to produce generalization because maladaptive behaviors are continuing to contact those environmentally based reinforcers. Thus, allocation of responding will favor the maladaptive behaviors rather than intended generalized appropriate behavior.

As with the recruitment of natural consequences tactic, the tactic of modification of maladaptive consequence is often implicit to FCT. Specifically, FCT often includes an extinction component and, in fact, previous studies have demonstrated that extinction is, at times, a necessary component of FCT (e.g., Fisher et al., 1993). For example, Moes and Frea (2002) evaluated the generalization of FCT treatment effects across routines, family members, and contexts with three families with children with autism diagnoses who engaged in multiply-maintained problem behavior. All phases of the study were conducted in the home by family members during routines that had been identified as common during the day. Specifically, Moes and Frea (a) conducted an antecedent analysis to assist in the generation of hypotheses regarding functions of problem behavior, (b) tested their hypotheses via brief functional analyses to confirm the functions of problem behavior, (c) conducted FCT during one target routine, and (d) evaluated the extent to which FCT was effective during other routines (identified via collaboration with the family) with multiple family members implementing the treatment. In addition to the reinforcement of FCRs, extinction was a primary component of FCT during the initial FCT condition, the "Contextualized FCT" condition in which multiple routines and family members were targeted during treatment, and the generalization probes (i.e., probes taken during routines in which no direct training occurred) conducted during the initial FCT and "Contextualized FCT" conditions. The treatment results showed that the treatment effects of FCT (i.e., rates of FCRs were high; rates of problem behavior were low) successfully generalized as evidenced by the results of the generalization probes across untrained routines.

Punishment procedures have also been shown to be, at times, a necessary component for the success of FCT (e.g., Wacker et al., 1990). Similar to extinction, the embedding of punishment within FCT treatment arrangements constitutes the inclusion of the tactic of modifying maladaptive consequences. Wacker et al. (2005) provided an example of the inclusion of punishment in the form of time-out as a component during FCT as part of a systematic evaluation of generalization. Specifically, Wacker et al. conducted FCT with 23 children who engaged in escape-maintained problem behavior. The authors first conducted pre-treatment probes across stimuli/contexts (i.e., people, tasks, settings) with the results showing high levels of problem behavior across stimuli/contexts demonstrated by 12 of the 23 participants. Subsequently, the authors implemented FCT which included a time-out procedure for a subset of the participants. Following FCT, which produced high levels of FCRs and low levels of problem behavior, the authors implemented generalization probes (i.e., across novel/untrained people, tasks, and settings) with the 12 children who had engaged in problem behaviors during the pre-treatment probes. Substantial reductions in problem behavior were observed during the generalization probes with each of the untrained stimulus conditions.

Reinforce Occurrences of Generalization Although Stokes and Osnes (1989) referred to the tactic of reinforcement of occurrences of generalization "probably the least of the current 12 tactics to be called a legitimate programming strategy" (p. 343), the authors also characterized the tactic as possibly "a most reliable and legitimate technique that facilitates generalization." The tactic of reinforcement of occurrences of generalization is one in which instances of generalization are identified and consequated with stimuli intended to reinforce those instances; thereby increasing the likelihood that generalized responding will continue to occur.

Silbaugh et al. (2018) provided an example of the use of the tactic of reinforcement of occurrences of generalization within the context of programming for variable responding exhibited by two individuals with autism diagnoses. Specifically, Silbaugh et al. implemented lag schedules of reinforcement in combination with progressive time delays (TD) to facilitate the variable mand responding. The authors first implemented a lag 0 (e.g., fixed-ratio [FR] 1 schedule) condition in which reinforcement was delivered for any mands. No novel mands (i.e., response generalization) occurred during the lag 0 condition. Next, the authors implemented a Lag 1 plus TD condition in which they prompted (following delays; i.e., the TD component) specific and variable mands and reinforced prompted and independent variable mands via a lag 1 schedule of reinforcement (i.e., for a mand to be reinforced it had to be different from the immediately preceding mand). The authors also reinforced novel (i.e., untrained) mands that emerged during the lag schedule procedure in addition to reinforcing specifically prompted variable mands. In addition to demonstrating variability in mand responding during the lag 1 plus TD arrangement, both individuals also demonstrated novel mands during the procedure which were reinforced within the lag schedule (if they varied from the preceding mand). These novel mands constituted response generalization and the reinforcement provided within the lag schedule represented reinforcement of occurrences of generalization.

Schindler and Horner (2005) provided an additional example of the implicit use of the tactic of reinforcing occurrences of generalization within the context of FCT; specifically, when generalization did not occur as a result of the implicit tactic of recruiting natural consequences. Schindler and Horner (2005) first conducted FCT with three individuals with histories of engagement in problem behavior. The authors implemented FCT in several settings including (a) a one-to-one and (b) a preschool setting. In addition, the authors evaluated generalization in two non-training settings including (c) a non-training room at the preschool and (d) in the individuals' homes. Schindler and Horner found that although FCRs increased and problem behavior decreased in the training settings, levels of FCRs and problem behavior did not change in the non-training settings; thus, generalization did not occur. Following the authors' incorporation of additional procedures (i.e., "low effort"), including the active encouragement of care providers to make FCR materials available and to prompt and reinforce FCRs, FCRs increased and problem behavior decreased in the generalization settings. In addition to providing an example of the systematic use of the tactic of reinforcement of occurrences of generalization, Schindler and Horner's procedures also illustrated the approach described by Stokes and Osnes (1989) to "set up conditions for generalization of responding" in the form of making FCR materials available and actively prompting the occurrence of FCRs; and, in turn, reinforcing the occurrence of the FCRs in the generalization settings.

Train Diversely

Behavior-analytic research has consistently demonstrated that diverse and varied programming generally results in diverse and varied behavioral outcomes. Diverse training, whether it be for increasing responding to novel stimuli or producing novel responses, can be promoted through a variety of ways. Stokes and Osnes (1989) identified four prominent tactics that are consistent with the concept of training diversely including (a) *use sufficient stimulus exemplars*, (b) *use sufficient response exemplars*, (c) *make antecedents less discriminable*, and (d) *make consequences less discriminable*. The former two are similar in that they highlight the importance of using the necessary number of examples of stimuli or responses to produce the desired stimulus or response generalization. The latter two stress the significance of making the antecedent-response or response-consequence contingencies less discernible to an individual, such that responding by the individual is not just controlled by narrowly contrived stimuli, but instead that stimulus control is broaden to a diverse universe of antecedents and consequences.

Use Sufficient Stimulus and Response Exemplars This tactic, which is also sometimes referred to as *multiple-exemplar training* (MET), involves the direct training of various examples of a stimulus or direct training of various examples of a response. The logic for using a variety of examples is so that an individual learns that the trained examples are not distinct from one another (i.e., they are part of the same "class" or "universe"), which then hopefully translates into learning that similar untrained examples are not distinct from the directly taught examples (Holth, 2017). Emphasis on using a *sufficient* number of examples is made primarily because a clear number of required examples needed to produce generalization has not been empirically demonstrated (Holth, 2017). Thus, it follows that setting an arbitrary number of examples across individuals may result in using too few or too many exemplars (i.e., it is possible that too many unnecessary exemplars may be wasteful if less are needed, because doing so would require an unnecessary amount of time and resources).

Schroeder and Baer (1972) distinguished that the number of exemplars that are presented during training can be introduced in different ways: either by sequentially adding one exemplar at a time (i.e., serial MET [S-MET]), or by adding two or more exemplars simultaneously (i.e., concurrent MET [C-MET]). For example, Eikeseth and Nesset (2003) followed an S-MET approach to teach participants with phonological disorders to blend letter sounds, wherein they introduced one letter sound blend at a time until generalization to untrained blends was observed. Conversely, a study by Reeve et al. (2007) followed a C-MET approach to teach four participants with ASD to provide help to other people by introducing four different examples of situations where helping behavior should be emitted, such as helping someone carry heavy objects or finding lost items. Both studies demonstrated that their specific MET approach can produce generalized responding, which has been confirmed by other studies as well (e.g., Panyan & Hall, 1978; Schroeder et al., 1998).

Although there is evidence that S-MET and C-MET tactics are effective, it is unclear which specific arrangement is most efficient. A study by Schnell et al. (2018) noted that the corpus of MET studies has suggested C-MET is most effective, but that idiosyncrasies exist that may potentially favor S-MET in some cases. For instance, Schnell et al. compared the efficiency of S-MET vs. C-MET on tact acquisition and generalization and found that S-MET was most efficient because it produced the lowest mean training time per mastered exemplar for two of three participants; a finding that was inconsistent with previous MET literature that examined other skill domains (e.g., Schroeder et al., 1998; Wunderlich et al., 2014). Thus, it is important that those who pursue generalized behavior change consider that the number of sufficient exemplars needed may vary across individuals and skills, such that efforts for generalization may involve weighing multiple factors prior to determining the number of exemplars to use.

Stimulus Exemplars Research over the past 50 years has shown that stimulus MET can result in generalization across a variety of skill domains. For example, early in the inception of applied behavior analysis, Baer et al. (1967) demonstrated that direct training of various imitation exemplars with people with intellectual disabilities resulted in the emergence of independent imitations of novel imitation models, which was then used to develop their verbal behavior. Likewise, Schnell et al. (2018) showed that using various examples of stimuli to teach tacts resulted in independent tacts to novel examples of those same stimuli.

When teaching various stimulus exemplars, it might also be useful to teach "don't do it" examples as well; that is, when a response should not occur or when a response will not come in contact with reinforcement. For instance, a study by Taylor-Santa et al. (2014) demonstrated how this could be accomplished with neutral stimuli by teaching three participants with ASD the difference between neutral stimuli that would signal the occurrence of reinforcement (i.e., discriminative stimuli [S^D]) and neutral stimuli that would signal nonoccurrence of reinforcement (i.e., stimulus delta; [S-delta]) through stimulus–stimulus pairing and discrimination training. First, the researchers paired preferred edibles with neutral stimuli when target responding occurred. Then, the researchers exposed the participants to trials involving S-delta stimuli, which were interspersed between S^D trials, in which no reinforcement was delivered even if an independent target response occurred. Their results showed that previously neutral stimuli acquired either an S^D or S-delta value based on the way reinforcement was delivered for one and not the other. One valuable implication from this study, as it relates to using sufficient exemplars, is that it may be useful for practitioners to consider how the use of various praise exemplars (while also embedding "don't do it" examples) could result in "a broader range of verbal stimuli that will have reinforcing effectiveness" (Taylor-Santa et al., 2014, pg. 173). Also, consistent with the "Stimulus Discrimination" section of this chapter, Taylor-Santa et al. highlighted the importance of delimiting the class or universe of stimuli so that accurate responding occurs.

Response Exemplars Previous studies have shown that response MET can be an effective tactic to promote generalization of a variety of skills. For instance, Rozenblat et al. (2019) taught four adolescents with ASD to initiate bids for joint attention using a variety of response exemplars in the form of textual and audio scripts. Rozenblat et al. found that the participants learned to initiate bids for joint attention using the scripts that were directly taught (e.g., "That's cool"; "look at that!"); and that they also learned to emit novel bids, sometimes by blending language from directly taught exemplars (e.g., "look at that cool thing!"). Another novel use of this tactic can be found in Silbaugh et al. (2018) described earlier in this chapter, where two participants with ASD were taught to emit various response exemplars of mands through progressive TD prompts and lag schedules of reinforcement. Using a multiple baseline design across behaviors with embedded reversals, Silbaugh et al. demonstrated that lag schedule conditions produced higher rates of mand variability per minute as well as more occurrences of novel mand responses (i.e., response exemplars). The results from these studies exemplified that not only can the use of various response exemplars produce generalization, but also that, when coupled with other interventions (e.g., lag schedules of reinforcement), other generalization outcomes can be achieved as well (in this case, response variability).

When teaching various examples of responses, it can be beneficial to also teach non-examples of responses (i.e., how a behavior should not be emitted). One way this can be accomplished is through the use of the Teaching Interaction procedure (TIP), which involves (1) identifying the response being taught, (2) providing the logic for learning said response, (3) instructing how to conduct the response, (4) modeling examples and non-examples of the response, (5) allowing the individual to role-play, and (6) giving feedback to the individual (Phillips et al., 1974). The effectiveness of this procedure for teaching examples and non-examples was illustrated by Leaf et al. (2010), who used TIP to teach a group of participants with autism how to emit social skills appropriately (e.g., showing appreciation, giving compliments, making empathetic statements), which resulted in generalization as well. Another way non-examples can be taught is through the "cool versus not cool" procedure (Leaf et al., 2016), in which individuals are taught to discriminate between "cool responses" (i.e., appropriate behaviors) and "not cool responses" (i.e., inappropriate behaviors). Leaf et al. (2016) embedded this strategy within TIP to teach eight participants with ASD how to engage in appropriate game play with others by asking the group of participants to label whether an example or non-example was either cool or not cool.

Make Antecedents Less Discriminable Also known as *loose training* or *teaching loosely*, this tactic involves manipulating the environment such that the individual is exposed to a broad array of stimuli that contains random, non-necessary qualities. This arrangement can reduce the likelihood that irrelevant characteristics of any one stimulus will exert excessive control over an individual's response, because exposure to a group of stimuli that bear non-necessary characteristics essentially teaches that individual that responding in the presence of those non-necessary qualities will still occasion reinforcement. For example, Pelios et al. (2003) showed how this tactic could be embedded in a multi-treatment package to establish independent academic work with participants with ASD. This was done by first teaching the students to engage in consistent on-task behavior when the instructor was present and then fading the presence of the instructor systematically by increasing the distance between the instructor and the participants until the instructor was able to exit the room and enter randomly 3–5 min after. By the end of the intervention, the three participants demonstrated independent academic work completion in the absence of the instructor with the materials and settings they were directly trained with, as well as with novel materials and in novel settings. By making antecedents less discriminable (e.g., varying the presence of the instructor), the researchers were able to promote higher rates of generalized responding (e.g., completion of academic work across materials and settings).

Make Consequences Less Discriminable Commonly referred to as *indiscriminable contingencies*, this tactic describes the deliberate arrangement of an environment after a response occurs such that the occurrence of reinforcement is less discernable or predictable by an individual. Generally, this is done to produce response maintenance. One way this can be accomplished is by shifting from continuous to intermittent schedules of reinforcement. For example, Andersen and Redd (1980) demonstrated this by teaching four participants to engage in academic work despite being told that the instructor would return and/or check the assignments. This was done by first teaching the participants to complete work using verbal prompts and praise, then fading the verbal prompts and presence of the instructor, and last making consequences indiscriminable by telling the participants that the work might be checked when the instructor returned.

Another method that can help produce response maintenance is delayed reinforcement (i.e., increasing the time between a target response and the occurrence of a reinforcer). For instance, Freeland and Noell (2002) used delayed reinforcement to increase correct single-digit math completion per minute by two third-grade participants. Initially, the researchers provided immediate reinforcement for each worksheet that met goal criteria from a box of possible reinforcers. Then, the researchers shifted to delayed reinforcement whereby only one of every two worksheets was selected for grading, followed by every one in four worksheets. Using a withdrawal design, the researchers showed that delayed reinforcement produced higher rates of digit completion per minute when compared to phases that replicated baseline conditions. In the end, the researchers concluded by fading the reinforcers altogether and showed that responding was maintained across numerous sessions.

Incorporate Functional Mediators

According to Stokes and Osnes (1989), functional mediators are stimuli that are present during training that, when also present during generalization conditions, facilitate generalization. Thus, the purpose of the tactics that comprise the incorporate functional mediators strategy is to use the discriminative control of specific stimulus (or set of stimuli) that were created during direct training conditions to produce responses under generalization conditions when the same discriminative stimulus/stimuli are present as well. This can be accomplished by using common and/or self-mediated stimuli.

Incorporate Common Salient Stimuli Incorporation of common salient stimuli involves the use of commonly occurring physical or social stimuli to facilitate generalization. An example of common physical stimuli was provided by Spohn et al. (1999), in which they taught three children with developmental disabilities to engage in social interactions during mealtimes by using modified placemats as a common salient physical stimuli. The researchers created 12 different placemats that contained collages of images of cartoon characters, food items, animals, and "something ridiculous or funny such as a cat dressed as a baby seated in a carriage" (pg. 6; Spohn et al., 1999), which were used as visual prompts for conversation topics during breakfast time. After the children were taught to engage in conversations with peers using the placemat during breakfast, the researchers then examined whether the placemats facilitated generalization by (a) removing the adult facilitator and (b) representing the placemats during lunch time. All three participants showed increased social interactions during lunch time when compared to baseline, which suggested that the placemats may have acted as functional mediators in that generalized responding emerged when common stimuli with discriminative properties were presented in a new context. A variety of physical stimuli can be used to produce this effect, such as commonly requested items (Charlop et al., 1985), or even academic materials (Marholin & Steinman, 1977). The use of common and salient stimuli is recommended during direct training because it is likely to promote more generalized responding given that it is highly likely that those stimuli will appear often in the environment where responding needs to occur. Conversely, using artificial stimuli may do very little for producing generalized responding, because those stimuli do not naturally appear in the targeted environments.

Social stimuli are another type of common stimuli that can be taken advantage of for their discriminative properties (i.e., common salient social stimuli; Stokes & Osnes, 1989). For example, parents, teachers, therapists, peers, and/or siblings can all produce stimulus control over responses, which can then be used to facilitate responding in generalization contexts (e.g., novel settings, novel materials). Schmidt and Stichter (2012) demonstrated this programming tactic by recruiting and training three typically developing peers as mediators (i.e., common social stimuli) to help produce generalized social interactions across two novel settings (e.g., lunch room, math class). The researchers first taught six adolescents with ASD to engage in social interactions (e.g., greeting, asking/answering questions, commenting) in a group format by holding 1-h lessons that incorporated modeling and rehearsal. Following training, the participants were then observed during lunch time and math class, during which peer mediators were instructed to initiate interactions with the participants during that time. Upon the introduction of the peers in these novel settings, social interactions increased when compared to baseline levels. The study by Schmidt and Stichter demonstrated that peers may take on discriminative stimulus properties that can result in generalized responses across environments.

Incorporate Salient Self-Mediated Stimuli In line with the concept that discriminative stimuli can be used to improve generalization outcomes, such stimuli can also be embedded within self-management strategies to produce generalized responses, typically through physical, verbal, and covert stimuli (Stokes & Osnes, 1989). An example of self-mediated physical stimuli was illustrated in a study by Prater et al. (1992) in which a participant with learning and behavioral issues showed generalized self-monitoring of on-task behavior across various classrooms when visual prompts (symbols in his notebook and on a poster) were present in those settings. The 14-year-old participant was first taught the meaning of visual prompts and how to self-monitor via modeling. Then, the participant was taught to self-monitor when studying 20 spelling words by (a) following an auditory prompt to ask himself "was I working?" and (b) scoring his on-task behavior on a self-monitoring sheet every 1–8 min. The auditory prompts were systematically faded until only the visual prompts remained. Using a multiple baseline design with reversals across settings, the researchers demonstrated the effects of the initial training and the presence of visual prompts on academic performance by (a) showing that academic performance increased across all settings and (b) that academic performance decreased during reversal phases in which visual prompts were removed. The results from the study suggested that self-mediated physical stimuli, such as self-monitoring checklists or posters, can result in effective stimulus control over generalized responses. Other physical stimuli that can be used for self-mediation include things such as bracelets with beads (Holman & Baer, 1979) strings (Stokes & Osnes, 1989), or even wearable technology (e.g., smart watch; O'Brien et al., 2016).

Self-mediated stimuli can also take the form of verbal or covert stimuli, which is commonly referred to as *self-instruction* in the self-management literature (Erhard et al., in press). This tactic involves teaching an individual to use their own verbal behavior to occasion target responses and, in some instances, produce generalized target responses. For instance, Swanson and Scarpati (1985) demonstrated generalization of academic performance across settings and tasks when they taught two participants in special education to engage in self-instruction. The researchers taught the participant to self-instruct themselves through (a) modeling, (b) instruction, (c) rehearsal involving self-instruction out loud, (d) rehearsal involving self-instruction through whispering, and (e) rehearsal involving self-instruction quietly. It is worth noting that this type of intervention shares characteristics that are grounded in cognitive behavioral theoretical frameworks (e.g., teaching someone to self-instruct silently).

Other Important Considerations

Baer's (1981) book, *How to Plan for Generalization*, highlighted many of the tactics presented in the current chapter. In addition, he also noted that when one is attempting to produce generalized behavior change, it is also imperative that one takes into consideration the application of said generalized behavior change with regards to the individual being taught and their current skill repertoire and where the stimuli the responses need to occur in. Finally, Baer recommended that one take into account response maintenance and how it will be planned for. In the following section, we have combined some of the recommendations from Baer with current behavioral practices as a guide for practitioners to use for programming for generalization.

Assessing the Individual and the Stimuli

The first recommendation Baer (1981) provided was for one to begin the process of generalization by closely examining the individual's skill repertoire so that one can list all behaviors that need change. For practitioners, this is similar to conducting an initial assessment or evaluation and establishing behavioral goals based on those observations. However, the purpose of this pre-assessment component is not to just understand the skill repertoire that an individual possesses so that we can determine what behaviors need to be taught and which need to be reduced, but so that one can determine what skills require systematic generalization programming. Further, pre-assessment allows for the subsequent measurement of the emergence of generalized responding based on the specific tactics implemented. One way this can be accomplished is through the use of a *generalization map* (Allen et al., 1991), a dichotomous assessment tool that groups generalization outcomes (e.g., time, settings, behaviors, people) into 16 different classes by whether those outcome combinations are present or absent. For example, if one could observe the presence of an individual's generalization across subject-behavior-setting-time, then the corresponding class (Class 16) would be marked as present for this individual.

Next, Baer (1981) recommended that one create a list of all the people, situations, and settings in which the target behavior needs to occur. This step is meaningful so that one can delineate the extent of programming needed to produce generalized responding. One way that this can be accomplished is by conducting a *general case analysis* or *general case programming*, where one (1) defines the instructional universe, (2) defines the range of relevant stimulus and response variations with that universe, (3) selects examples from the instructional universe for use in teaching and probe testing, (4) sequences teaching examples, (5) teaches the examples, and (6) tests with non-trained probe examples (Albin & Horner, 1988; Becker & Engelmann, 1978). Another way this can be accomplished is through *matrix training*, whereby practitioners create a grid or table that lists all the possible combinations desired between stimuli (e.g., red circle, red triangle, yellow circle, yellow triangle, and so on; Pauwels et al., 2015). Akin to conducting assessments and creating behavioral goals, general case analyses and matrix training allow practitioners to establish target stimuli for an individual to respond to.

Determining the Reinforcement Schedule

When an individual's repertoire has been assessed and generalization outcomes have been targeted, it is then useful to establish a reinforcement schedule, a reinforcer fading plan, and to follow the schedule/plan as precisely as possible. The importance of establishing a consistent schedule was underscored by Fragale et al. (2012), which showed how an abolishing operation (Langthorne & McGill, 2009) can result in less generalized responding. In their study, Fragale et al. demonstrated how three children with disabilities engaged in fewer mands across novel people and places when access to preferred stimuli was given prior to the "beginning" of their training session, when compared to sessions in which no *presession access* was scheduled. The results of Fragale et al. showed that individuals may emit less generalized responses if the motivating operation (MO) has been manipulated such that the value of a reinforcer is diminished. To the layman, it may seem as if generalization has not occurred (or may occur less than direct training), when in fact it is the value of the reinforcer which may "hide" the individual's capacity to generalize. Therefore, deliberate control and delivery of reinforcers is strongly recommended during training to ensure that one can assess generalized behavior change more accurately.

One of the main goals in producing behavior change is that such changes are durable and long-lasting (i.e., response maintenance). As indicated by Ferster and Skinner's *Schedules of Reinforcement* (1957), response maintenance effects are strongly influenced by the schedule of reinforcement that is used to train the occurrence of behaviors; denser schedules of reinforcement produce less persistent responses, whereas thinner schedules of reinforcement tend to produce more persistent responses. In line with this behavioral mechanism, then, one should consider how one will modify the response–reinforcer ratio and/or delay to reinforcement to produce more long-lasting responding (Baer, 1981). When doing this, it might be beneficial to determine the terminal ratio or delay that is most consistent with naturally occurring contingencies. For example, a child whose behavior is reinforced by a teacher's attention may not be able to gain her undivided attention repeatedly during class, so it is imperative that reinforcement is thinned to the point that the child may tolerate the delay of attention until it can be provided by the teacher at an appropriate time (e.g., unstructured learning time, lunch, recess, after class).

Establishing a Plan with Others

As it is true for any group effort, one should also consider the level of involvement and buy-in needed from stakeholders when attempting to produce generalized behavior change. It is imperative that one ensures stakeholders are aware of the effort needed to make these changes and willing to facilitate these efforts. In some cases, this may not be arduous if the individual in question has already begun producing generalized responding with minimal assistance. But in other cases, deliberate and systematic efforts may be warranted. As such, one should ask when beginning services: Is it possible to collaborate with others effectively given their level of training and availability? How much training will be required of each stakeholder? Can time be allocated sufficiently among all parties to attain the desired behavioral change? What barriers can be expected, and how can those barriers be overcome?

Finally, practitioners should be parsimonious when programming for generalized behavior change. One must allocate resources at their disposal judiciously: the more manipulatives one adds to an intervention (e.g., visual supports, token systems, measurement systems), the more opportunities there may be for any one of those stimuli to create excessive or restricted stimulus control over responding (and measurement reliability may be reduced as well). As such, consider that less may be more. For instance, when determining how many stimulus and response exemplars are enough, consider whether one exemplar is sufficient or if multiple exemplars are needed, and evaluate generalization as necessary (cf. Schnell et al., 2018).

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16 Response Interruption and Redirection

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Redirection Procedures of Automatically Reinforced Behavior

Unlike behavior maintained by social consequences, behavior maintained by automatic reinforcement poses treatment challenges due to the inaccessibility of maintaining sensory consequences (Vollmer, 1994). Several procedures have approached the treatment of automatically reinforced behavior by enriching the environment with competing stimuli (e.g., Hagopian et al., 2020; Piazza et al., 2000) and/or by contingently prompting alternative responses, including overcorrection (Foxx & Azrin, 1973), contingent demands (e.g., Fisher et al., 1994a, b), and response interruption and redirection (RIRD; Ahearn et al., 2007). Competing stimuli alone have not been found to be consistently effective (e.g., Hagopian et al., 2017, 2020; Piazza et al., 1998, 2000). Redirection in isolation or especially when combined with other procedures has been found to be generally effective. For the purposes of this chapter, *redirection* is defined as the contingent prompting of appropriate alternative responses.

RIRD is the most common redirection procedure in recent publications, and it has been identified as an evidence-based practice for automatically reinforced behavior (Tomaszewski et al., 2017). The Ahearn et al. (2007) evaluation of RIRD in the treatment of automatically maintained vocal stereotypy is often cited as a seminal reference for RIRD. The procedure involved the contingent interruption of stereotypy, followed by prompts to emit appropriate vocalizations until the individual complied with these demands in the absence of stereotypy. In the years following the Ahearn et al. study, there have been numerous evaluations and variations of the RIRD procedure.

Martinez and Betz (2013) provided a brief review of early RIRD studies published in the *Journal of Applied Behavior Analysis* from 2007 to 2012. The authors outlined areas for future research to improve the practicality of the procedure, including treatment evaluations during naturally occurring activities and component analyses of procedural variations. In the past 20 years, redirection has been evaluated with automatically reinforced behavior extensively (e.g., Ahearn et al., 2007; Ahrens et al., 2011; Hagopian & Adelinis, 2001; Hagopian et al., 2011). In order to summarize the redirection literature, we conducted a 20-year systematic review of empirical evaluations of redirection procedures with automatically reinforced behavior.

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Literature Review Method

Peer-reviewed papers were collected through a search of relevant databases and behavior-analytic journals, including APA PsycInfo, Academic Search Premier, JSTOR, ERIC, *Journal of Applied Behavior Analysis*, *Behavioral Interventions*, and *Behavior Modification*. All databases and journals were searched by combining the terms "automatic reinforcement," "pica," and "stereotypy," with the terms, "redirection," "response redirection," "response interruption and redirection," "RIRD," "contingent demands," and "overcorrection" to conduct advanced searches. Articles were also identified by reviewing the references of papers obtained from the database and journal searches. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method recommended by Liberati et al. (2009) for obtaining and including papers in our review. The database and journal searches were last conducted in September 2020.

Inclusion Criteria

Studies were included if they (1) were published in a peer-reviewed, English-language journal, (2) were published between the years of 2000 and 2020, (3) involved an empirical evaluation of redirection, (4) were conducted with individuals with autism or other related developmental disability, and (5) targeted behavior presumably maintained by automatic reinforcement. As noted above, for the purposes of this chapter, *redirection* was defined as the contingent prompting of an appropriate alternative response following the occurrence of a target response for decrease. The target behavior was considered to be maintained by automatic reinforcement if (1) the authors reported an assessment of function (e.g., functional analysis, persistence in a no-interaction condition) or (2) the target behavior was stereotypy based on the conclusion of Rapp and Vollmer (2005) that stereotypy is most often automatically reinforced.

Exclusion Criteria

Titles and abstracts were reviewed, and studies were excluded if (1) they were duplicates of other obtained studies, (2) they were review or discussion papers, (3) they did not evaluate a redirection procedure, (4) they did not involve participants with autism or other developmental disabilities, and (5) they targeted behavior maintained by socially mediated consequences (i.e., not automatic reinforcement). The full-text articles of all remaining studies were then reviewed for the same criteria. Given the current definition of redirection, any studies that involved the redirection of hands down, or similar response, rather than the prompting of active engagement in appropriate alternative behavior were also excluded from the current review.

Summary of Redirection Literature

In reviewing the redirection literature, we have identified three main takeaway points with respect to redirection procedures in the treatment of automatically reinforced behavior. Firstly, redirection can be an effective strategy for automatically reinforced behavior. Additionally, there is evidence to support that promoting appropriate behavior likely improves the efficacy of redirection. Lastly, there are procedural variations of redirection and treatment components to consider when developing a redirection treatment package. These variations and components present methods for individualizing and contextualizing redirection treatment packages to improve the efficacy and social acceptability of the procedure. Table 16.1 lists the redirection studies that we identified from 2000 to 2020, procedural details, and redirection efficacy.

Redirection Efficacy

Redirection procedures have most often been evaluated with stereotypy. Of the 48 studies that we reviewed from 2000 to 2020, redirection was

Table 16.1 Reviewed redirection studies, procedural details, and redirection efficacy

Study	Participants N/Setting	Target behavior	Comparative study conditions	Redirection treatment package: Reinforcement components	Redirection treatment package: Other treatment components	RD efficacy
Ahearn et al. (2007)	4*	VS	N/A	DRA (AV)	N/A	Yes
Ahrens et al. (2011)	Exp. 1: 2 Exp. 2: 2 Exp. 3: 1	MS, VS	N/A	DRA (AV)	N/A	Yes
Athens et al. (2008)	1	VS	N/A	CS (leisure); NCA	RC	Yes
Brusa and Richman (2008)	1	MS	N/A	CS (leisure)	DRO; RB; RC	Yes
Carroll and Kodak (2014)	2	VS	RD, CS	N/A	N/A	Yes
Cassella et al. (2011)	2	VS	N/A	CS (leisure)	N/A	Yes
Cividini-Motta et al. (2019)	3	MS, VS	RD, DRA, RD + DRA	CS (leisure); DRA (AV, leisure)	N/A	Yes
Cividini-Motta et al. (2020)	4	PM	RD, RI (VR + RB)	CS (leisure)	N/A	Yes
Colón and Ahearn (2019)	Exp. 1: 3 Exp. 2: 3	VS	N/A	N/A	N/A	Yes
Colón et al. (2012)	2	VS	N/A	DRA (AV)	N/A	Yes
Cook & Rapp (2020)	1	MS, VS	N/A	Instruction; DRA (academic)	VR	Yes
DeRosa et al. (2019)	3	MS	RD, RB	N/A	N/A	Yes
Dickman et al. (2012)	1	VS	RD, RD + DRA	CS (leisure); DRA (AV)	RC	Yes
Frewing et al. (2015)	1*	MS, VS	N/A	Instruction	RB	Yes
Friedman and Luiselli (2008)	1**	Daytime Sleep	N/A	Instruction; DRA (general)	N/A	Yes
Gauthier et al. (2020)	4	VS	N/A	CS (leisure); DRA (AV)	N/A	Yes
Gibbs et al. (2018)	2*	VS	N/A	Instruction; CS (music); DRA (AV)	N/A	Yes
Gibney et al. (2020)	4**	VS	RD, CS	Instruction	N/A	3 of 4 participants
Giles et al. (2012)	3	MS	RD, RB	N/A	N/A	Yes
Giles et al. (2018)	3**	MS	N/A	Instruction	N/A	2 of 3 participants
Gould et al. (2019)	1*	MS	N/A	Instruction	VR; RB	Yes
Guzinski et al. (2012)	4**	VS	N/A	Instruction; DRA (AV)	N/A	3 of 4 participants
Hagopian and Adelinis (2001)	1	Pica	RB, RB + RD	NCE	VR; RB	Yes
Hagopian et al. (2011)	2*	Pica	CS, RD package (CS + RD + DRA)	CS (leisure); DRA (discard)	RB	Yes
Hagopian and Toole (2009)	1	Body Tensing	N/A	CS (leisure)	N/A	Yes
Karmali et al. (2005)	5	VS	N/A	Instruction; CS (leisure); DRA (AV)	N/A	Yes
Liu-Gitz and Banda (2010)	1**	VS	N/A	Instruction; DRA (AV)	N/A	Yes

(continued)

Table 16.1 (continued)

Study	Participants N/Setting	Target behavior	Comparative study conditions	Redirection treatment package		RD efficacy
				Reinforcement components	Other treatment components	
Love et al. (2012)	2	VS	RD, CS, RD + CS	CS (leisure); DRA (AV)	RC	Yes
Martinez et al. (2016)	1*	VS	N/A	Instruction; CS (leisure); DRA (AV, academic)	VR; RC	Yes
McNamara and Cividini-Motta (2019)	3	VS	RD, RC, RD + RC	N/A	RC	Yes
Meany-Daboul et al. (2007)	3	MS, VS	N/A	N/A	N/A	Yes
Miguel et al. (2009)	1	VS	N/A	CS (leisure); DRA (AV)	RC	Yes
Pastrana et al. (2013)	2	MS	N/A	N/A	N/A	Yes
Peters and Thompson (2013)	3	MS	N/A	CS (activities)	VR	Yes
Ricciardi et al. (2003)	1**	Pica	N/A	Instruction	N/A	Yes
Saini et al. (2015)	4	MS, VS	N/A	CS (leisure); DRA (leisure)	RC	Yes
Schmidt et al. (2017)	3*	Pica	N/A	DRA (discard)	RB	Yes
Schumacher and Rapp (2011)	2	VS	N/A	N/A	N/A	Yes
Shawler et al. (2020)	2	VS	RD, CS (sound), CS (no sound)	CS (leisure); DRA (AV)	RC	Yes
Shawler and Miguel (2015)	5	VS	N/A	CS (leisure); DRA (AV, leisure)	RC	4 of 5 participants
Sivaraman and Rapp (2020)	2	VS	N/A	CS (leisure); DRA (AV)	N/A	Yes
Sloman et al. (2017)	1**	VS	N/A	Instruction; DRA (academic)	N/A	Yes
Taylor (2020)	1	Pica	CS, RD package 1 (CS + DRA + RB + RD), RD package 2 (DRA + RB + RD)	CS (leisure); DRA (discard)	RB	Yes
Toper-Korkmaz et al. (2018)	3	VS	RD, RC, RD + RC	CS (leisure); DRA (AV)	RC	Yes
Verriden and Roscoe (2019)	4	MS	CS + DRA + RD, CS + DRA + VR, CS + DRA + RB, CS + DRA + RC	CS (leisure); DRA (leisure)	N/A	Yes
Vorndran and Lerman (2006)	1	HV	N/A	CS (leisure)	RC	Yes
Wells et al. (2016)	1**	VS	N/A	Instruction; DRA (AV)	N/A	Yes
Wunderlich and Vollmer (2015)	7	VS	N/A	N/A	N/A	1 of 7 participants

*progressed to natural setting, **natural setting, *AV* appropriate vocalization, *CS* competing stimuli, *DRA* differential reinforcement of alternative behavior, *DRO* differential reinforcement of other behavior, *HV* hyperventilation, *MS* motor stereotypy, *NCA* noncontingent attention, *NCE* noncontingent edible, *RB* response blocking, *RC* response cost, *VR* verbal reprimand, VS vocal stereotypy also evaluated with automatically reinforced pica, public masturbation, daytime sleep, body tensing, and hyperventilation. Across all studies, the authors concluded that redirection decreased the target behavior or there was a clear level change during redirection for 107 of 117 participants (91.5%). This includes redirection evaluations with modest decreases in the target behavior, but a clear change in the level of behavior was obtained.

Although we limited our literature search to behavior maintained by automatic reinforcement, the persistence of the target behavior in no-interaction conditions or automatic reinforcement screens (Querim et al., 2013) was used to suggest the behavior was at least partially maintained by automatic reinforcement in several studies. Automatic reinforcement screens, however, do not assess if behavior is maintained by both automatic and social reinforcement. Multiple studies reported this as a limitation affecting redirection efficacy, noting that redirection might involve attention that reinforces the target behavior. This possibility should be considered when reviewing published and clinical evaluations of redirection. When developing redirection packages for behavior possibly maintained by both automatic reinforcement and attention, practitioners might consider conducting a variation of the Cividini-Motta et al. (2020) brief attention screen.

With *redirection* defined as the contingent prompting of an alternative response, there were considerable variations across the reviewed studies that likely impacted the observed redirection efficacy. Numerous studies evaluated the additive effects of treatment components paired with redirection, and some evaluated the relative efficacy of redirection compared to other interventions. Other treatment components and interventions included medication prescribed for the target behavior, noncontingent competing stimuli, reinforcement of alternative behavior, verbal reprimands, response blocking, and response cost.

Measures and Interpretations of Efficacy

Target Behavior Measurement

Response measurement and the interpretations of redirection efficacy have been an area of discussion and study in the redirection literature. Methods of measurement and data analysis directly affect interpretations of functional relations. In the Meany-Daboul et al. (2007) comparison of momentary time sampling (MTS) and partial interval recording (PIR) to continuous duration recording (CDR), the MTS method most closely aligned with the CDR method. These results suggest that MTS should be used when the target behavior is best measured using duration recording, but CDR is impractical, which is likely the case in clinical or classroom settings.

Some redirection studies measured the target behavior using *interrupted measurement* that involved pausing the session timer during redirection (redirection may prevent targeted behavior from occurring thus creating unequal opportunity for targeted behavior to occur between baseline and treatment) continuing the session until a set duration outside of redirection or maximum total duration, and only recording occurrences of the target behavior outside of redirection. Several studies that compared this practice to *uninterrupted measurement* (i.e., total session recording) were among studies that concluded redirection was ineffective or resulted in modest reductions (e.g., Carroll & Kodak, 2014; DeRosa et al., 2019; Wunderlich & Vollmer, 2015). Carroll and Kodak suggested that interrupted measurement overestimates the efficacy of redirection, and Wunderlich and Vollmer replicated these results with four of seven participants. Subsequent research has resulted in inconsistent conclusions in this area, with several studies demonstrating significant redirection treatment effects using uninterrupted measurement methods (e.g., Martinez et al., 2016; McNamara & Cividini-Motta, 2019; Toper-Korkmaz et al., 2018). Given that interrupted measurement has been demonstrated to overestimate redirection efficacy, at least in some cases, future evaluations should (1) use uninterrupted measures and/or (2) provide supplemental measures with respect to redirection implementation. Although uninterrupted measures are more stringent with respect to the redirected behavior, uninterrupted measures might inflate measures of appropriate behavior.

Supplemental Measures

In addition to measuring the automatically reinforced target behavior, several redirection studies have included supplemental measures to evaluate redirection. These supplemental measures have often included redirection implementation, appropriate behavior, and untargeted challenging behavior. As noted in the *Target Behavior Measurement* section (Sect. 3.1.1), measures of redirection implementation (e.g., frequency, duration) might serve as supplemental measures to interpret redirection efficacy or treatment practicality when implementing redirection in natural settings.

Lanovaz et al. (2013) concluded that reducing stereotypy often results in response reallocation and, therefore, suggested that measures of untargeted behavior might be relevant when treating behavior maintained by automatic reinforcement. Response reallocation might be to other forms of automatically maintained behavior or appropriate behavior. Cook and Rapp (2020) and Pastrana et al. (2013) specifically evaluated the effect of stereotypy redirection on untargeted forms of stereotypy. Researchers and practitioners should monitor the levels of other forms of presumably automatically reinforced behavior during redirection procedures.

As for supplemental measures of appropriate behavior, numerous redirection studies have measured topographies of adaptive behavior. Measures of appropriate vocalizations are common in redirection evaluations targeting stereotypy, but other measures of adaptive responses during redirection include leisure engagement and academic responding (Cook & Rapp, 2020; Gibbs et al., 2018). Some studies with supplemental measures of appropriate behavior arranged reinforcement to promote reallocation to appropriate alternatives, and other studies simply measured the indirect effects of redirection. Supplemental measures of contextually appropriate behavior should be used to evaluate if the target behavior is interfering with functional engagement and the effects of redirection (e.g., Steinhauser et al., 2021).

With the objective of identifying socially acceptable punishers, Verriden and Roscoe (2019) measured the indirect effects of putative punishers on *emotional responses*, defined as whining, crying, screaming, aggression, self-injury, attempts to escape from the procedure, or physical resistance. Similarly, Hagopian and colleagues (Hagopian & Adelinis, 2001; Hagopian & Toole, 2009) evaluated redirection procedures with participants who engaged in aggression when the target behavior was blocked and measured the effects on aggression. Supplemental measures of untargeted challenging behavior might also be useful measures to interpret the social validity or acceptability of redirection.

There are various supplemental measures that might guide interpretations of redirection efficacy. We recommend that practitioners and researchers include measures relevant to the individual and context. That is, supplemental measures of appropriate behavior should be informed by the behavior that constitutes functional engagement in the treatment context or activity (e.g., social, vocational, academic). In addition to supplemental measures of appropriate behavior, future research and clinical applications of redirection should include supplemental measures of challenging behavior as a measure of social validity (e.g., Verriden & Roscoe, 2019). Therefore, future evaluations of redirection should include at least three key areas of measurement to interpret the efficacy of redirection, including measures of (1) the automatically reinforced challenging behavior, (2) contextually appropriate behavior, and (3) emotional responses or other forms of challenging behavior.

Mechanism of Behavior Change

The mechanism of behavior change responsible for redirection efficacy is a recurring discussion in the redirection literature. The results of Ahrens et al. (2011) Experiment 3 support the assertion that redirection functioned as positive punishment with one participant. The same can be said about the Colón and Ahearn (2019) systematic analysis of redirection treatment integrity, with low levels of stereotypy during phases of diminished treatment consistency. This interpretation of positive punishment as the mechanism of behavior change needs to be considered in context. Redirection has interdependent components (e.g., prompting, alternative responses) that vary considerably across redirection procedures, and redirection is often packaged with other treatments. Reinforcement-based treatment components often involve sources of reinforcement either provided noncontingently or contingent on appropriate alternative responses. Other consequence-based treatment components (e.g., verbal reprimands, response blocking, response cost) might also function as punishment (see also Lerman and Iwata (1996) and Smith et al. (1999) for evaluations of response blocking). In most cases, response cost likely functions as negative punishment. Therefore, the mechanism of behavior change may be idiosyncratic, and there is likely not a single mechanism of behavior change.

Comparative Studies and Relative Efficacy

Numerous studies have evaluated the relative efficacy of redirection compared to other interventions. Several reviewed studies, including Carroll and Kodak (2014), Gibney et al. (2020), Love et al. (2012), and Shawler et al. (2020), suggested that noncontingent competing stimuli can effectively decrease automatically reinforced behavior without redirection in some cases. Noncontingent competing stimuli might be a practical alternative to redirection when resources are limited. Similarly, the reinforcement of appropriate alternative behavior might mitigate the need to redirect behavior. Colón et al. (2012) and Cividini-Motta et al. (2019) produced preliminary results that suggested differential reinforcement of alternative behavior (DRA) without redirection can effectively decrease automatically reinforced behavior in some individuals.

Relatedly, Hagopian et al. (2015, 2017) proposed a model for subtyping automatically reinforced self-injurious behavior (SIB) based on functional analysis response patterns and treatment outcomes. Subtype 1 is characterized by the differentiation between the alone and play conditions and corresponds to the effectiveness of reinforcement-based intervention. This can be conceptualized as other sources of reinforcement competing with the automatic reinforcement of the target behavior. Contrarily, Subtype 2 with high and undifferentiated levels in functional analyses might be indicative of the need to include redirection as well as reinforcing appropriate behavior to observe sufficient treatment effects. Although published applications of this model have been specific to SIB, the level of differentiation obtained during functional analysis may be a general indicator of the likelihood of effective intervention with reinforcement-based intervention alone. That is, if there is differentiation in the FA, competing stimuli or other reinforcement-based intervention may be effective, but if there is no differentiation, redirection may be a necessary component of the intervention.

Although we recommend that practitioners first consider reinforcement-based interventions when designing treatments for automatically reinforced behavior, practitioners are often selecting between punishment-based procedures. Several reviewed studies evaluated the relative efficacy of redirection compared to response blocking and response cost. The reviewed studies include conflicting conclusions with respect to the relative efficacy of redirection and response blocking. Giles et al. (2012) concluded that redirection was both more effective and preferred by participants. More recently, DeRosa et al. (2019) suggested that response blocking was more effective with all three participants and attributed these conflicting results to measurement methods. Similar to redirection, response blocking procedures vary with respect to numerous dimensions, lasting only several seconds to longer durations up to 30 s. Therefore, the relative efficacy of the two procedures needs to be interpreted in the context of the specific procedures compared in each study and not generalized to the procedures more broadly. Toper-Korkmaz et al. (2018) and McNamara and Cividini-Motta (2019) concluded that response cost alone can sufficiently decrease automatically reinforced behavior with some participants, but redirection effectively decreased behavior with all participants. The results of the Verriden and Roscoe (2019) punisher assessment, however, suggest that perhaps the most effective and socially valid punisher is idiosyncratic across individuals and relevant stakeholders. Therefore, future research should emphasize refining methods for identifying the most appropriate consequences in particular cases rather than asking generalized relative efficacy questions.

Redirection and Promoting Appropriate Behavior

Similar to the Lanovaz et al. (2013) conclusion that decreasing automatically reinforced behavior often results in response reallocation, both Vollmer (1994) and Rapp and Vollmer (2005) suggested that treatment packages might promote response reallocation to appropriate alternatives and improve the reductions of automatically reinforced behavior. Many reviewed studies evaluated redirection packaged with other treatment components, including reinforcement or interventions implemented contingent on the target behavior. Reinforcement components packaged with redirection have included noncontingent sources of reinforcement (e.g., competing stimuli) and reinforcement delivered contingent on alternative behavior (i.e., DRA).

Redirection and Noncontingent Competing Stimuli

Several redirection studies have evaluated redirection combined with noncontingent access to competing stimuli, which has also been referred to as *matched stimulation*, *enriched environment*, or *noncontingent reinforcement* in the behavior-analytic literature (see Gover et al., 2019, for a review). For the purposes of this chapter, we refer to all treatment components involving response-independent stimulation as *competing stimuli*. Noncontingent access to competing stimuli, in the form of free access to leisure items and/or sound-producing items, was a treatment component packaged with redirection in nearly half of the reviewed studies. Additionally, other studies were conducted during classroom activities or academic instruction. Classroom settings involve various contingencies, demands, and stimuli that can potentially compete with the automatic reinforcement of the target behavior. In one redirection study, Gibbs et al. (2018) prompted engagement in an ongoing task independent of the target stereotypy. However, we did not identify any studies that evaluated the effect of noncontingent prompting of contextually appropriate behavior on the efficacy of redirection.

Two studies have experimentally evaluated the additive effects of competing stimuli with redirection. Love et al. (2012) compared redirection, competing stimuli that produced presumably matched stimulation, and redirection plus competing stimuli. All three procedures decreased stereotypy for both participants, but the redirection plus competing stimuli was slightly more effective for one participant and resulted in higher levels of appropriate vocalizations and less time implementing redirection. With these results, the authors posited that noncontingent competing stimuli could mitigate the need for redirection by competing with the target behavior. Similarly, Gibbs et al. (2018) replicated Love et al. and concluded that redirection with competing stimuli resulted in lower levels of stereotypy than redirection alone.

Redirection and Differential Reinforcement of Appropriate Behavior

Redirection is often combined with DRA arrangements in treatment packages for automatically reinforced behavior. Over half of the redirection studies that we reviewed discussed differential reinforcement of appropriate behavior, including appropriate vocalizations, engagement with leisure items, academic responses, and appropriate discard responses of pica items. The reinforcement of appropriate vocalizations, involving praise and requested items, was the most common reinforcement procedure in the reviewed studies. Other studies noted that appropriate vocalizations were acknowledged but did not describe specific reinforcement procedures. As noted in the *Redirection and Noncontingent Competing Stimuli* section (Sect. 3.2.1), several studies were conducted in natural settings that likely included other sources of reinforcement, including naturally occurring reinforcement contingencies for appropriate behavior.

Several redirection studies have systematically trained appropriate alternative responses prior to redirecting automatically reinforced challenging behavior, including Colón et al. (2012), Hagopian et al. (2011), Schmidt et al. (2017), and Taylor (2020). Colón et al. approached the treatment of vocal stereotypy by building upon the participants' verbal repertoires in the form of tact training and one participant also received mand training. Following verbal operant training, stereotypy and appropriate vocalizations were measured outside of the training sessions. Verbal operant training sufficiently decreased the vocal stereotypy of one participant and redirection was added for the other participants. The Colón et al. results suggest that the training and reinforcement of appropriate alternative responses can obviate the need to implement redirection in some cases. Similar to the Colón et al. procedures, Hagopian et al., Schmidt et al., and Taylor systematically trained alternative discard responses in treatment packages targeting pica. Once discard responses were established, redirection with a DRA for discard responses maintained clinically significant treatment effects.

Dickman et al. (2012) evaluated the role of reinforcement contingent on appropriate alternative behavior paired with redirection in a treatment package for vocal stereotypy. The study involved a comparison of redirection with two different reinforcement procedures contingent on appropriate vocalizations. Although both procedures decreased stereotypy, the procedure involving additional token reinforcement resulted in consistently higher levels of appropriate vocalizations and lower levels of vocal stereotypy. Dickman et al. posited that the additional reinforcement better competed with the automatic reinforcement of stereotypy and/or the appropriate vocalizations were incompatible with the target vocal stereotypy.

More recently, Cividini-Motta et al. (2019) conducted a similar comparison of redirection, DRA, and redirection plus DRA in the treatment of stereotypy. The DRA involved praise contingent on appropriate vocalizations, requested items when possible contingent on mands, and a tangible reinforcer delivered contingent on engagement with leisure items. The results suggest that DRA can sufficiently decrease automatically reinforced behavior in some cases, but redirection might be a necessary treatment component to observe treatment effects. Notably, Cividini-Motta et al. did not observe sustained increases in appropriate vocalizations or item engagement during any of the procedures. The tangible reinforcer delivered contingent on toy engagement likely affected these results by competing with appropriate behavior. Given this limitation and few evaluations in this area, further investigations are warranted to evaluate the additive effects of DRA packaged with redirection on levels of the automatically reinforced target behavior and contextually appropriate behavior.

Recommendations for Promoting Appropriate Behavior

In addition to improved treatment efficacy, evaluating redirection with reinforcement available for appropriate behavior is in accordance with behavior-analytic ethical standards (Behavior Analyst Certification Board® [BACB], 2020; Pokorski & Barton, 2021). Although other sources of reinforcement might significantly decrease automatically reinforced behavior, redirection might be warranted depending on the severity of behavior and treatment goals (e.g., Hagopian et al., 2011). As we mentioned in the *Supplemental Measures* section (Sect. 3.1.1), some redirection studies have specifically programmed for appropriate behavior by arranging reinforcement and others measured the indirect effects of redirection on appropriate behavior.

We recommend that practitioners arrange other sources of reinforcement, including noncontingent sources of reinforcement and reinforcement contingent on contextually appropriate

Initial Considerations	**Reinforcement Considerations**	**Redirection Considerations**	**Treatment Components**

Consider the target behavior and context to inform treatment package development
 	
Target Behavior
• Function
  ○ Automatic reinforcement?
  ○ Sensitive to attention?
• Topography
  ○ Inherently harmful? SIB?
  ○ Can it safely occur?
 	
Context
• Identify problematic context(s)
• What constitutes functional engagement?
• Measure baseline levels of target behavior and contextually appropriate behavior
	Assess available reinforcement promoting appropriate behavior before implementing redirection
	
	Context Reinforcement
	• Noncontingent Competing Stimuli
	  ○ What stimuli are present? (e.g., leisure, social, academic)
	• Differential Reinforcement of Appropriate Behavior
	  ○ Is there reinforcement contingent on functional engagement?
	
	Individual Repertoire
	• Do they have the skills to contact reinforcement?
	• Do new functional skills need to be trained?
	• Would prompting functional engagement promote response reallocation?
		Add redirection component to reinforcement procedures if target behavior warrants intervention
		
		Contingent Component
		• Likely redirecting all or most occurrences of target behavior initially
		
		Prompting Component
		• Redirection topography
		  ○ Verbal or physical redirection?
		  ○ Consider listener repertoire
		• Do they readily comply with demands?
		  ○ Consider prompt hierarchy
		
		Alternative Response Component
		• Redirect back to contextually appropriate behavior
			Consider other treatment components to improve treatment package efficacy
			
			Differential Reinforcement of Other Behavior (DRO)
			• Consider contingent access to periods without redirection
			
			Verbal Reprimands
			• Low responding in functional analysis attention condition?
			
			Response Blocking
			• Dangerous topography? Response blocking might be necessary
			• Can target behavior be blocked?
			
			Response Cost
			• Redirection during preferred activity?

Fig. 16.1 Redirection treatment package development considerations for practitioners

behavior, when developing redirection treatment packages. (See Fig. 16.1 for practitioner considerations during the development of a redirection treatment package.) Similar to the Colón et al. (2012), Hagopian et al. (2011), Schmidt et al. (2017), and Taylor (2020) procedures, practitioners should consider building upon individuals' existing behavioral repertoires by systematically training new appropriate behavior and maintaining it with a DRA to promote response reallocation to contextually appropriate behavior. Considering the limitation of the Cividini-Motta et al. (2020) study, the reinforcer contingent on appropriate behavior should be easy to deliver and not compete with contextually appropriate behavior (e.g., praise, token delivery). Ultimately, functional engagement in contextually relevant behavior should be the end goal of intervention. Producing independent functioning will presumably bring the individual's behavior into contact with the natural consequences for responding in the community at large.

Individualizing and Contextualizing Redirection Treatment Packages

The procedural variations in the redirection literature can inform individualized redirection treatment packages for automatically reinforced challenging behavior. With the individual's safety and wellbeing as a priority, socially valid redirection procedures and outcomes for automatically reinforced SIB differ from those of stereotypic behavior. Unlike SIB, stereotypy is not inherently harmful. Therefore, it is not always necessary, or socially acceptable, to intervene. In the subsequent procedural variations, this distinction must be applied when considering how to best individualize and contextualize redirection procedures.

Treatment Package Components to Improve Redirection Efficacy

Earlier in this chapter, we highlighted that reinforcement procedures can obviate or mitigate the need to implement redirection procedures. In addition to noncontingent sources of reinforcement and differential reinforcement of appropriate behavior, other treatment components can be packaged with redirection to improve treatment efficacy. These procedures include differential reinforcement of other behavior (DRO), verbal reprimands, response blocking, and response cost.

Redirection and Differential Reinforcement of Other Behavior (DRO)

For target responses that are not inherently harmful, such as stereotypy, it is possible to provide contingent access to the target response without redirection. Brusa and Richman (2008) arranged a DRO that involved presenting a stimulus paired with no redirection following intervals without stereotypy. With discrimination training and contingent access to stereotypy, stereotypy occurred at high levels in the presence of the discriminative stimulus and low levels in the presence of the inhibitory stimulus paired with intervention. However, the practicality of the procedure was limited by the brief interval requirements without stereotypy and stereotypy was permitted half of the session duration. These results provide preliminary support suggesting that periods without redirection might be a viable reinforcer that can be arranged in a DRO with non-harmful target behavior in some cases.

Redirection and Verbal Reprimands

In our literature review, we identified several studies that reported general verbal reprimands (e.g., "Stop") or specific reprimands (e.g., "Don't X") paired with redirection. For example, the Hagopian and Adelinis (2001) evaluation involved a contingent verbal prompt to stop engaging in pica followed by either response blocking or response blocking plus redirection. Other redirection procedures involved similar verbal directives, or reprimands, but none of the reviewed studies specifically evaluated the effects of redirection with and without reprimands.

In a treatment analysis for public masturbation, Cividini-Motta et al. (2020) compared redirection to response interruption. Redirection involved 1 min of physical activity and response interruption procedure involved a verbal reprimand (e.g., "stop doing that") paired with brief physical interruption (i.e., response blocking). Both procedures effectively decreased public masturbation, but the response interruption procedure required significantly less time and fewer resources to implement. These results suggest that similar brief interventions might prove to be equally effective as more resource-intensive interventions, such as physical and/or time-based redirection procedures.

Redirection and Response Blocking

Response blocking is another consequent intervention combined with redirection. We identified seven studies that reported combining redirection with a response-blocking component. Notably, multiple redirection evaluations targeting pica (Hagopian & Adelinis, 2001; Hagopian et al., 2011; Schmidt et al., 2017; Taylor, 2020) described response-blocking components combined with redirection. Some redirection procedures involving physical prompts during redirection have the potential to block opportunities to engage in motor target responses, but other redirection procedures have programmed blocking components.

Frewing et al. (2015) described different consequent interventions for vocal stereotypy and motor stereotypy. Vocal stereotypy was followed by redirection to appropriate vocal responses, but motor stereotypy was followed by physically prompting hands-in-pockets. The consequence for vocal stereotypy met our definition of redirection by prompting an active response but the consequence for motor stereotypy is an example of response blocking. Brusa and Richman (2008) noted a response-blocking component in the treatment of stereotypic string play. Contingent to string play, the therapist presented verbal redirection to play with leisure items followed by response blocking in the form of string removal. Similarly, Gould et al. (2019) evaluated a redirection treatment package that involved response blocking prior to presenting redirection demands.

Although we identified numerous studies that combined redirection and response blocking, none of the studies systematically evaluated the additive effects of response blocking. However, Hagopian and Adelinis (2001) demonstrated that redirection can be a useful component to package with response blocking when response blocking alone evokes aggression. In a comparison of response blocking alone and response blocking packaged with redirection, the procedure with redirection effectively treated pica with minimal aggression. Similarly, Hagopian and Toole (2009) demonstrated that verbal redirection might be another alternative to response blocking when it evokes aggression. As previously discussed, Cividini-Motta et al. (2020) compared redirection and a response interruption procedure, involving a reprimand and brief physical blocking. Response interruption effectively decreased the target behavior and required less time to implement the procedure, suggesting brief response blocking can be a useful treatment component that requires few resources to implement. However, it is unclear to what degree the reprimand or blocking was each responsible for the efficacy of the Cividini-Motta et al. procedure.

Redirection and Response Cost

A response cost component has been packaged with redirection in various studies. In several redirection evaluations, the authors did not report a *response cost* component but the redirection procedure involved blocking or removing leisure items during redirection. Procedural components like this, involving the contingent removal of putative reinforcers, can be conceptualized as examples of response cost procedures. Response cost treatment components have the potential to improve the efficacy of redirection treatment packages.

The Brusa and Richman (2008) study, involving a DRO with periods without redirection following intervals without stereotypy, arguably involved a response cost component. Following 10 s without stereotypy in the presence of the red card paired with intervention, the green card was presented, and stereotypy was free to occur. If stereotypy occurred in the presence of the red card, redirection or response blocking was implemented, and the interval was restarted with the latency to reinforcement extended. When redirecting non-harmful target behavior, a DRO combined with a similar response cost component might add to the efficacy of a redirection treatment package.

In recent years, Toper-Korkmaz et al. (2018) and McNamara and Cividini-Motta (2019) evaluated the additive and relative efficacy of redirection and response cost in the form of contingent toy removal. The most effective intervention and the relative efficacy were idiosyncratic across the participants, which is in line with the Verriden and Roscoe (2019) punisher assessment conclusions. In some cases, however, redirection packaged with response cost was more effective than redirection alone. These results suggest that response cost treatment components can add to the efficacy of redirection with some individuals. Additionally, Toper-Korkmaz et al. posited that other published reports of redirection efficacy might have been affected by the inclusion of a response cost component.

Recommendations for Treatment Package Components

When incorporating empirically supported redirection procedures into practice, the goal should be to develop efficient and effective treatment packages that (1) promote appropriate behavior and (2) decrease interfering or dangerous automatically reinforced behavior. In addition to the reinforcement-based treatment components outlined in the *Recommendations for Promoting Appropriate Behavior* section (Sect. 3.2.3), practitioners can consider packaging DRO, verbal reprimands, response blocking, and/or response cost with redirection. Firstly, it is important to consider if the target behavior can safely be permitted to occur. If so, it might be feasible to arrange a DRO with contingent access to intervals without redirection following intervals without the target behavior (e.g., Brusa & Richman, 2008).

Although there is limited research evaluating the additive effects of verbal reprimands paired with redirection, verbal reprimands might be a useful treatment component in some cases. In addition to functional analyses informing whether or not reinforcement-based procedures will decrease automatically reinforced behavior, low levels of responding in an attention condition may be indicative of reprimands functioning as a positive punisher. The social acceptability of verbal reprimands might also be improved when paired with redirection by promoting appropriate behavior with redirection. Verbal reprimands that provide a precise description of contextually-relevant behavior should be considered.

Considering the Verriden and Roscoe (2019) punisher assessment conclusions that the most effective and socially valid intervention is likely idiosyncratic, we recommend that practitioners consider the individual and context when developing treatment packages. For topographies of automatically reinforced SIB, response blocking might be a necessary treatment component to package with redirection to prevent occurrences of the target behavior (e.g., Hagopian & Adelinis, 2001; Hagopian et al., 2011; Schmidt et al., 2017; Taylor, 2020). Additional contingent intervention components (e.g., verbal reprimands, response blocking, response cost) paired with redirection have the potential to improve treatment effects, but they also may require more resources to implement in some cases. Notably, response cost may not be necessary, and if not, the intervention will likely be more socially acceptable. Similar to what was noted in the *Redirection and Promoting Appropriate Behavior* section (Sect. 3.2), we reiterate the Pokorski and Barton (2021) recommendation to pair all consequence-based interventions with reinforcement available for appropriate behavior to promote response reallocation to appropriate alternatives.

Contextualize Redirection Treatment Packages

In a review of RIRD studies, Martinez and Betz (2013) noted that the efficacy and practicality of redirection in natural settings were unknown. Our review of redirection studies involved broader inclusion criteria and more evaluations conducted in natural settings in recent years. Although recent studies have been conducted in naturalistic settings, few studies have informed redirection procedures and supplemental measures based on the treatment context. Naturally occurring contexts and activities dictate what responses constitute functional engagement and the contingencies of reinforcement at play. Therefore, we recommend that practitioners consider the treatment context when developing redirection treatment packages.

Identify Problematic Contexts

The consideration of "Is the target behavior inherently harmful?" is of particular importance when identifying the contexts in which the target behavior is problematic. As mentioned, it is not always appropriate or necessary to intervene with stereotypic behavior. Therefore, it is important to identify contexts in which the target behavior warrants intervention. Supplemental measures of contextually appropriate behavior can inform if the automatically reinforced challenging behavior is interfering with functional engagement in particular contexts.

In the redirection studies that we reviewed, over half of the studies measured appropriate vocalizations during redirection and only several studies measured other topographies of appropriate behavior. With the aim of implementing redirection during naturally occurring activities, supplemental measures of contextually appropriate behavior (e.g., social, vocational, academic) should be informed by the contexts in which redirection is being considered. Therefore, we recommend measuring baseline levels of the target behavior and contextually appropriate behavior to (1) determine if redirection of non-harmful behavior is warranted in a particular context and (2) measure the effects of redirection on contextually appropriate behavior. If the target behavior is both not harmful and not interfering with functional engagement in the context, redirection of the behavior may not be warranted or socially valid. When targeting automatically reinforced SIB, it is likely irrelevant to identify problematic contexts because intervention will likely be necessary in all contexts in which the target behavior occurs.

Promote Contextually Appropriate Behavior

As noted, more recent redirection studies have been conducted in natural settings. Natural settings lend to noncontingent competing stimuli and natural reinforcement contingencies for contextually appropriate behavior. Pokorski and Barton (2021) asserted that behavior-analytic research must evaluate less-intrusive reinforcement-based interventions prior to implementing punishment-based procedures. Therefore, prior to implementing redirection, researchers and practitioners should consider if there are other sources of reinforcement to promote and maintain contextually appropriate behavior. In addition to including measures of contextually appropriate behavior, we recommend that redirection evaluations need to promote appropriate behavior by prompting functional engagement in ongoing activities (e.g., Gibbs et al., 2018), training new adaptive skills (e.g., Colón et al., 2012; Hagopian et al., 2011; Schmidt et al., 2017; Taylor, 2020), and/or arranging reinforcement contingencies.

Redirection to Contextually Appropriate Behavior

Most of the redirection studies that we identified evaluated redirection demands unrelated to an ongoing activity (e.g., social questions, vocal imitation), and few studies redirected the target behavior by prompting contextually appropriate behavior. Some studies redirected the target behavior by prompting item engagement with leisure items (e.g., Brusa & Richman, 2008; Peters & Thompson, 2013; Verriden & Roscoe, 2019). The redirection demands described by Karmali et al. (2005), Guzinski et al. (2012), and Wells et al. (2016) involved vocal demands related to the ongoing activity. Karmali et al. and Guzinski et al. redirected by prompting tacts related to the ongoing activity. Whereas Wells et al. implemented redirection during group instruction in a classroom and the redirection demands were questions related to the ongoing instruction. Similarly, Cook and Rapp (2020) evaluated contingent physical redirection to engage in an ongoing academic task (e.g., puzzle, pegboard, sorting) that required motor responses.

Multiple redirection procedures targeting pica involved redirection to discard possible pica items. During redirection in naturalistic settings, Hagopian et al. (2011) programmed for generalization by only redirecting to discard items when the item was suitable to discard, but otherwise redirecting to functionally engage with the item. We suggest that practitioners program for generalization across settings by redirecting the target behavior by prompting functional engagement in the ongoing activity.

Several studies, including Ahrens et al. (2011), Shawler and Miguel (2015), and Wunderlich and Vollmer (2015), have compared redirection demands requiring motor responses with those requiring vocal responses on the efficacy of redirection. To date, these comparisons have concluded that redirection efficacy does not correspond to the topography of redirection demands. In addition to supporting the use of motor redirection contingent on automatically reinforced vocalizations with individuals without vocal verbal repertoires, these results provide flexibility to practitioners to redirect automatically reinforced behavior back to the ongoing activity irrespective of topography. Although additional research is warranted to evaluate the possible additive effects of redirection to contextually appropriate behavior, it has the potential to increase contextually appropriate behavior (e.g., academic, social, vocational) in addition to decreasing interfering automatically reinforced behavior. Redirection back to contextually appropriate behavior might also prove to be more socially valid in natural settings.

Social Acceptability Considerations

Similar to what was outlined in the seminal paper by Wolf (1978), redirection treatment package development and treatment goals should be informed by input from relevant stakeholders. Verriden and Roscoe (2019) provided a model for identifying socially valid interventions by incorporating clinician input throughout the assessment and evaluating putative punishers in the context of reinforcement for appropriate behavior (i.e., competing stimuli, DRA). According to Pokorski and Barton (2021), evaluations of consequence-based procedures should adopt a variation of the Verriden and Roscoe model to evaluate consequent interventions with reinforcement simultaneously available. Following the Verriden and Roscoe assessment, the researchers reviewed the results and videos with the participants' clinicians to evaluate the acceptability of the procedures, outcomes, and goals, and the feasibility of implementation. Similarly, Athens et al. (2008) used caregiver input to inform the treatment thinning goal to systematically program for socially significant outcomes. In addition to these methods for developing socially acceptable redirection treatment packages, researchers and practitioners need to consider the practicality of the procedure in natural settings.

Several redirection studies that progressed to naturalistic contexts evaluated treatment package variations to improve implementation practicality and treatment effect durability. The reviewed studies conducted in natural settings provide empirical support for redirection during naturally occurring activities. However, evaluations of redirection in natural settings need further development, but practitioners can incorporate existing empirical research to develop socially acceptable redirection treatment packages.

Redirection Procedural Variations

Several reviewed studies conducted in controlled settings evaluated procedural variations to reduce redirection implementation. Saini et al. (2015) and Toper-Korkmaz et al. (2018) concluded that one-demand redirection produced significant treatment effects, and the redirection implementation was significantly less or equal to that of three-demand redirection. These results suggest that reduced redirection requirements might result in equally effective treatments and require less time to implement redirection. The Cividini-Motta et al. (2020) treatment comparison of brief response interruption and 1-min physical redirection produced similar results, with the brief interruption being equally effective but requiring considerably fewer resources. However, similar systematic evaluations with time-based redirection procedures (e.g., 30 s of physical guidance) are lacking in the current literature. Future investigations need to evaluate more practical time-based redirection procedures to maintain treatment efficacy and improve practicality for implementation in natural settings. These evaluations are especially relevant to redirection treatment packages in natural settings when redirection often interrupts ongoing activities and requires effort on the part of an implementer.

Redirection procedures have also varied with respect to prompt topography, including both verbal and physical prompts to engage in appropriate alternative responses. Practitioners should consider listener repertoires (i.e., following verbal directives), compliance with demands, challenging behavior that might be evoked by physical prompting, and the practicality and social acceptability of the form of prompting. For example, redirection involving physical prompts might be most effective and feasible for small children with limited verbal repertoires who do not engage in challenging behavior when physically prompted. Some redirection procedures have involved prompt hierarchies to prompt compliance with redirection demands after initial redirection, but Ahrens et al. (2011) also suggested that redirection can be effective without requiring compliance. Hagopian and Toole (2009) elected to evaluate a verbal redirection procedure because the participant engaged in aggression when stereotypic behavior was blocked. More research is needed with respect to the relative efficacy and social validity of redirection prompts and prompt hierarchies, but we recommend that practitioners consider client-specific characteristics and repertoires. Similarly, repertoires of appropriate behavior should inform the alternative responses of redirection. As noted in the *Redirection to Contextually Appropriate Behavior* section (Sect. 3.3.2), comparisons of redirection to motor and vocal responses (e.g., Ahrens et al., 2011; Shawler & Miguel, 2015; Wunderlich & Vollmer, 2015) all suggest that the redirection alternative responses do not need to match the target behavior topography. This finding allows practitioners to develop redirection procedures informed by individuals' repertoires, including redirection procedures similar to those described by Steinhauser et al. (2021) that involve teaching contextually relevant functional engagement that are likely more socially acceptable than arbitrary redirection demands.

Treatment Integrity and Redirection Thinning

With concerns about the practicality of redirection implementation in natural settings, Giles et al. (2018), Colón and Ahearn (2019), and Gauthier et al. (2020) evaluated redirection treatment integrity. Experiment 1 of Colón and Ahearn suggested that the most common treatment integrity error in classroom settings was the failure to implement redirection contingent on the target behavior. However, the procedure was implemented with accuracy when it was implemented. The results from Experiment 2 replicated the Ahrens et al. (2011) Experiment 3 results, suggesting that redirection remains effective at as low as 50% integrity (i.e., treatment consistency). Additionally, the level of stereotypy during the phase alternating 100% integrity booster sessions and 25% integrity sessions suggests that redirection just needs to be implemented with high treatment integrity at least some of the time. Unlike the Colón and Ahearn arrangement, Gauthier et al. compared 33% and 100% integrity in an alternating treatment component within an ABAB design. The 33% condition was evaluated prior to obtaining treatment effects with a full integrity condition and decreased stereotypy in some cases. The results suggest that exposure to full or integrity redirection might be necessary before thinning treatment consistency. Given the outcomes of Colón and Ahearn and Gauthier et al., scheduling occasional booster sessions might maintain redirection treatment effects when implementing redirection in natural settings with uncertain integrity. The Sivaraman and Rapp (2020) findings are also informative for clinical applications, suggesting that longer exposure to redirection procedures can have longer lasting effects on the target behavior when the intervention is no longer in place.

Similar to the Colón and Ahearn (2019) findings and the Martinez et al. (2016) and Sloman et al. (2017) redirection thinning, we suggest that practitioners consider thinning the redirection procedure after the treatment package effectively decreases the automatically reinforced target behavior. After repeated exposure to five-demand redirection, Martinez et al. improved the redirection practicality by reducing the redirection requirement to one-demand redirection. With the aim of improving the practicality of redirection during academic and vocational activities, Sloman et al. approached redirection thinning by fading the consistency of redirection in an intermittent redirection phase following an initial redirection evaluation. The intermittent redirection procedure involved consistent redirection implementation for the first minute of the condition and then on a fixed interval (FI) 1-min schedule, and the target behavior remained at low levels during intermittent redirection. With no redirection as the desired end point, we recommend that practitioners arrange systematic redirection thinning based on available resources in the natural environment and empirically supported procedural variations.

With redirection often evaluated with socially significant topographies of challenging behavior, the maintenance over time and generality of treatment effects across naturalistic settings, activities, and implementers are particularly important. We identified numerous studies that paired a stimulus (e.g., colored card, wristband) with contingent redirection with the aim of establishing inhibitory stimulus control, but the reviewed studies provide minimal support for the establishment of inhibitory control (e.g., Martinez et al., 2016). Multiple studies involved datasets with delays to recapture original baseline levels, suggesting that there is more evidence to support the assertion that the implementer of redirection or treatment setting acquired inhibitory stimulus control (e.g., Cividini-Motta et al., 2020; Wunderlich & Vollmer, 2015). Therefore, we recommend that future applied evaluations systematically evaluate redirection across settings, activities, and implementers similar to the

Hagopian et al. (2011) treatment application in naturalistic settings.

Although studies have evaluated procedural variations to improve the clinical practicality of redirection, Vorndran and Lerman (2006) was the only study that we identified that paired redirection with a less-intrusive procedure that did not involve redirection. After pairing the less-intrusive procedure with redirection, the less-intrusive procedure without redirection maintained the treatment effects. We suggest that future investigations further evaluate methods for pairing redirection with less-intrusive alternatives and thinning interventions.

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Error-Correction Procedures

17

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Discrimination Training and Error Correction

Discrimination is defined based on differential responding in the presence of a target (i.e., discriminative) stimulus and not its absence (Catania, 2013; McIlvane, 2013). Differential reinforcement of responding in the presence of a given stimulus, and extinction of responding in its absence, has been shown to establish discriminated responding in some (Petursdottir & Aguilar, 2016; Schilmoeller et al., 1979), but not all cases (Saunders & Spradlin, 1990, 1993). Further, a history of this training arrangement may be detrimental to the acquisition of future discriminations (Schilmoeller et al., 1979; Stoddard & Sidman, 1967). This arrangement has historically been referred to as *trial-and-error learning*, although reference to *differential reinforcement* may be preferred (Skinner, 1984). Regardless of the terminology used, a major limitation of these arrangements is the considerable number of errors that may be emitted during training.

Establishing differential responding in the presence of a stimulus with few to no errors is a prominent goal of discrimination training in educational or therapeutic interventions (Mueller et al., 2007; Sidman, 2010; Wolery & Gast, 1984). Doing so may require a variety of antecedent manipulations commonly referred to as *errorless* strategies (Moore & Goldiamond, 1964; Terrace 1963a, b; Touchette & Howard, 1984). Reference to these strategies as *errorless* can be misleading as these procedures commonly produce discriminated responding in fewer errors than differential reinforcement procedures, although errors are still emitted (Mueller et al., 2007). Indeed, initial discrimination training that includes errorless strategies may be associated with a considerable number of errors, particularly for individuals with intellectual disabilities (Graff & Green, 2004; McIlvane et al., 2016; Stoddard & Sidman, 1967). As a result, additional error-contingent consequences may be programmed in concert with antecedent manipulations (e.g., errorless strategies) to facilitate the efficient transfer of stimulus control.

Error-correction procedures include a range of consequence strategies presented following an error that increase the probability that a correct response will occur in the future (Cariveau et al., 2019; McGhan & Lerman, 2013). Although procedural variations are common, the function of error correction is often twofold: (a) to decrease the likelihood that an incorrect response will be emitted under similar conditions and (b) to prompt the target response. As such, the primary

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_17

goal of error correction is to arrange disparate consequences for correct and incorrect responding and to facilitate the transfer of stimulus control within and across learning trials.

To date, limited research on error-correction procedures has considered the nature (i.e., controlling relations) of incorrect responding. The fine-grain stimulus control analyses offered by McIlvane (2013) may not be incorporated into typical clinical programming and are similarly absent from the extant literature on error-correction procedures. Instead, a single strategy may be applied to all learners' programming in a given clinical or educational setting. It is unsurprising, then, that research in this area has predominantly included comparative studies in which the efficiency of discrimination training is examined across two or more error-correction procedures. This body of comparative research serves to illustrate the various components of error-correction procedures that may contribute to the efficient transfer of stimulus control. Nevertheless, considering an operational definition of errors and the conditions that produce errors is critical to arranging effective instructional practices.

What Are Errors?

In educational and therapeutic settings, errors may commonly be defined based on some cultural, social, or normative criterion. This point was already made by Skinner:

> I do not believe that organisms ever misbehave. I long ago adopted the basic rule in animal research that the organism is always right. It does what it is induced to do by its genetic endowment or the prevailing conditions. If anyone misbehaves, it is the experimenter in making a bad prediction (Skinner, 1977, p. 1007).

> The term 'error' does not describe behavior, it passes judgement on it (Skinner, 1984; p. 583).

As such, the characterization of an organism's responding as incorrect or as misbehavior may suggest that (a) the perceived controlling relations and those actually controlling responding are incongruent (McIlvane & Dube, 2003) or (b) our understanding of the many effects of the arranged contingencies is inadequate (Skinner, 1977). Further complicating the matter, patterns of responding may be affected by selection at the phylogenic level (Breland & Breland, 1961), referenced as the organism's genetic endowment in the Skinner (1977) quote above.

Errors may commonly be defined as instances in which the target response is not emitted under the target conditions (i.e., errors of omission) or when a target response is emitted under nontarget conditions (i.e., errors of commission; Bergmann et al. (2017), Fisher et al. (2014), Leon et al. (2014)). This categorization is limited, however, as it does not include further consideration of the controlling relations of the incorrect response. McIlvane and Dube's (2003) concept of *stimulus control topography (SCT) coherence* may provide instructors with a greater understanding of the conditions producing incorrect responding. In short, SCT coherence is said to occur when the controlling relations specified by the instructor and those actually controlling the learner's response are concordant (McIlvane & Dube, 2003; McIlvane, 2013). The level of stimulus control analysis offered in descriptions of *SCT coherence* allows for a more robust determination of controlling relations. This is critical to understanding errors as conditions that may initially appear to produce accurate responding may later be shown to have contributed to faulty stimulus control (e.g., Grow et al., 2011; McIlvane, 2013).

In one exceptionally pertinent example, instructional programs may commonly attempt to establish discriminations under *select* control. That is, selection of the target stimulus (S+) is made regardless of what nontarget stimuli (S−) are presented. This may be assumed under situations in which the learner selects the picture of a mouse when the instructor says "mouse"; however, it is also possible that the learner is responding away from the other comparison stimuli, termed *reject* control (Sidman, 2009). A number of conditions may contribute to the development of reject control (McIlvane et al., 1987, 1988; Wilkinson & McIlvane, 1997; Sidman, 1987; Wilkinson et al., 2009), and the instructor may be completely unaware of this faulty stimulus control until incorrect responding is observed when minor changes to the instructional procedure (e.g., the comparison stimuli) are made (Sidman, 1987, 2009).

In the above-example, selection of the mouse in the presence of the auditory stimulus "mouse" may occur through select or reject control (or a combination of select and reject control; McIlvane, 2013). Regardless, the learner's response would be considered correct until future conditions were arranged in which the controlling relations were not present (e.g., when the S− are also unknown). This may illustrate the complexity of error analysis as even correct responding (e.g., selecting the mouse) may be incorrect (i.e., under faulty stimulus control; Sidman, 1987). Further contributing to this complexity are pervasive patterns of responding that may develop before or during discrimination training, referred to as *response* or *stimulus biases*. Although a thorough description of this literature is beyond the scope of this chapter, some pertinent domains for instructors to consider are described below.

Bias as Errors

Responding may be said to exhibit *bias* when it occurs in the presence of some stimulus condition despite no differential consequences being arranged (Irwin, 1958). Differentiated responding to some dimension of a discrimination paradigm (e.g., position or stimulus) is commonly reported (Lander, 1968; Kieffer, 1965) and may persist in the early stages of acquisition. Stimulus bias is most evident under concurrent schedules of reinforcement in which two or more response alternatives, and corresponding stimuli, are presented simultaneously (Biederman et al., 1988), although other schedule arrangements have been used (e.g., multiple schedules; Kieffer, 1965; Starr & Staddon, 1982). Biased responding is said to occur when differentiated response rates are observed even though the schedule on each alternative is identical. This finding was previously termed *sensory superstition* and believed to arise from adventitious reinforcement (Morse & Skinner, 1957; Starr & Staddon, 1982). Nevertheless, the relations controlling these biased patterns of responding are often unclear, although they may be related to variables such as the interfood interval and stimulus duration (Starr & Staddon, 1982), stimulus onset (McIlvane et al., 2002), stimulus modality (Kieffer, 1965), or stimulus intensity (Biederman et al., 1988; Blue et al., 1971; Raslear, 1981).

Biased responding may commonly be endorsed as adhering to win-stay or win-shift patterns. These response patterns may be most apparent in an example of a red/green color discrimination. Following reinforcement of a response to the green stimulus, win-stay responding would be characterized by persistent responding to the green stimulus. In contrast, win-shift responding would be characterized by responding immediately shifting to the red stimulus after reinforcement on the green. Some authors have suggested that these response patterns are species-specific, with pigeons and rats exhibiting more durable stay (Shimp, 1966; Zeiler, 1987) and shift (Timberlake & White, 1990) patterns of responding, respectively (Randall & Zentall, 1997). Nevertheless, other features of the environment may affect the durability of these response patterns (Hearst, 1962; Randall & Zentall, 1997; Shimp, 1976).

Additional response biases have been reported in human populations and may be most prevalent in individuals with autism spectrum disorder (ASD) or intellectual disabilities (Dickson et al., 2006; Koegel & Schreibman, 1977; Lovaas et al., 1979; Schreibman et al., 1982). In these populations, responding may be controlled by specific components of a compound stimulus instead of all relevant features, termed *stimulus overselectivity* (Schreibman et al., 1982), *overselective stimulus control* (Dickson et al., 2006; Farber et al., 2017), or *restricted stimulus control* (Dube & McIlvane, 1997; Dube et al., 2010). Overselective responding may have considerable implications for learning under a variety of conditions (Lovaas et al., 1979) and has accordingly received substantial attention in the extant literature (see review by Ploog, 2010). An additional concern in overselective or biased responding by individuals with intellectual or developmental disabilities is control by irrelevant features of an instructional arrangement, such as biased responding to a stimulus position.

Position bias is a significant concern in discrimination training programs that include a stimulus array (i.e., simultaneous discriminations; Grow et al., 2011; Mackay, 1991; Sidman, 1980). Stimulus position is often a nonfunctional feature of discrimination paradigms, yet numerous studies have reported responding that is controlled by position (e.g., responding exclusively to one side of an array; Berryman et al., 1963; Bourret et al., 2012; Grow et al., 2011; Kangas et al., 2011; Kangas & Branch, 2008; Schneider et al., 2018). Position biases may be evident early in discrimination training and resolved quickly through contact with reinforcement on alternatives (Berryman et al., 1963; Schneider et al., 2018); yet they have also been shown to inadvertently arise as a direct result of discrimination training (Grow et al., 2011). A number of variables may contribute to the development of position biases (Bourret et al., 2012); although a prominent concern is the schedule of reinforcement available for responding exclusively to one position (MacKay, 1991; Skinner, 1950). This schedule is functionally related to the number of comparison stimuli in the arrangement, such that more comparisons would be associated with a reduced reinforcement schedule for position-exclusive responding. Further, alternating the position of the discriminative stimulus across trials, a commonly recommended practice (Green, 2001), may produce a variable schedule of reinforcement for biased responding. As a result, interventions that directly affect the reinforcement available for responding to a single position may be particularly effective (e.g., Bourret et al., 2012), including certain error-correction procedures. For example, error-contingent trial re-presentations until a response to the correct stimulus is emitted require (a) a shift in responding to the other comparison stimulus to produce reinforcement and (b) a reduction in the schedule of reinforcement as durable responding to a side will result in greater extinction (Kangas & Branch, 2008; Mackay, 1991). As a result, error-correction procedures may play a critical role in the reduction of response biases during discrimination training.

Evaluating Error-Correction Procedures

Error-correction procedures in the extant literature have included a considerable number of procedural variations. Evaluating these procedures requires consideration of at least four domains: (a) effectiveness, (b) efficiency, (c) intrusiveness, and (d) the learner's preference for a particular procedure.

Effectiveness

A procedure is effective if it produces responding at the mastery criterion. Effectiveness serves as a necessary condition for all other evaluative domains. Specifically, efficiency, intrusiveness, and learner's preference would not be considered if the procedure is ineffective. As described below, a number of error-correction procedures have been shown to be effective, which has allowed for researchers to consider other evaluative measures, such as efficiency.

Efficiency

Efficiency is relationally defined, such that a procedure may only be considered efficient relative to another condition (e.g., typical instruction). As such, studies of efficiency require the use of comparative research designs (see Ledford & Gast, 2018). Wolery et al. (1991) describe five conceptualizations of efficiency, although research on error-correction procedures has generally only considered rapidity of acquisition. Specifically, a procedure may be endorsed as efficient when it produces responding at the mastery criterion in fewer trials/exposures, sessions, or time than another procedure (Cariveau et al., 2016; Kodak et al., 2016; Wolery et al., 1991). Efficiency may often take precedence over the intrusiveness of, or a learner's preference for, a procedure; although this should certainly not always be the case (Van Houten et al., 1988).

Intrusiveness

Intrusiveness has been defined as the amount or duration of responding required by the instructor or learner (McGhan & Lerman, 2013). Less-intrusive or less-restrictive interventions are commonly recommended in the behavior analytic literature (Bailey & Burch, 2016; BACB, 2014; Foxx, 2008; Van Houten et al., 1988). McGhan and Lerman (2013) have similarly recommended that the intrusiveness of error-correction procedures be considered. Interestingly, it may be commonly assumed that more-intrusive strategies are less efficient; yet, the description of error-correction procedures below will show this is not always the case. Nevertheless, instructors may select interventions that are more intrusive if they are more efficient, although some behavior analysts have argued for refining less-intrusive interventions to be more effective or efficient (Lerman & Vorndran, 2002). Finally, it is commonly assumed that the intrusiveness and aversiveness of a given procedure are positively correlated (McGhan & Lerman, 2013), yet some research has shown that learners may prefer more-intrusive interventions (Hanley et al., 2005; Kodak et al., 2016; Markham et al., 2020).

Learner Preference

Learner preference for error-correction procedures should also be considered. Preference for an instructional intervention is commonly assessed using a concurrent-chains assessment (Hanley et al., 1997; Kodak et al., 2016). In this arrangement, a learner is allowed to select a condition and then receives instruction using the selected procedures. To date, only two studies examined learners' preference for error-correction strategies (Jessel et al., 2020; Kodak et al., 2016). Findings of preference are often idiosyncratic and may not be related to intrusiveness or efficiency. For example, of the five participants included in the study by Kodak et al. (2016), four exhibited a preference for a condition. For three of these participants, the least-intrusive intervention was also the most efficient; yet this condition was preferred by only a single participant. As a result, selecting an error-correction procedure may require instructors to consider efficiency, intrusiveness, and preference, although the extant literature would suggest that concordance among these variables should not be expected.

Error-Correction Procedures

An abundance of error-correction procedures has been described to date. Instructors may face challenges in navigating this literature as a result of the (a) number of procedures described, (b) prevalence of minor procedural differences across studies, and (c) use of similar or identical names to describe unique procedures (see review by Cariveau et al. (2019)). In this section, error-correction procedures are grouped based on methodological similarities and presented from least-to-most intrusiveness.

Extinction

Extinction following an incorrect response is consistent with procedures described previously as trial-and-error learning or differential reinforcement. In comparative research on error-correction procedures, extinction-only conditions predominate as control conditions. Vast amounts of experimental data suggest the efficacy of these differential reinforcement arrangements (see above). Notably, these procedures have not been shown to be similarly efficacious in applied research (Carroll et al., 2018; Kodak et al., 2016), likely due to the inclusion of topography-based response requirements (Michael, 1985). Nevertheless, when the response modality is selection-based, applied research has found differential reinforcement procedures to be effective, but often less efficient, than other error-correction procedures (Harris & Tramontana, 1973; Rodgers & Iwata, 1991; Smith et al., 2006).

Punishment Alone

Additional research has arranged for error-contingent consequences that do not include demonstrating or prompting the target response. We have referred to these conditions as *punishment alone* procedures as increases in correct responding would still occur only through contacting the prevailing contingencies (i.e., differential reinforcement). Common arrangements in this literature include timeout from positive reinforcement, negative punishment, and error statements.

Timeout

Research on the punishment of incorrect responding in discrimination training received attention from prominent scholars in behavior analysis in the 1960s. In this work, timeout from reinforcement following incorrect responses was often studied (Ferster & Appel, 1961; Miller & Zimmerman, 1966; Zimmerman & Baydan, 1963; Zimmerman & Ferster, 1963). This literature has generally found that the duration of timeout is functionally related to the suppression of incorrect responding (Ferster & Appel, 1961). As the duration of timeout increases, however, this effect has been shown to diminish past some optimal value (Chelonis et al., 2007), potentially due to complete suppression of responding (Miller & Zimmerman, 1966; Zimmerman & Baydan, 1963). Although the duration of timeout has received prominent attention, the schedule of timeout is also implicated in the effectiveness of a given procedure. In one example, Zimmerman and Baydan (1963) evaluated the effects of intermittent schedules of timeout on discrimination accuracy in undergraduate students and found that continuous schedules produced greater accuracy than intermittent schedules. Similarly, Zimmerman and Ferster (1963) examined different schedules and durations of timeout on the accuracy of performance on a matching-to-sample task with two pigeons and observed optimal performance when S- responding produced a continuous schedule of "timeout of intermediate duration" (p. 355). The findings of this experimental research would suggest that timeout is an important variable to be considered in error-correction procedures.

Negative Punishment

Negative punishment is the error-contingent removal of a reinforcer or conditions discriminative for reinforcement (Catania, 2013). Negative punishment contingencies have not received substantial attention in the error-correction literature, although prominent examples exist. In one such example, Harris and Tramontana (1973) evaluated the effects of response-contingent removal (negative punishment) or addition (positive reinforcement) of candy on simple discrimination task performance with 24 children with intellectual disabilities. The authors also included a third condition that combined both contingencies. Participants exhibited significantly fewer trials to criterion in negative punishment and combined conditions compared to the positive reinforcement-only condition. Similar outcomes have been shown across numerous studies on discrimination learning (Hemry, 1973; Munson & Crosbie, 1998; Witte & Grossman, 1971). These findings suggest that error-contingent removal of reinforcers or conditions discriminative for reinforcement facilitates discrimination learning.

Error Statements

In the applied literature, error statements, such as saying "no" following an incorrect response, have also been evaluated. These arrangements may be conceptualized as a positive punishment procedure, which have been shown to be efficacious in a number of error-correction studies (McGhan & Lerman, 2013; Rodgers & Iwata, 1991; Smith et al., 2006). Smith et al. (2006) compared the effects of no feedback, error statement, and a demonstration condition on the acquisition of two-choice word-to-picture matching tasks for six children with ASD. During all conditions, correct responding produced reinforcement and errors produced either (a) no differential consequences (no feedback), (b) the instructor saying "no" (error statement), or (c) the instructor demonstrating the target response (demonstration condition). Across 33 comparisons, responding met the mastery criterion in the fewest number of trials in the demonstration condition for eight comparisons, the error statement condition for six comparisons, and the no feedback condition for three comparisons. For the remaining 16 comparisons, trials to mastery were similar in at least two conditions with five target sets being acquired in the same number of trials across all three conditions. These results suggest that the error statement and demonstration conditions are superior to no feedback following incorrect responding. Nevertheless, the similar efficiency outcomes in the error statement and demonstration conditions may be surprising, although this finding may not be generalizable to tasks beyond two-choice discrimination procedures. Specifically, using identical conditions and larger stimulus arrays, McGhan and Lerman (2013) found the demonstration condition to be superior to an error-statement condition across all comparisons. These findings suggest that error-statement procedures may be effective under limited conditions. Nevertheless, this research has also shown that other minimally intrusive procedures may also be effective (e.g., demonstration procedures).

Demonstration and Active Student Response

Demonstration and active student response error-correction procedures are commonly included in comparative studies and differ only in the response requirement of the learner. In a typical demonstration error-correction procedure, errors result in the instructor demonstrating the correct response and removing the discriminative stimulus (Cariveau et al., 2019). The term *demonstration* is preferred over *modeling* as the learner is not required to emit the target response. In contrast, active student response procedures involve the therapist modeling the target response and requiring the student to echo or imitate the prompt (Cariveau et al., 2019). Barbetta and Heward (1993) compared the effects of demonstration and active student response procedures on the acquisition of state and country capitals for three students with learning disabilities. Following an error in the demonstration condition, the instructor provided an error statement and demonstration (i.e., "No, it's ____. Look at it.") and gave the learner 2 s to look at the card. The instructor then praised the learner for looking at the stimulus and presented the next trial. The learner was not required to emit the correct response and doing so did not produce any differential consequences. In the active student response condition, the same corrective statement was presented (i.e., "No, it's _____.) followed by a model prompt. The learner was required to emit a prompted correct response, which produced verbal praise and the next trial. The authors found that the learners acquired more targets under the active student response condition, although both procedures were effective.

The findings of Barbetta and Heward (1993) are generally consistent with other comparative studies suggesting that active student response procedures may produce more efficient learning (Barbetta et al., 1993; Drevno et al., 1994). Interestingly, the demonstration procedure was shown to be effective in producing mastery levels of responding in the majority of comparisons (Barbetta et al., 1993; Drevno et al., 1994). More recently, research with individuals with developmental disabilities has found the opposite finding, suggesting that demonstration conditions may be more efficient than active student response procedures (Isenhower et al., 2018; Kodak et al., 2016; McGhan & Lerman, 2013).

Kodak et al. (2016) compared five different error-correction procedures on the acquisition of sight words and prepositions for five children with ASD. The authors found that the demonstration condition was the most efficient form of error correction for four out of five participants when assessing sessions, exposures, and minutes to mastery. Isenhower et al. (2018) also evaluated the effectiveness of a demonstration and active student response error-correction procedure on the acquisition of auditory-visual conditional discriminations (e.g., pointing to a dog from an array when instructed to "point to the dog"). In a subsequent phase, the authors modified the demonstration condition to minimize the learner's ability to emit the target response following the demonstration by moving the card out of the learner's reach. Similar to the findings of Kodak et al., the demonstration condition with and without blocking were more efficient at producing mastery level responding relative to the active student response procedure.

The findings of both Kodak et al. (2016) and Isenhower et al. (2018) are particularly interesting as they do not replicate the findings of earlier research on these procedures (Barbetta & Heward, 1993; Barbetta et al., 1993; Drevno et al., 1994). In an attempt to account for these differences, Kodak et al. measured the emission of echoic responses in the demonstration condition, even when they were not required or produced any differential consequences. The authors found that the learners who acquired targets more rapidly in the demonstration condition emitted the echoic following the instructor's demonstration during an average of 79% of trials. Isenhower et al. also found that the learners in the demonstration condition emitted the correct response following the instructor's demonstration during all presentations. Participants even did so when the instructor attempted to remove the target stimuli to prevent these responses in a subsequent modification to the demonstration condition. Although earlier research also reported responses during the demonstration condition (e.g., Barbetta & Heward, 1993), responding reportedly occurred in only a small portion of trials. As a result, it is unclear whether participants' overt responses, even when not required, affected the efficiency of the demonstration condition.

The emission of the target responses in the demonstration condition would seemingly equate the demonstration and active student response procedures in the studies by Kodak et al. (2016) and Isenhower et al. (2018). Indeed, the only apparent difference between these two conditions would be the instructor's expectations for the learner to emit the response. The instructor's expectations certainly would not have an effect on responding by the learner, so additional characteristics of the procedures must be considered. Demand characteristics of the prompting procedure in active student response conditions are of interest as they may function as aversive conditions; yet other procedural variations may be responsible for some of these unique findings, particularly those by Kodak et al. Specifically, differential reinforcement of unprompted correct responses differed in the demonstration and active student response conditions.

Criteria for arranging a greater magnitude, schedule, or quality of reinforcement for unprompted, relative to prompted, correct responses have been shown to affect the efficiency of instructional procedures (Johnson et al., 2017; Karsten & Carr, 2009; Olenick & Pear, 1980). The onset of these differential reinforcement procedures, however, has only been evaluated in a single study to date (Campanaro et al., 2019). Campanaro et al. (2019) found that the immediate onset of differential reinforcement of unprompted correct responding produced more efficient acquisition for three children diagnosed with ASD compared to early onset (i.e., two consecutive sessions with unprompted correct responding at or above 33%), late onset (i.e., two consecutive sessions with unprompted correct responding at or above 55%), and nondifferential conditions. These findings suggest that the onset of differential reinforcement procedures is functionally related to acquisition and should be controlled in studies comparing error-correction procedures. Interestingly, Kodak et al. (2016) introduced differential reinforcement of unprompted correct responses at the outset of instruction in the demonstration condition and after a set criterion in the active student response condition (i.e., two consecutive sessions with 40% or higher unprompted correct responses). Considering the results of Campanaro et al., the greater efficiency observed in the demonstration condition may be related to differences in the onset of differential reinforcement between the two conditions.

A final procedural variation included in the active student response condition includes the error-contingent presentation of a brief timeout (e.g., 2 s) followed by the re-presentation of the discriminative stimulus (S^D) and an immediate prompt (Carroll et al., 2015; Turan et al., 2012). Although infrequently studied, this procedure has been shown to be effective for the vast majority of participants. Further, this variation, termed *remove and re-present* (Cariveau et al., 2019; Carroll et al., 2015), was the most efficient procedure in teaching sight word reading for one child with ASD in the study by Carroll et al. (2015). This finding is promising, although this condition was not compared to a traditional active student response or demonstration condition, so conclusions regarding relative efficiency are not known.

Both demonstration and active student response error-correction procedures have been shown to be effective; yet findings of efficiency have differed across studies. In addition, both procedures require a similar number of responses by the instructor. Nevertheless, the response requirement in the active student response procedure would make this condition slightly more intrusive. Slight variations of this procedure (e.g., brief timeout or onset of differential reinforcement) may contribute to greater efficiency without drastically increasing their intrusiveness. Nevertheless, further research comparing these conditions is needed. Additional research should seek to (a) further elucidate the variables responsible for the efficacy of these procedures, (b) describe the behavioral repertoires needed to benefit from either condition (e.g., imitative or echoic repertoires), and (c) consider procedural modifications that may increase the efficiency of discrimination learning without increasing the intrusiveness of these strategies.

Re-present Until Correct

In this procedure, the instructor presents a prompt and requires the learner to echo or imitate the target response before the S^D is re-presented and the learner is required to emit the target response a second time (Cariveau et al., 2019). Typically, an error during the re-presentation results in the procedure being repeated until a correct response is emitted. The re-present until correct procedure provides the learner with additional opportunities to emit the target response, which has been hypothesized to facilitate acquisition (Plaisance et al., 2016). Three variations of the re-present until correct procedure have been described in the literature. These variations include (a) trial re-presentations with an unprompted response opportunity (Carroll et al., 2015), (b) trial re-presentations with a prompted response opportunity (Kodak et al., 2016), or (c) embedding mastered targets before trial re-presentations (Plaisance et al., 2016; Turan et al., 2012).

Unprompted

Some procedures require the emission of an unprompted response on the trial re-presentation. This procedure may be commonly used in experimental research, although rarely studied (Kangas & Branch, 2008). In their work, Kangas and Branch (2008) used a re-present until correct procedure to eliminate position and stimulus biases of pigeons in a two-choice color discrimination task. Following an incorrect response, the trial was repeated until a correct response was emitted. The authors compared the onset of error-correction and found that birds exposed to the re-presentation procedure from the outset of training exhibited more rapid acquisition of the target task. Further, two birds in the control group who did not acquire the target discrimination were subsequently exposed to the error-correction procedure and performance increased immediately.

In an applied example, Carroll et al. (2015) evaluated the effectiveness of the re-present until correct procedure on the acquisition of sight words and tacts of item functions or features. Following an error, the instructor prompted the target response, and the learner was given 2 s to echo the prompt. After the learner emitted a prompted correct response or 2 s passed, the instructor re-presented the trial. This procedure was repeated until the learner emitted an unprompted correct response or 20 re-presentations. If the learner emitted the correct response during error correction, the instructor provided verbal praise and the next trial was presented. The authors found that the re-present until correct procedure was the first or second most efficient procedure for all participants.

In a subsequent study, Carroll et al. (2018) found that the re-present until correct condition produced acquisition in the fewest number of minutes to mastery in two out of nine comparisons across four children with ASD or global developmental delay. This finding suggests that including unprompted opportunities during re-presentations may be an efficient error-correction strategy for some participants. To note, a cursory review of participant characteristics from the Carroll et al. (2015, 2018) studies seems to suggest that greater verbal repertoires may be correlated with the efficacy of this procedure.

Interestingly, Rodgers and Iwata (1991) included a procedure similar to the Carroll et al. (2015, 2018) studies and found that the re-presentation of the target relation was not necessary to produce acquisition. In their study, Rodgers and Iwata (1991) evaluated the effects of (a) error-statement, (b) practice, and (c) avoidance procedures on the cumulative number of correct identity or arbitrary matching responses by seven adults with intellectual disabilities. During all conditions, correct responses produced praise and food or pennies. In the practice condition, incorrect responses resulted in an error-statement and the repeated presentation of the target stimulus until a correct response was emitted. The avoidance condition was similar to the practice condition; however, instead of re-presenting the target stimulus, the participant was required to complete a color-matching (irrelevant) task. The number of color matching trials was yoked to the number of re-presentations in the practice condition. The authors observed the greatest number of targets being mastered in the avoidance condition for three participants, the practice condition for two participants, and a similar number across all conditions for the remaining two participants. This finding may suggest that re-presentation of the target relation may not facilitate discrimination. Instead, the negative reinforcement contingency arranged in both the practice and avoidance conditions may be responsible for the observed effects. Additional research is needed to further determine the role that unprompted response opportunities may have on acquisition, particularly relative to prompted re-presentations.

Prompted

Another variation of the re-present until correct procedure involves re-presenting the S^D with an immediate prompt (Cariveau et al., 2019; Kodak et al., 2016). Kodak et al. (2016) evaluated the effectiveness of this procedure on the acquisition of sight words and prepositions for five participants with ASD. Following an error, the instructor prompted the correct response and immediately re-presented the trial using a 0-s prompt delay. After the learner emitted the second prompted correct response, the instructor provided verbal praise and presented the next trial. This procedure was effective for all participants; however, it was also consistently one of the least efficient. This may suggest that including an additional prompted correct response may be an effective, but inefficient error-correction procedure.

Embedded Mastered Targets

The last variation of the re-present until correct procedure includes the presentation of a mastered demand before the re-presentation of the trial. Embedding mastered demands between the prompted and unprompted response opportunities is suggested to facilitate stimulus control by requiring discrimination between targets when the target relation is repeatedly presented (Plaisance et al., 2016). Plaisance et al. (2016) examined the effectiveness of inserting mastered targets in their re-present until correct procedure when training a variety of targets (i.e., intraverbals, auditory-visual conditional discriminations, and motor imitation) to four children with ASD. In the no-insertion condition, after the learner emitted an error, the instructor modeled the correct response and re-presented the discriminative stimulus and allowed an independent opportunity. In the insertion condition, a mastered target trial was presented before the re-presentation of the discriminative stimulus. These procedures were repeated until the learner emitted an unprompted correct response during the re-presentation. The findings of Plaisance et al. suggest that the no-insertion condition was effective for all four participants and the insertion condition was effective for three participants. When both procedures were effective, they were also similarly efficient. Although these findings may suggest that the insertion procedure is unnecessary, this may not be the case under all conditions. For example, win-stay response patterns, characterized by the repeated emission of the last prompted or reinforced response, may be more responsive to the inclusion of a mastered demand as this arrangement may require that responding is controlled by the relevant stimulus. Further, although the insertion condition does not appear to influence rapidity of acquisition, additional research is needed to determine whether this procedure is associated with greater maintenance or generalization.

Multiple Response Repetition

The final error-correction procedure described in the extant literature is multiple response repetition (MRR). In MRR procedures, the learner is required to emit multiple responses following an error (Rodgers & Iwata, 1991), sometimes likened to positive-practice overcorrection procedures (see review by Axelrod et al., 1978). This procedure is the most-intrusive error-correction procedure in the literature and commonly includes the therapist prompting the learner to repeat the correct response either three (Kodak et al., 2016; McGhan & Lerman, 2013) or five times (Carroll et al., 2015; Drevon & Reynolds, 2018; Marvin et al., 2010; Rapp et al., 2012; Worsdell et al., 2005). Multiple response repetition procedures have been shown to be efficacious across numerous skills and populations. For example, Marvin et al. (2010) evaluated the effects of MRR on sight-word reading for four children between the ages of 7 and 12 years old. The introduction of the MRR procedure produced mastery level responding across all target sets and participants. In a subsequent study from the same lab, Rapp et al. (2012) demonstrated the effectiveness of an MRR procedure on correct responding to single-digit addition, subtraction, and multiplication problems for three out of four boys with intellectual disabilities. For one participant, responding met the mastery criterion for a single target set and the intervention was terminated when no change in responding was observed after 10 sessions for the subsequent set. These findings suggest that MRR error-correction procedures are effective in teaching math and reading skills to children and adolescents with and without developmental disabilities.

Additional research has compared the efficiency of the MRR procedure to other, less-intrusive, error-correction strategies. Multiple studies have found the MRR procedure to be superior to differential reinforcement (Carroll et al., 2018; Drevon & Reynolds, 2018; Kodak et al., 2016) and active student responding (Kodak et al., 2016; Worsdell et al., 2005) conditions across various measures of efficiency. In one direct comparison, Worsdell et al. (2005) examined the effects of active student response and MRR error-correction procedures on sight-word acquisition for six adults with developmental disabilities (Study 1). The results showed that all six participants mastered more sight words in the MRR condition relative to the active student response condition. This finding may suggest that the number of repeated trials may be positively correlated with instructional efficiency.

The MRR arrangement is among the most-studied error-correction procedures. As a result, some work has attempted to elucidate the role that response repetition may serve in the effectiveness of these procedures. In a similar arrangement to Rodgers and Iwata (1991), Worsdell et al. (2005; Study 3) compared the effects of relevant and irrelevant responses during MRR procedures on the acquisition of sight words for nine adults with developmental disabilities. The authors found that a similar number of words were acquired in both conditions for five participants, although the relevant condition was the most effective for three of the participants. The finding of similar acquisition across conditions in the study by Worsdell et al. is similar to those of Rodgers and Iwata, suggesting that the effects of repetitive error-correction procedures may result from the arranged negative reinforcement contingency and not the repeated emission of the target response.

The combined results of these studies suggest that MRR is efficacious in teaching new skills to children and adults with and without developmental disabilities. Moreover, MRR procedures may be more efficient than other commonly used strategies (Carroll et al., 2015, 2018; Kodak et al., 2016; Worsdell et al., 2005). Notably, MRR is also the most-intrusive error-correction procedure included in this literature. Although problem behavior is often assumed to be correlated with intrusiveness, studies that have recorded problem behavior have not consistently reported higher rates in MRR conditions. Carroll et al. (2015) noted increased rates of problem behavior during training using MRR for a single participant; however, the authors did not provide a definition or interobserver agreement calculations for problem behavior, so additional research is warranted. Researchers might also consider procedural modifications designed to reduce intrusiveness or increase the efficiency of MRR procedures. Doing so may capitalize on an effective method for remediating discrimination errors, while increasing the acceptability of the procedure.

Learner-Based Assessments

The need for highly individualized instructional procedures has become increasingly evident with the common finding of idiosyncratic results in comparative studies (Carroll et al., 2015; Delfs & Frampton, 2014; Kodak et al., 2016). Recently, comparative research designs have been presented as a method to identify an optimal error-correction procedure for individual learners (Carroll et al., 2018; Frampton et al., 2017; Johnson et al., 2017; McGhan & Lerman, 2013; Slocum & Tiger, 2011). Additional within-subject replications often referred to as a *validation* phase (e.g., Carroll et al., 2018; McGhan & Lerman, 2013) allow for an analysis of the predictive validity of the initial assessment on future discrimination learning. Two studies have evaluated the potential utility of such an assessment.

McGhan and Lerman (2013) compared the acquisition of listener responses by five children with ASD across four error-correction procedures: (a) error-statement, (b) demonstration, (c) active student response, and (d) MRR. Following the initial assessment, the procedure that produced mastery in the fewest number of trials was compared to a more- and less-intrusive procedure. This validation phase included three additional comparisons for each learner. The demonstration condition was the most efficient procedure for four out of five participants during the initial assessment. During the validation phase, the demonstration condition was also the most efficient procedure in 11 of the 12 comparisons. For the remaining participant, active student response was identified as the most efficient procedure during the initial assessment; however, this finding was replicated in only one of three comparisons in the validation phase. Interestingly, the demonstration condition was not included in the validation phase for this learner. As a result, the findings of McGhan and Lerman may suggest that either (a) an initial assessment may predict the future efficiency of error-correction procedures or (b) the demonstration error-correction procedure may be the most efficient and least-intrusive procedure, so an assessment is unnecessary.

In an extension of McGhan and Lerman (2013), Carroll et al. (2018) conducted an abbreviated assessment that compared (a) extinction, (b) demonstration, (c) active student response, (d) re-present until correct, and (e) MRR error-correction procedures on the acquisition of target skills for four children with developmental disabilities. The abbreviated assessment included between 36 and 60 trials in each condition. Following this assessment, the authors ranked each procedure based on the number of correct responses, errors, and error-correction trials. The authors then conducted at least two additional within-subject comparisons during a replication phase. The abbreviated assessment suggested that the most efficient error-correction procedure varied across participants, which was predictive of the most efficient procedure in four out of nine validation comparisons. The findings of McGhan and Lerman and Carroll et al. may suggest that an individualized assessment of error-correction procedures may aid instructors in identifying appropriate instructional techniques for individual learners. Nevertheless, additional research is needed to determine optimal assessment conditions and systems of measurement that may allow for more precise prediction of performance on subsequent discrimination tasks.

Future Research

Research on error-correction procedures may continue in several domains. Among the most fruitful areas may be those that identify functional relations between the efficacy of a given procedure and (a) particular patterns of responding (e.g., position biases or overselective responding), (b) participant characteristics (e.g., prerequisite repertoires), or (c) other related variables. Doing so will allow for greater individualization of instructional programs without requiring extensive assessment procedures. Of these three domains, identifying prerequisite repertoires that may facilitate acquisition under a given procedure may be particularly meaningful to current practice and research. Prerequisite skills necessary for learners to acquire targets in the demonstration procedure may be of particular interest as the literature reviewed above might seem to suggest that a universal endorsement of this procedure for all learners' programming would be appropriate. Nevertheless, it is likely that certain repertoires and even a particular instructional history may be needed for a learner to acquire novel discriminations using this procedure. Additional research might include participants with less-developed repertoires or particular barriers to learning (e.g., prompt dependence) to determine the extent of the effects previously reported in demonstration and related procedures.

Additional research should also consider current practices in applied settings. Surveys or descriptive studies of error-correction procedures in educational and therapeutic programs may guide future research and training initiatives. It is currently unclear whether the procedures commonly included in comparative studies align with those used in applied settings. In fact, based on the numerous modifications to standard procedures (described above), it may be presumed that additional modifications would be present in applied work. Describing these practices might further elucidate those variables influencing the instructors' selection of instructional practices, and subsequent research might evaluate methods to reduce the intrusiveness or increase the efficiency of those procedures. As one example, embedding mastered demands during error correction (e.g., Plaisance et al., 2016) or active student response procedures may be commonly used in applied settings despite a growing body of research suggesting that these may not be optimal strategies. Nevertheless, minor modifications to these procedures may have robust effects on instructional efficiency while maintaining or even reducing their intrusiveness (e.g., procedures more closely aligned with demonstration conditions).

Finally, future research should consider the findings of extensive experimental and translational research on stimulus control in an effort to develop or refine error-correction procedures that produce more robust instructional outcomes. Although rapidity of acquisition is certainly of interest, components that produce greater generalization to untrained conditions (Stokes & Baer, 1977) or emergence of untrained relations (Wolery et al., 1991) might also be explicitly arranged during error correction.

Conclusion

A number of error-correction procedures have been shown to be effective in facilitating the transfer of stimulus control. These procedures have been found to differ in efficiency, intrusiveness, and learner preference, which may require individualized assessments to identify optimal procedures. Finally, although error-correction procedures are ubiquitous in instructional arrangements, discrimination learning with minimal errors should endure as the most desirable training outcome. As a result, error-correction procedures should constitute a small but consequential component of effective instruction.

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Mand and Tact Training for Children with Language Impairment

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In his text *Verbal Behavior*, Skinner (1957) described a behavioral approach to language in terms of the role of environmental variables on the occurrence of language. Skinner identified a taxonomy of language that classified responses, which he called verbal operants, based on the variables that preceded and followed these operants. That taxonomy has served as a guide for the successful practice of verbal behavior instruction for individuals with language impairment (e.g., children and adults with intellectual and developmental disabilities).

Skinner's taxonomy (1957) includes seven elementary verbal operants, two of which serve as the focus of this chapter. The mand is a verbal operant that occurs under motivating conditions (e.g., deprivation, satiation) and specifies the consequence that will reinforce the response. Mands can be colloquially referred to as requests, and this operant occurs when another person is present to respond to a mand for certain objects (e.g., a ball), activities (e.g., pushing a swing), or information (e.g., the name of an unfamiliar object). For example, a child who has not had anything to eat for a few hours (i.e., the motivating condition of food deprivation) may mand for a peanut butter and jelly sandwich when his mom enters the kitchen. If this mand produces the outcome specified by the response (i.e., the child receives a peanut butter and jelly sandwich), this response will be more likely to occur again under similar conditions. The tact is a second verbal operant that occurs in the presence of a nonverbal stimulus (e.g., objects in the environment, private events like thoughts and feelings) and produces a conditioned reinforcer (e.g., praise, attention). For example, a girl walking with her father says, "an orange cat" while pointing at a cat under a bush by a house. Her father says, "I see it, too! It looks like our cat," which is the social consequence that increases the likelihood that the tact will occur again in the future under similar circumstances.

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Mand and Tact Assessments

There are several assessments that assist behavior analysts in measuring an individual's mand and tact repertoires. These assessments are beneficial to conduct prior to verbal behavior instruction to identify types of mands and tacts should be the focus of intervention, to assist in selecting an intervention, or to identify the function(s) of the child's current vocalizations.

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_18

Standardized Verbal Behavior Assessment Tools

The Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP) measures the level of a child's language skills to guide verbal behavior intervention (Sundberg, 2008). It was developed based on Skinner's conceptualization of verbal behavior and in consideration of a child's developmental milestones. The VB-MAPP is comprised of three assessments including the Milestones Assessment, Transition Assessment, and Barriers Assessment. The Milestones Assessment serves as the core assessment, which evaluates 16 domains of behavior (e.g., mands, tacts, social behavior, and social play) that are divided into three developmental levels (0–18 months, 18–30 months, and 30–48 months). Assessment data are collected during tests of specific skills and through naturalistic observations. Based on the results of the Milestones Assessment, behavior-analytic intervention focuses on teaching domains with the lowest scores until all domains are at a similar developmental level (e.g., all scores fall within the 18- to 30-month level). Thereafter, all domains within a level are targeted for instruction. The Milestones Assessment is repeated at scheduled intervals (e.g., every 6 months) to track a child's progress toward meetings important developmental milestones.

The Assessment of Basic Learning and Language Skills–Revised (ABLLS-R) is an assessment that identifies skill domains that require intervention for children with language impairment and developmental disabilities (Partington, 2006). The ABLLS-R includes skills grouped into 25 domains (e.g., self-help, motor skills) that most children acquire before entering kindergarten and is based on Skinner's (1957) account of verbal behavior. Assessment data are gathered during interviews with caregivers and other familiar individuals, tests of specific skills, and naturalistic observations. The ABLLS-R also is repeated at scheduled intervals to track a child's progress on learning skills across domains included in the assessment.

Assessments to Identify Functions and Interventions

The importance of assessing mands and tact for children with developmental disabilities (DD) led to the publication of assessment strategies that link assessment outcomes to specific interventions. Researchers have developed several assessments to evaluate environmental variables that affect the occurrence of mands and/or tacts (e.g., Bourret et al., 2004; Lerman et al., 2005). For example, Bourret et al. (2004) developed a mand assessment to measure potential barriers to mand training (e.g., only engaging in partial responses such as saying "t" rather than "tunes," waiting for prompts to mand). Three participants with deficient mand repertoires completed a mand assessment that included 10-trial sessions. Each trial began with the presentation of a preferred item (e.g., candy) and a 10-s opportunity to mand for the item, and the intrusiveness of prompts increased within the trial (e.g., nonspecific prompt, vocal model of response). The authors evaluated patterns of responding during the assessment to guide their selection of an intervention. For example, one participant consistently waited for a prompt to mand before engaging in the targeted vocalization. That participant's pattern of responding resulted in an intervention that addressed prompt dependence and included fading of prompts. All three participants in Bourret et al. acquired mands as a result of intervention that addressed their specific pattern of responding in the assessment. Nevertheless, the clinical utility of the assessment may be reduced due to the assessment duration; assessment of a single mand requires 1–2 h.

When children are referred for verbal behavior intervention, it can be helpful to assess the function (i.e., reinforcing consequences) of existing vocalizations. For example, a child may frequently say, "ball" yet refuse to play with a ball given to him. In these situations, the function of the child's vocalization may be unknown, thereby making it difficult for adults to identify how they should respond to the child's vocalization. Lerman et al. (2005) developed a functional analysis to assess functions of emerging speech in children with DD. Similar to functional analyses used to identify the function of problem behavior (e.g., Beavers et al., 2013), a functional analysis of verbal behavior includes specific conditions that isolate and manipulate common consequences that follow behavior. For example, the mand condition was conducted after the participant did not have access to the item for 60 min (i.e., arranged a period of deprivation as a motivating condition). Following the target response (e.g., the child said, "ball"), the participant was given the ball for 20 s. Thereafter, the ball was removed and only returned following another occurrence of the target response.

The results of the functional analysis were analyzed to determine which condition(s) resulted in high rates of responding compared to the control condition. One or more functions were identified for at least one of the assessed responses for their four participants (Lerman et al., 2005). Nevertheless, the functional analysis required considerable time to assess the function(s) of one targeted vocalization, which may limit its feasibility in practice. Thereafter, Kelley et al. (2007) modified the functional analysis conditions to reduce the overall duration of the assessment and improve its practical utility.

Mand Training

Verbal behavior intervention often includes, and frequently begins with, mand training. Skinner (1957) described the mand as the verbal operant that has a direct benefit to the speaker, because mands allow people to gain access to objects, assistance, and information in their environment under conditions of deprivation or aversive stimulation. All people experience some form of deprivation throughout the day (e.g., long intervals of time between meals, engaging in activities when it is hot outside without drinking water) that will serve as motivating conditions to engage in behavior and produce outcomes that can reduce deprivation. However, children who have deficits in verbal behavior may learn inappropriate or problematic ways to obtain these outcomes. Prevalence estimates indicate as few as 8% to as high as 94% of children with autism spectrum disorder (ASD) engage in problem behavior (Jang et al., 2010; Matson et al., 2009). For example, a child with ASD who has not eaten for a while may tantrum (i.e., cry loudly and pound on the floor with her fists), which results in her parents approaching her and guessing the reason for her tantrum. If her parents hypothesize that she might be hungry, they may give her a snack to stop the tantrum. Thereafter, future tantrums may function as a mand that occurs during conditions of food deprivation and produces access to food. If tantrums continue to produce food for extended periods, the child may not learn more appropriate ways to mand for food without targeted intervention.

A well-supported and common behavioral intervention for problem behavior is Functional Communication Training (FCT; Tiger et al., 2008). Children are taught to engage in an appropriate communicative response (i.e., mand) to obtain the consequences that used to follow problem behavior. For example, if a child engages in problem behavior to obtain a preferred toy (e.g., a tablet), FCT involves teaching the child to mand for the preferred toy, such as saying, "Tablet, please." FCT is more likely to be effective if extinction for problem behavior is included in the intervention, meaning that the consequence for problem behavior (e.g., the tablet in the example above) does not follow an occurrence of problem behavior (Hagopian et al., 1998). FCT is frequently conducted as an initial intervention to address problem behavior that may interfere with acquisition of other skills. Furthermore, the inclusion of mand training in early behavioral intervention is recommended to help prevent the development of problem behavior (Sundberg & Michael, 2001).

Mand training also is conducted at the start of intervention because mand acquisition may lead to the emergence of other untrained repertoires. For example, research suggests that mand training may result in the emergence of tacts without any additional training (e.g., Egan & Barnes-Holmes, 2009). Finn et al. (2012) taught four children with ASD to build a four-part construction task. Each piece of the construction was assigned an arbitrary name, and participants were either taught to mand for pieces needed to complete the construction task or tact (i.e., label) the parts. Following training, researchers measured whether mand training led to the emergence of tacts without additional training. All four participants engaged in correct tacts following mand training, showing the transfer of training across verbal operants. From the perspective of training efficiency, the identification of strategies for training one skill that result in learning of other untrained skills will decrease the overall amount of time needed to develop and strengthen the verbal behavior repertoires of children with language impairment. Therefore, early and ongoing mand training that results in learning of novel skills should be emphasized during verbal behavior instruction.

Mand Modalities

Vocal verbal behavior is often a goal of many parents of children with language impairment. Although vocal mands are likely the most socially acceptable mand form, there are circumstances under which training of alternative mand modalities should be considered. For example, a portion of children with DD may not be able to echo (i.e., a vocalization that has point-to-point correspondence and formal similarity to a preceding auditory stimulus; Skinner, 1957; colloquially referred to as vocal imitation) another person's vocalization. Vocal mand training is unlikely to be effective for children who are unable to echo at least two syllables (Valentino et al., 2019).

Alternative mand modalities such as sign or exchange-based communication systems have been successfully established in children with language impairment. A variety of augmentative communication systems exist for teaching exchanged-based and sign modalities, although there is considerable empirical support for training with lower cost, low-tech options (e.g., sign, paper-based Picture Exchange Communication System [PECS]; Bondy & Frost, 1994). The PECS is a paper- and app-based communication program to teach mands and other verbal operants to children with language impairment. The PECS program includes six training phases; it begins with single picture exchanges to mand for preferred items and activities and progresses to full-sentence mands (e.g., "I want chips"), answering questions, and tact training.

Some researchers advocate for sign training, whereas other researchers advocate for training with an exchange-based system. Those who advocate for sign suggest it is easier to acquire than exchange-based systems (e.g., PECS) because a different response topography (motor movements associated with the sign) is required for every mand, whereas an exchange-based system has the same response topography (e.g., pointing at or exchanging a picture) for every mand (Sundberg & Michael, 2001). In addition, sign does not require physical materials so it can occur in any setting, and there is a community of people who engage in sign and can provide this training (i.e., the hearing-impaired community). Researchers who advocate for exchange-based systems suggest training can be efficient, training does not require children to engage in complex motor responses and have well-developed motor imitation skills, and the community does not require any specialized training to respond to picture-based communication (e.g., Bondy, 2001; Mirenda, 2003).

Several assessments have been developed to investigate the efficacy of teaching different mand modalities based on a child's putative prerequisite skills. It is hypothesized that motor imitation may be a prerequisite for successful sign mand training, whereas identity matching (i.e., matching identical pictures) may be a prerequisite for exchange-based mand training. Valentino et al. (2019) measured matching and motor imitation as well as vocal imitation of one- and two-syllable words taken from the Early Echoic Skills Assessment (EESA; Esch, 2008). Thirteen participants completed the prerequisite assessment and then received sign, exchange-based, and vocal mand training. Their results showed weak correlations between motor imitation assessment scores and successful sign training and weak correlations between matching assessment scores and exchange-based mand training. In contrast, the vocal imitation assessment (specifically, the two-syllable words) was strongly correlated with successful vocal mand training. Overall, the authors concluded that individuals who do not correctly imitate two-syllable words are unlikely to benefit from vocal mand training, and an alternative format of training (either sign or exchange-based training) should occur.

When a child's matching and motor imitation repertoires are strong, it is often the case that the format of training will be decided by the intervention team comprised of professionals and the child's parent(s). The team might consider variables such as the supports in place for the selected format of training (e.g., a community of individuals who sign, participation in an intervention model that uses exchange-based communication), parent's preference as to the type of training they would like their child to receive, among others. Although vocal mand training is typically preferred by many parents, the results of Valentino et al. (2019) suggest that either sign or exchange-based mand training should occur first for children who cannot echo two-syllable words. If vocal mand training remains a priority of the intervention team, vocal imitation training could occur to strengthen the child's vocal imitation repertoire (i.e., echoic training) while simultaneously establishing mands in an alternative format.

If the treatment team selects exchange-based mand training, there are many augmentative and alternative communication (AAC) devices and applications that can be included in this training. For example, Proloquo2go® is an app-based program for the iPad® that functions as a speech-generating device. Children select picture icons in Proloquo2go®, which then emits the vocalizations that accompany the selected icons. The community may be able to respond more effectively to an exchange-based system when paired with a speech-generating device, because the device produces a vocal output of the mand through the iPad® speaker, such as saying, "I want to play tag" (Still et al., 2014). Research shows children with DD acquire mands taught with Proloquo2go® (e.g., Lorah et al., 2013).

Mand Training Formats

There are several common formats of training for the mand including naturalistic environmental training and trial-based instruction. Depending on the intervention program provider selected by parents, one or both formats of mand training are likely to occur.

Trial-Based Instruction

Researchers have successfully taught mands using trial-based instructional arrangements (e.g., Brodhead et al., 2016; Shillingsburg et al., 2019). Mand training that occurs within a trial-based format includes highly structured and repeated learning opportunities within instructional training sessions. This training often begins with the therapist identifying one or more highly preferred items that will be included in an instructional session, which occurs during periods of item deprivation (i.e., when there is an establishing operation [EO]). During trials, the therapist and child often sit close together either on the floor or at a table, and the therapist retains access to all items included in training trials. The therapist first assesses whether the child is motivated to access the item by presenting it in front of the child and measuring whether the child reaches for, points at, or engages in some other approach behavior to the item. If a child does not frequently engage in approach behavior, the therapist could measure attending behavior as an alternative indicator of a putative EO.

Following the occurrence of an approach or attending response, the therapist might remove the item and place it out of sight (e.g., in a paper bag) so that the child engages in the targeted mand in the absence of the item. This step is beneficial to include in mand trials so that the child learns to mand under motivating conditions (i.e., item deprivation) rather than only when the item is visually present, otherwise the child will not likely mand for items under natural conditions (e.g., when in a different room than the item, when items are in opaque containers, when items must first be purchased from another setting).

Once the item is out of sight, the therapist waits for the child to independently mand during a pre-established response interval (e.g., 5 s). Following an independent mand, the therapist removes the item from the bag and gives it to the child. If the child does not mand or makes an error during the response interval, the therapist models the target response (e.g., says, "cookie"; signs cookie; exchanges the cookie icon) and waits for the child to imitate the modeled response. Responses following the model also result in the therapist giving the child the item, although the duration of access may be shorter to increase the likelihood that the child will respond independently on the next trial to receive a longer period of item access (referred to as arranging differential reinforcement for independent correct responses; Vladescu & Kodak, 2010).

The therapist may conduct repeated trials with the target item for a predetermined number of trials (e.g., 10) or until the child no longer engages in an approach or attending response. If the latter occurs, the therapist could either initiate mand training with another preferred item for the remainder of the scheduled training trials, or the training session could be discontinued until item deprivation can again be contrived (e.g., by restricting access to the item or providing access to another item that might rapidly establish the value of the restricted item) or until the next day or training.

Although mands are successfully taught with trial-based instructional arrangements, there are some limitations to this format. For example, it may be difficult to contrive motivation for an item across repeated trials. If the child has access to the item for multiple trials in a row, it is possible that the child will become satiated on the item. Under conditions of satiation, an individual should not be taught to mand for access to that specific item, or it is likely that mands will come under faulty sources of control (e.g., the mand occurs to avoid prompts rather than to access the item). In addition, it is possible that a child will mand for different items than those programmed during training trials. If this occurs, the targeted mand is not likely to be taught until the child is satiated on items that may compete with the motivating conditions necessary for training other mands. Finally, trial-based mand training that repeatedly occurs in one setting may not result in generalization of the mand to novel settings or conditions (e.g., the child only mands for food at the table in a clinic setting but not when food deprived at home or at school). Due to potential limitations associated with trial-based instruction, a combination of trial-based and naturalistic environmental training could be conducted.

Natural Environmental Training

Naturalistic teaching consists of methods that have been recommended to establish mands and increase generalization to the natural environment. Natural environmental training (NET) focuses on capturing the child's motivation in the context of play or other events, rather than through structured teaching or work at a table. A teaching opportunity begins with the child pointing, gesturing, or approaching an item. At this point, the therapist or caregiver withholds the item and waits for an independent mand or prompts a response. For example, a child reaches for a green train while playing, and the therapist picks up the green train in her hand and holds it up to the child. The child mands, so the therapist immediately gives the child the green train to play with for a specified time. Rogers-Warren and Warren (1980) taught three children to mand for items during play. When the child approached an item, the teacher said, "Tell me what you want" and provided the item (e.g., red ball) and praise (e.g., "Terrific; you asked for the red ball") following a mand. This training increased mands.

Unlike trial-based instructions, NET relies on child initiation of learning opportunities often within the context of play. NET can be implemented across a variety of environments such as in the home with caregivers and in classrooms with teachers. An additional advantage to NET is that the therapist or caregiver is paired with positive interactions and access to preferred items, which may decrease problem behavior (Sundberg & Partington, 1999). Nevertheless, it may be difficult to determine what a child is motivated to interact with if the child does not frequently approach items or has few toys with which s/he plays. Under these circumstances, the therapist may attempt to contrive learning opportunities that may not be relevant to the child's motivation and result in less positive interactions. Furthermore, it may not be possible to always deliver the preferred item due to competing demands or other activities which are not necessarily associated with the child's interests (e.g., social studies). Thus, a combination of trial-based instruction and NET is recommended under most training conditions.

Sequence of Mand Training

Mands are one of the first verbal operants that children acquire because they directly benefit the speaker (Sundberg & Michael, 2001). Additionally, mand training often occurs in a sequential order to ensure appropriate motivational and stimulus control. Through a shaping process early, simple mands become more sophisticated. As mands progress from simple to complex, the items or information requested may also become more abstract.

Early mands may consist of partial or single words which result in access to tangible items. For example, a child says, "bah" or exchanges a picture icon of a ball, and the parent gives the child his favorite ball. It is beneficial to reinforce early mands that are less complex so that the child's verbal behavior consistently results in preferred outcomes rather than other behavior (e.g., problem behavior) producing reinforcers. Thereafter, the complexity of the response may be shaped toward a developmentally appropriate response that is more socially valid across environments (see Table 18.1).

In the example shown in Table 18.1, the most effective mand is when the child includes a mand frame (i.e., "May I have"), because the verbal community is more likely to reinforce this response with access to a ball. If the response "ball" is not accompanied by the mand frame, the verbal community may be unsure of how to respond to the vocalization. Some people might respond as if the child is labeling an object s/he sees in the environment and provide general praise (e.g., "Yes; it's a ball"), whereas others may provide access to the ball. Inconsistency in consequences provided by the verbal community may weaken or prevent acquisition of the mand, and the child may engage in other behavior (e.g., problem behavior) that more consistently produces access to the ball. Furthermore, mand frames may result in generalization of the response across operants (e.g., Finn et al., 2012). Thus, establishing a mand frame early can produce several beneficial outcomes for the child.

Mand frames can be taught through several methods of instruction. For example, practitioners could vocally model a response with the mand frame (e.g., "may I have a ball") and permit an opportunity for the child to echo. This is an efficient method of training for children who have the prerequisite echoic behavior of imitating longer utterances. Mand frames could also be taught via the PECS. For example, a child can be taught to place a picture icon for "I want" on a sentence strip before placing a picture of a preferred item on the strip. After the child exchanges the sentence strip, the therapist points to each icon while demonstrating the vocal response (e.g., says, "I want crackers"), and then gives the child crackers.

Regardless of the method of training, it is beneficial to use procedures that increase variability of mand frames (e.g., Brodhead et al., 2016). Lag schedules result in reinforcement of a response that is different from a predetermined number of previous responses. For example, a lag 2 schedule requires a response that differs from the previous two responses to produce a reinforcer. Thus, if a child emits the mand frames "I want" and "can I have," the third mand frame must be different from the previous two to result in the consequence. Variation in mand frames may prevent stereotypic or invariant mands that are not socially valid. However, research on natural variation in mand frames in populations of typically developing children can guide the extent of variability that should be targeted in treatment for individuals with language impairment.

Table 18.1 Example shaping steps of mand response topography[a]

Step	Functional communication response
1	A vocal mand in a sentence fragment (e.g., "Ball")
2	A polite vocal mand in a sentence fragment (e.g., "Ball please")
3	A polite vocal mand with a mand frame (e.g., "May I have a ball please?")
4	A mand for attention plus a polite vocal mand with a mand frame (e.g., "Excuse me. May I have a ball please?")
5	A mand for attention with a pause for acknowledgement plus a polite vocal mand with a mand frame (e.g., "Excuse me." [pause; adult looks at child], "May I have a ball please?")

[a]Adapted from Ghaemmaghami et al. (2018)

Mands for Information

A mand for information is evoked by an EO and reinforced by access to some type of information rather than specific items (e.g., "where is the cookie" results in information about the location of a cookie). Nevertheless, the information obtained may lead to access to preferred items (e.g., the location of a puzzle piece), which can condition the information as a reinforcer. For example, if Jamie asks her parent, "where is the air pump" in order to inflate an old basketball, the information about the location of the pump leads to Jaime locating the pump, filling the deflated basketball, and then playing a game of basketball with her siblings. Thus, the information is paired with increased access to a preferred activity, and this pairing will likely increase the value of information in the future.

Children with ASD often display deficits in their question-asking repertoires (Charlop & Milstein, 1989). Yet, mands for information are critical for children to acquire, because they play a large role in language development (McNeil, 1970). Mands should be taught when the information is valuable (i.e., an EO is present) and not when the information is already available (i.e., AO conditions). For example, Shillingsburg et al. (2014) taught three children with ASD the mands "who" and "which" to access information. During EO trials, an array of different opaque colored cups was presented on the table ("which" trials) or three therapists stood by the table ("who" trials). Independent and prompted mands for information ("which cup" or "who has it") were reinforced by access to relevant information (i.e., the color of the correct cup or person who had the item), which the participant then used to access a preferred item. During AO trials, the therapist provided information on how to access the item at the start of the trial (i.e., the location of the preferred item), thereby eliminating the value of engaging in behavior that produces information that is already available. The AO trials served as a type of control that reduced the probability of these mands coming under other sources of control (e.g., the presence of cups) during trials. Procedures like this can be valuable to ensure that the child is able to engage in mands for information under the correct stimulus and motivating conditions.

Mands to Terminate Aversive Stimuli

It is common to encounter stimuli in the environment that one finds aversive or unpleasant. For example, a very loud noise, a non-preferred type of music, or the persistent smell of tuna-fish lingering in the office fridge may be aversive stimuli to some individuals. Termination of unpleasant or aversive stimuli can function as a reinforcer (Skinner, 1953). As such, mands for termination can consist of requests for removal and termination of non-preferred or low-preference items (e.g., Groskreutz et al., 2014) as well as requests for the removal of obstructing stimuli that block access to a preferred activity (e.g., Shillingsburg et al., 2013). If children do not learn to mand for termination, they may experience prolonged or intense exposure to aversive stimulation, which may evoke problem behavior.

Caregivers and stakeholders (e.g., teachers) indicate they find it important for children to appropriately communicate about non-preferred events or items (Groskreutz et al., 2014). There are several, socially appropriate ways to mand for termination of unpleasant events and stimuli. For example, a child could ask someone to "please stop" doing something or say, "move, please" if someone is obstructing access to preferred items. However, for children with ASD, mands for termination are not acquired though naturalistic interactions with the environment and may need to be directly taught (Sundberg & Michael, 2001).

Groskreutz et al. (2014) taught two children with ASD to mand for termination in the presence of aversive stimuli using a prompting procedure. Results showed training with two exemplars was necessary to observe generalization of mands for termination to untrained stimuli. Furthermore, results suggested that the mand was under the control of relevant Eos, because the participants rarely engaged in mands for termination when they were exposed to trials with preferred items and when programmed aversive stimuli were not present. Also, the mand generalized to untrained contexts.

After training mands for termination, it is important that practitioners consider procedures that may need to be implemented to prepare the child for when these mands cannot be honored on a consistent (i.e., fixed-ratio [FR] 1) schedule. For example, if a loud noise cannot be turned down (e.g., siding on a house is being replaced) or if a peer engages in vocal stereotypy (i.e., repetitive sounds) that has not been treated, children will need to tolerate some exposure to these aversive stimuli. Tolerance training procedures may consist of thinning the schedule of reinforcement, increasing delays to reinforcement, teaching mands for items that may reduce or block the aversive stimulus (e.g., mand for noise-canceling headphones), or teaching social skills such as compromising or negotiating with the person associated with the aversive event.

Generalization of Mands

It is critical that mands occur across settings, with novel people, and with materials that are not included in training. Baer et al. (1968) described generality as one of the seven dimensions of applied behavior analysis, suggesting that practitioners consider and specifically program for behavior change across contexts. There are at least three types of generalization that should be considered when conducting mand training, including generalization across SDs, generalization across MOs, and response generalization. Mands may generalize across SDs, such as when a mand to use the restroom that is taught at school also occurs when the child is at the grocery store. The MO for this mand is the same (e.g., deprivation of access to a toilet when one has a full bladder), but the stimulus conditions paired with the MO (e.g., the setting, the people present when the mand occurs) differ. In contrast, mands may generalize across MOs, such as when a child mands "play" following periods of deprivation from watching a preferred video and also mands "play" when it has been several hours since recess. Researchers have investigated the generalization of mands across SDs, such as people (e.g., Greenberg et al., 2012) and settings (e.g., Wacker et al., 2005). Fewer studies have assessed generalization of mands across MOs (e.g., Lechago et al., 2010). In one example, Lechago et al. (2010) taught a participant to mand "spoon" while making a volcano and probed for generalization across MOs by evaluating whether the participant would mand "spoon" to complete the behavior chains for making chocolate milk and setting the table. Results showed mands generalized across MOs.

A third type of mand generalization involves engaging in a novel response form based "on the analogy of old ones" (p. 48, Skinner, 1957). Skinner referred to these responses as magical mands, because they have never occurred before and have not previously contacted reinforcement. For example, a child who has learned to mand "where" to obtain information about the location of items may mand, "where is God" when she and her parents are at church. The deprivation of information on the whereabouts of people (MO) and aspects of the church environment (e.g., a cross, prayer) may collectively evoke this mand, although it has never occurred before.

Nevertheless, this mand will likely produce some information (e.g., "God is in our hearts") that may function as reinforcement.

Tact Training

Most children who receive verbal behavior intervention have a deficient tact repertoire; children may not yet know how to label or describe items in the world around them. The tact is occasioned by nonverbal stimuli and produces generalized conditioned reinforcers (Skinner, 1957). For instance, a child who plays outside in her backyard sees a plane fly overhead. She points up at the airplane and says, "I see a huge plane, Mommy!" Her mother responds, "Wow! It is big. You went on a plane like that last year." As can be seen in this example, the daughter's tact of the airplane resulted in attention and a vocal exchange with her mother (i.e., generalized conditioned reinforcement).

According to Skinner (1957), the nonverbal stimuli for the tact include (1) the audience and (2) "nothing less than the whole of the physical environment—the world of things and events" (p. 81). When one considers the vast number of stimuli in the whole of the physical environment, there are many stimuli that must acquire control over an individual's responding. Thus, tact training may account for a portion of a child's intervention services for several years to establish many relevant stimuli as tacts. Children are also taught to tact private stimuli, which are stimuli that are not available to the general public (e.g., feelings, pain). For example, a child who has a stomach ache and feels as if she might vomit can inform a parent of this private event so that her parent can behave more effectively, such as offering her a bowl or bringing her to the bathroom. As such, the tact allows the speaker to bring others into contact with many aspects of the environment that can help the listener (the person to whom the tact is directed) respond more effectively.

An extensive tact repertoire is necessary to establish other verbal operants. For example, if a child can talk about items that are present (e.g., a thick blanket), then he may quickly learn to mand for the item when he is cold, answer questions about the blanket (i.e., engage in intraverbal behavior, which is another elementary verbal operant that is critical to conversational and social skills development), and can learn to talk about the blanket when it is no longer present (i.e., the nonverbal stimulus that evokes the tact might include visual imagery).

Tact training can lead to the emergence of other, untrained behavior (Matter et al., 2020). For example, research suggests tact training may result in the emergence of listener behavior (i.e., identifying a stimulus in an array; Petursdottir & Carr, 2011). Delfs et al. (2014) compared tact and listener training with four participants with ASD. The authors conducted both tact and listener training with each participant and examined the emergence of listener responding following tact training and tacts following listener training. Consistent with previous research, the results showed tact training produced untrained listener relations for all participants, whereas listener training only produced some emergence of tacts for two participants.

The outcomes of studies showing the emergence of listener relations following tact training are important for several reasons. First, any verbal behavior instruction that results in the emergence of untrained relations will increase the efficiency of intervention and reduce time that must be spent directly teaching those relations. Second, the results support a framework, known as bidirectional naming (BiN; Miguel, 2016), through which verbal behavior instruction can be designed. Originally referred to as naming (Horne & Lowe, 1996), this framework describes the point in a child's development when speaker and listener behavior are interrelated, and training of one of these repertoires produces mediating verbal behavior that leads to the emergence of the other repertoire. For example, when an adult asks a child to "get the balloon," the child might echo the adult's vocalization (i.e., repeat the response "balloon") while looking around at items, respond to oneself as a listener by self-echoing the response (i.e., saying "balloon" to oneself several times) while picking up the balloon, and hand the balloon to the adult who provides praise (e.g., "Thanks for getting the balloon!"). This praise reinforces the verbal mediating behavior (i.e., echoic and self-echoic behavior) as well as the listener response of handing the balloon to the adult, and the reinforcer provided for those behaviors facilitates the emergence of the tact in the future. Thus, when an adult asks, "what is this" while holding out a balloon later that day, the child may say, "It's a balloon." If these repertoires become interrelated, and training of one repertoire (tacts) results in the emergence of the other repertoire (listener responses), then verbal behavior instruction can primarily focus on tact training and omit most or all listener training. Therefore, practitioners who provide verbal behavior instruction should assess the presence of a BiN repertoire prior to designing this training to evaluate the necessity of teaching both listener and tact relations versus tact relations only.

Tact training may also lead to the emergence of untrained mands. When tacts of highly preferred items are taught, research suggests tact training results in transfer across operants; mands for these items may emerge following tact training (Wallace et al., 2006). For example, Wallace et al. taught tacts of items ranked highest or lowest in a preference assessment to three participants with DD. Following tact training, the authors assessed whether participants engaged in untrained mands. Results showed all participants engaged in mands for items that were highly preferred, but they did not consistently mand for low-preference items. Because the mand specifies its reinforcer and occurs under the control of a MO, it is no surprise that participants would not engage in a mand for low-preference items. That is, being deprived of an item that one does not prefer to consume (e.g., broccoli) is not likely going to result in a mand for this item. In contrast, deprivation of a highly preferred item (e.g., popcorn) that one has recently learned to tact is likely to evoke the mand for that item so that it can be consumed. Therefore, practitioners should consider including tacts of highly preferred items in verbal behavior instruction to facilitate the transfer of control from the tact to the mand without any additional training; doing so will increase the efficiency of intervention.

Tact Training Formats

Similar to mand training, tacts are often taught through naturalistic environmental training and trial-based instruction. However, trial-based instruction is the predominant format of tact training, because tacts are under the control of nonverbal stimuli that can be precisely arranged by a therapist during trials and produce generalized conditioned reinforcement (e.g., praise). Trials of pictures or objects of common stimuli are presented in rapid succession to efficiently teach children to tact stimuli in the world around them.

There are instructional strategies frequently included in trial-based tact training to further increase the efficiency of instruction. For example, instructive feedback (IF) may be embedded in tact training trials in either the antecedent or consequence portion of the learning trial (e.g., Vladescu & Kodak, 2013). During IF, the therapist presents a secondary target to which the child is not required to respond, nor are reinforcers provided for responding. A learning trial that includes antecedent IF begins with the presentation and model of a response to the secondary target immediately followed by the presentation of the primary target that is being taught in the learning trial and to which the child is required to respond. Following a correct response to the primary target, the therapist provides a reinforcer. In comparison, a learning trial that includes consequence-based IF begins with the presentation of the primary target. Following a correct response to the primary target, the therapist provides praise and then immediately presents and models the response to the secondary target. After instructional sessions that include either type of IF, probes are conducted to measure whether the child learned the secondary targets.

Previous studies demonstrate the benefits of IF embedded in tact training for children with language impairment (e.g., Vladescu & Kodak, 2013). Interestingly, some studies show that secondary targets may be acquired before primary targets (e.g., Leaf et al., 2017), and other studies demonstrate that IF presented alone, rather than being embedded in a learning trial with a primary target, also results in acquisition of secondary targets (e.g., Vladescu & Kodak, 2013). Taken together, these studies support the inclusion of IF in tact training to increase the efficiency of instruction.

Error correction is another method of increasing the efficiency of trial-based tact training for children with language impairment. Following an error, the therapist models the correct response and provides either one or multiple opportunities for the client to practice responding correctly (e.g., Carroll et al., 2015). Although there are many types of error correction to select from when conducting tact training, consideration should be given to the procedure that will result in the most efficient instruction. Studies show that the most efficient error correction is often learner specific; thus, an assessment of error-correction procedures could be conducted prior to tact training to identify the most efficient procedure for each client to include in subsequent tact training (e.g., Carroll et al., 2015).

Tacts as a Prerequisite for Other Skills

More complex verbal behavior, such as intraverbals (e.g., answering questions), are often under multiple sources of control (Michael et al., 2011). Researchers have suggested that tacts of stimuli should be trained prior to using such targets within intraverbal training procedures (e.g., Sundberg & Sundberg, 2011). For example, if the question, "what is a red vehicle" will be targeted during instruction, a child should first have tacts for the individual components (e.g., red, vehicle) and be able to tact relevant exemplars from categories (e.g., firetruck, sports car). May et al. (2013) evaluated the emergence of intraverbals following tact training and found untrained intraverbals emerged for three adolescences with ASD. However, other researchers have found that the training of component tacts does not increase all related intraverbals (e.g., Miguel, 2017).

Complex verbal behavior also may emerge following specific sequences of prerequisite skills training that include tacts. For example, DeSouza et al. (2019) investigated tact training as part of a prerequisite skills training sequence for intraverbals. Intraverbals (e.g., "A bird from the rain forest is a…") emerged at the end of the training sequence that included several types of tact training, suggesting that component and category tacts (e.g., tacts of locations such as the rain forest, categories of animals such as birds, and exemplars of bird such as Toucan) were likely prerequisites. Nevertheless, continued research is required to identify the sequence of prerequisite skills, including types of tact training, that leads to more advanced and complex verbal behavior.

Tact Modalities

Vocal verbal behavior, sign, PECS, and AAC are all relevant modalities for tact training. For example, Lorah et al. (2014) used Proloqu2Go® on an AAC device to teach object tacts and tact frames (I have, I see) to children with DD. Researchers taught the tact frame "I see" with four items (i.e., dog, ball, crayon, book), followed by training of the tact frame "I have" and the same items. Following mastery of each tact frame in isolation, discrimination training was conducted in which the stimulus arrangements were randomized. Results suggested rapid acquisition of tacts and tact frames in isolation and when combined during discrimination training. However, it should be noted that tacts with AAC devices involve non-identical matching (selecting a picture on a device that is similar to an item in the physical environment) and may also be characterized as listener behavior in some contexts.

Similar to mand training, each modality has benefits or limitations for different learners (e.g., Tincani, 2004). At the present time, there is limited research on tact training across non-vocal modalities (e.g., Lorah & Parnell, 2017); however, it is likely that many of the assessments used to identify a mand-training modality would be applicable for tact training, along with client, caregiver, and stakeholder preference for a modality.

Sequence of Tact Training

Systematic tact training occurs early and often during comprehensive behavioral intervention for children with language impairment (e.g., Leaf & McEachin, 1999), because there are many nonverbal stimuli that a child must learn to tact in order to benefit from later pre-academic instruction (e.g., caregiver's names, household items). After one-to-two-word tacts of common items are taught, categorical tacts (e.g., animals, clothing) as well as tacts of features and functions of items are taught. In addition, practitioners should consider conducting training of tact frames, multiple-tact training, and training of multiply controlled tacts.

Tact Frames

Tact frames consist of the inclusion of autoclitics in addition to a tact. An autoclitic is verbal behavior "which is based upon or depends upon other verbal behavior" (Skinner, 1957, p. 315). As such, autoclitics accompany other verbal operants to help the listener respond more effectively to the speaker's verbal behavior. A descriptive autoclitic has been referred to as an autoclitic tact because it indicates the conditions of the speaker (MOs) and specifies the source(s) of control for the tact (i.e., describes the controlling variables). Tact frames including, "I see," "I hear," and "I have" specify the environmental stimuli controlling the tact and affect how the listener responds to the speaker's tact. For example, if a child says, "I hear a dog," the listener may be quiet for a moment to observe the environment for the sounds of a dog before responding to the speaker. In comparison, if a child says, "I see a dog," the listener may look around for the dog before responding with some observation about the dog (e.g., "It's really cute and fluffy").

There are benefits of teaching children with language impairment to use tact frames. First, the inclusion of autoclitic frames during training may lead to the emergence of other types of verbal operants (e.g., mands) by facilitating the transfer of control between verbal operants (Finn et al., 2012). For example, Finn et al. (2012) taught participants to emit the frame, "that's a…" during tact training and "I need a…" during mand training. Training resulted in the transfer of control from one verbal operant to another for three of the four participants. It is possible that these autoclitic frames can function as additional intraverbal prompts therefore assisting with the acquisition of other verbal operants.

Also, the use of autoclitic frames increases the child's length of utterance as well as the social acceptability of the tact for the verbal community. Researchers have suggested longer mand frames are more socially appropriate and equip learners with more advanced communication skills to converse with their community (Yosick et al., 2016). Relatedly, autoclitics frames can be useful for the speaker's verbal community as they may lead to more detailed discussions and potentially more specific tacts (Skinner, 1957).

Multiple-Tact Training

Most individuals will engage in varied tacts of stimuli in their environment, which indicates that children with language impairment should be exposed to multiple-tact training. Multiple-tact training commonly consists of teaching a tact of an object as well as the category to which the object belongs (Partington & Bailey, 1993). For example, multiple tacts can be established in the presence of pictures by teaching, "this is a carrot, and it is a vegetable" or "a piano is an instrument." An intraverbal relation (e.g., between carrot and vegetable or between piano and instrument) may be established when tacts are taught in this manner (Partington & Bailey, 1993). Nevertheless, the efficacy of multiple-tact training on the emergence of other verbal operants has been variable in the literature. For example, Miguel et al. (2005) found limited impact on intraverbal acquisition following multiple-tact training, and direct training of their intraverbal targets was necessary. In comparison, Ribeiro and Miguel (2020) used a slightly different procedure to teach multiple tacts of stimuli, which consisted of teaching object tacts prior to categorization tacts, rather than teaching both tacts simultaneously. For both participants, visual categorization (i.e., sorting by category) and listener responding emerged following multiple-tact training. Due to variable findings across studies, it is possible that learner characteristics, histories of reinforcement, and specific teaching procedures may impact the emergence of verbal operants following multiple-tact training. Additional research on the benefits of multiple-tact training is needed.

Multiply Controlled Tacts

Tacts assist children in responding to questions that are under multiple sources of control throughout their lives (Michael et al., 2011). For example, a father may hold up a block from part of a shape sorter toy and ask his son to tact the color of the block. Later, he may ask his son to tact the shape of the block. Different questions in the presence of the same object require children to attend to and respond differentially to aspects of the visual stimulus (the color and shape of the block) and the question that is asked about it (e.g., "what color" or "what shape"). Multiply controlled tacts are often impaired in children with ASD (Sundberg & Sundberg, 2011) due to delayed or limited vocal verbal repertoires. Furthermore, children with ASD may have difficulty acquiring this skill because it requires attending to multiple antecedents at the same time (or in close proximity) when learning multiply controlled tacts.

Few studies have evaluated ways to teach multiply controlled tacts. However, some researchers have evaluated training of similar and related skills such as teaching intraverbals about the feature, function, and class of stimuli (e.g., DeSouza et al., 2019), responding to complex questions about visual stimuli during training of one type of question at a time (i.e., instruction to respond to "what," then "why," and then "how"; Krantz et al., 1981), and teaching multiply controlled intraverbals (e.g., Kisamore et al. 2016). For example, Kisamore et al. (2016) taught children with ASD to answer questions containing multiple components such as "what is an animal that is yellow, "what is an animal that is green," "what is a fruit that is yellow," and "what is a fruit that is green" The responses to these questions are multiply controlled because both the category of the item in the question (animal or fruit) as well as the color specified in the question (yellow or green) must converge to occasion a specific response. Results suggested that repeating portions of the antecedent during training (e.g., repeating "fruit, yellow") assisted with acquisition. Due to the limited body of research on teaching multiply-controlled tacts, researchers should continue to evaluate effective teaching procedures in addition to examining the sequence of training of related skills.

Multiple Exemplar Training

Tact training for children with language impairment typically includes multiple examples of the same item. For example, a child is taught to tact "flower" in the presence of a dandelion, sunflower, rose, orchid, and daffodil. Practitioners teach multiple exemplars to establish members of a stimulus class (e.g., the stimulus class "flower") and so the tact comes under the control of relevant features that define members of the stimulus class (LaFrance & Tarbox, 2020). Thus, careful consideration should be given to the exemplars that are included in instruction. Exemplars should include critical (must have) features that help distinguish the exemplars in one stimulus class from another stimulus class (Layng, 2019). Exemplars also should include variable (can have) features that occur within members of the stimulus class but do not define the members. For example, several exemplars of flowers may share the variable feature of color (e.g., yellow), although that feature is not what defines membership in the stimulus class of flower.

Research suggests it may be more efficient to teach tacts of one exemplar of a stimulus at a time rather than teaching multiple exemplars simultaneously to establish a stimulus class (e.g., Schnell et al., 2018). The efficiency of single versus multiple exemplar training (MET) is evaluated by teaching one exemplar of a stimulus and evaluating generalization of correct responding to other exemplars in the stimulus class (Speckman et al., 2012). Training of exemplars continues until a child can respond correctly to all selected members of a stimulus class. The purpose of MET is to produce stimulus generalization and establish many stimulus classes for children with language impairment (LaFrance & Tarbox, 2020).

Evaluating Emergence Across Verbal Operants Following Training

Skinner (1957) suggested verbal operants are functionally independent, which means a response that is learned as one verbal operant (under one set of antecedent stimuli and with the specific consequences as defined within the operant) may not generalize to other operants. For example, if a child learns to mand "cookie," this does not mean that she will be able to tact the cookie nor answer questions about a cookie. Instead, a response that is learned as one verbal operant may require additional training to transfer control to other verbal operants. Shillingsburg et al. (2009) described how the response of yes and no can occur under a variety of environmental conditions, even though the topography of the response stays the same. For example, a child may say, "yes" if offered a dessert to consume after a long period without food (mand), but that response may not occur when the child is asked if the item she is eating is a dessert (tact), nor will the child say, "yes" when asked if cake is a type of dessert (intraverbal). Shillingsburg et al. taught three children with ASD to mand yes and no. They found mand training did not result in the emergence of yes and no as a tact nor intraverbal. Participants required direct training to also acquire yes and no as a tact and intraverbal.

In the natural environment, verbal behavior is usually under the control of variety of antecedent stimuli (i.e., multiply controlled). Thus, it is ideal to conduct training that can establish multiple verbal operants. One method to teach a response as multiple operants is called multiple exemplar instruction (MEI), which involves random rotation of trials targeting the same response (e.g., bubbles) as different verbal operants (LaFrance & Tarbox, 2020). For example, the child may say, "bubbles" so the adult blows bubbles (mand). The child also may say, "bubbles" when watching a video of bubbles blowing in the wind (tact). In addition, the child may point to a picture of bubbles in a book when the adult asks, "Where are the bubbles?" MEI is often introduced to establish the bidirectional relation between speaker and listener repertoires (i.e., BiN; Miguel, 2016). Research suggests that conducting MEI may lead to BiN, which is described as a prerequisite for complex verbal behavior such as categorization and problem solving. Therefore, implementing MEI promotes functional interdependence of operants as well as generative language.

Conclusion

Mand and tact training are necessary components of verbal behavior intervention for children with language impairment. Intervention should be carefully structured to teach mands and tacts under the proper motivating and stimulus conditions. Furthermore, training should be sequenced to promote the emergence of untrained exemplars and transfer across verbal operants. Successful mand and tact training, in combination with training of other verbal operants, can produce socially significant improvements in the verbal behavior of children with language impairment.

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Part III

Basic Assessment Methods

19 Essentials of Observing Behavior

Art Dowdy, Kenneth W. Jacobs, Jennifer Quigley, Joshua Jessel, and Corey Peltier

Essentials of Observing Behavior

Art Dowdy et al.

> The radical behaviorist is further characterized by the heavy value he places on the consequences of direct observation. In his view, the more he can bring his own verbal behavior under the control of what he has actually observed, the more productive and useful it is likely to be. (Day, 1969, p. 320)

The behavioral worldview is self-inclusive (Hineline, 1992), which is to say that the observer does not stand outside of the causal stream (Skinner, 1974). Contingencies of reinforcement operate on the observer just as much as they operate on the target of observation. In Skinner's (1956) words, "The organism whose behavior is most extensively modified and most completely controlled in research of the sort I have described is the experimenter himself" (p. 232). Applied behavior analysts, like the experimenter, are susceptible to the same contingencies of reinforcement influencing the behavior of their clients. Observing is behaving—the cornerstone of applied behavior analysis—and it must be taken into account.

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Behavioral Observation

Observation is traditionally identified with sensation. The observer is said to use the sensations of sight, hearing, touch, etc. If the observer cannot sense the target of their observation, then instrumentalities are used to clarify and amplify such as when the physiologist uses a microscope or when the astronomer uses a telescope. The identification of observation with sensation is also a defining feature of empiricism, whereby evidence from the senses is said to be the basis of our conclusions (Morling, 2018). The stimulation of the senses, however, is not the only feature of observation or empirical science more generally. The senses may be necessary, but they are not sufficient. The senses are a part of the observer's behavior, which has consequences of its own.

Who Observes?

Observation entails an observer. In some cases, we are our own observers. We can *self-monitor* our own behavior by recording its occurrence.

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_19

Self-monitoring can provide a baseline measure of one's own behavior or serve as an intervention itself (see Nelson & Hayes, 1981). In other cases, the observer is a parent, teacher, or school aide to the client whose behavior is being referred. Parents and educators may be considered *casual observers* when they do not use formal, behavioral science methods to monitor the behavior of concern. "If our casual observer spent enough time, he might discover some of the contingencies, but he would do so only if he knew what to look for" (Skinner, 1971, p. 149). This is to say that the casual observer does not know to look for behavior in terms of its antecedents and consequences. Compared to the casual observer, the applied behavior analyst is a *formal observer* because of his/her principled and methodical approach to measuring behavior.

What Do We Observe?

We observe *behavior* for its functional effects—from seemingly innocuous movements like a thumb twitch to writing a book (Hayes et al., 1988). Importantly, though, behavior analysts do not observe a thumb twitch to understand its mechanics. Rather, behavior analysts observe a thumb twitch for its effect on the environment. Similarly, behavior analysts do not observe the permanent products of the book to understand the rules of grammar. Rather, behavior analysts observe the permanent products of a book for its effect on the social environment. This is to say that the target of the behavior analyst's observations is *operant* (Skinner, 1935).

The emphasis on *operant* is important because it guides our formal observations. *Operant* is an open-ended, class-concept defined by the effect of behavior on the environment (Hackenberg, 1988). The open-ended nature of the operant means that the target of observation could have one or more effects under different circumstances. Therefore, the target of observation, otherwise known as the *target behavior*, is operant behavior under the differential control of antecedents and consequences in the environment. Additionally, operant behavior may be public or private, as there is no requirement for an operant to be publicly observable (Skinner, 1945). What is felt or introspectively observed is one's own body (Skinner, 1974), which can serve as an antecedent for operant behavior (Lubinski & Thompson, 1987; Rajagopal et al., 2021). Further, the thinking, feeling, and emotions that influence our behavior can be linked to the classes of motivating operations we observe in the environment (Killeen & Jacobs, 2017a, b).

Why Do We Observe?

Applied behavior analysts are inundated with verbal descriptions of things seen by parents, physicians, psychiatrists, social workers, support staff, teachers, and more. For example, we are told the client is "not listening" or is "defiant." Moreover, we are told that the client is "not listening because he is defiant." Such descriptions lack the specificity needed to identify a target behavior *and* its controlling variables. The purpose of observing, then, is to bring one's own verbal behavior under the control of relevant organism-environment interactions (Bijou et al., 1968; Day, 1969). After one or more observation periods, an applied behavior analyst might come to describe "not listening" as "screaming to escape from demands." When the cause for what we say is what we see, we can begin to work more effectively with the behavior of concern. *Screaming* becomes the target behavior, *demands* the antecedent, and *escape* the consequence. There are organism–environment interactions we can change in service of our ultimate aim to predict and influence behavior (Hayes et al., 2012).

Where Do We Observe?

Observational settings range from the highly contrived laboratory setting to the various contexts in the field. Applied behavior analysts may find themselves in clinics, homes, schools, places of work, or the community. Dependent upon the target behavior, we may observe in one or more settings and across stimuli and people in those settings. For instance, property destruction may occur at school but not at home. Furthermore, that same behavior might occur in the presence of one teacher but not another, or in the presence of one academic task but not another. In addition, parents may report a behavior of concern that occurs at home, with the mother but not the father, at a certain time of day (e.g., bedtime). In any case, the observational setting is chosen and described for its effect on behavior. Observational settings include the things, events, and people relevant to the behavior of concern. Importantly, the observer's choice of observational setting is not arbitrary and is not chosen for the sake of one's own convenience.

What Is Observing?

Observing is behavior under the control of things seen. The effect of observing is verbal descriptions under the control of relevant organism–environment interactions. Things seen and said, however, can be distorted by the colloquialisms that creep into our observations (Hineline, 1980). For example, when the observer goes looking for the "obsession," "aggression," or "defiance" described by a parent. That is, as "events taking place somewhere else, at some other level of observation, described in different terms, and measured, if at all, in different dimensions" (Skinner, 1950). Formal behavioral observations rely on what we know about the principles of *behavior*; not some mental or mediational events taking place somewhere else. Formal behavioral observations involve methods for identifying, defining, and measuring our behaviors of concern. The remainder of this chapter covers the behavioral observation methods used to predict and influence socially significant behavior.

Target Behaviors

Applied behavior analysts aim to select target behaviors that possess social relevance and select target behaviors that are significant to the individual whose behavior is of interest. The target behavior selected should (a) lead to the access of new reinforcers, contingencies, and/or environments; (b) be socially valid (Bosch & Fuqua, 2001); (c) be generalized across contexts, behaviors, and individuals; (d) have the ability to compete with inappropriate behaviors; and (e) be important to those that the behavior change effects (Rosales-Ruiz & Baer, 1997). With these criteria in mind, the applied behavior analyst is better equipped to select behaviors most appropriate for targeted change.

Defining Target Behaviors

When defining a target behavior, the response must first be identified. A response is a single instance of behavior and multiple responses comprise a response class (Catania, 2013). A response class is a collection of individual responses that have common sources of influence in the environment. The importance of accurately identifying and defining the target behavior directly impacts the design of the intervention and measurement system. Without a well-defined response class, behaviors may be erroneously clustered together without sharing common environmental features.

When applied behavior analysts define a target behavior, they should consider the definition with respect to both specificity and sensitivity (Johnston & Pennypacker, 2010). Specificity refers to clear inclusion and exclusion criteria that will separate responses that are included in the class from those that are not. Sensitivity refers to the ability of the target behavior's definition to capture its range of variability. Ongoing evaluation of the specificity and sensitivity of the target behavior should ensure accurate measurement during all stages of data collection (i.e., both assessment and treatment).

A six-step sequence can be used to guide the process to identify and define a target behavior (Johnston & Pennypacker, 2010). First, the characteristics of the response class should be considered. Second, the type of definition used to define the target behavior should be decided. Namely, whether the behavior will be defined functionally or topographically. Third, a draft of the target behavior definition should be written that captures the topographical range of the target behavior. The target behavior definition assists the observer with discriminating between those behavior(s) that should be measured among those behavior(s) that should not be measured. Fourth, observations of the target behavior should be carried out before formal data collection to present an opportunity to test and refine the definition. Fifth, the dimension of measurement is selected for measures (e.g., frequency, latency, etc.). Last, an assessment or intervention is implemented that includes the target behavior along with the selected system of measurement.

Even during times when the applied behavior analyst follows the six-step sequence to identify and define a target behavior, adjustments to the definition may be needed. For example, during behavior measurement, the applied behavior analyst might notice that an aspect of the target behavior is not captured by the current definition or that the measurement system is not accurately representing the behavior as it occurs. In this case, changes must take place and the definition should be updated prior to continuing with data collection. Once the definition is updated, only those data collected that are based upon the updated definition and measurement system are analyzed (cf. data collected from the previous definition).

Types of Definitions

As mentioned during the six-step sequence, the two primary approaches to define a target behavior are either a function-based definition or a topography-based definition. A function-based definition is an approach for defining behavior to include responses whose occurrence depends on (is a function of) a particular class of stimuli that precede or follow the response(s). The function-based definition may include behaviors that vary significantly in form and topography, yet share the same function given that all behaviors within a function-based response class do share the same function. For example, a function-based response class might include aggression in the form of hitting others and disruption in the form of throwing items yet are defined functionally in that both are maintained by access to peer's attention. A common reason for using function-based definitions is to interpret the effectiveness of the intervention on the selected target behavior.

A second approach to define a target behavior is to do so using a topography-based definition. Topography-based definitions capture the three-dimensional form of the response. However, not all responses that are defined topographically will serve the same function. Furthermore, given its emphasis on the *form* of behavior, topography-based definitions often disregard the influence of antecedents and consequences that might impact behavior change. Defining a target behavior using a topography-based definition is advantageous when the form of the behavior is of critical importance. To illustrate why topography-based definitions might be useful, suppose a child exhibits head hitting (self-injurious behavior) from a distance of 12 inches or more with a closed fist. The behavior analyst defines this behavior topographically to contrast it with the occurrence of those instances when the same child exhibits head hitting from a 1-inch distance with an open palm. Differences between the defined topographies of behavior may offer crucial information about the child's health (i.e., the greater distance will likely result in more harm). Thus, topographically defining both behaviors offers vital data about the safety and health of the child.

The Importance of Precise Definitions

Precise behavioral definitions directly impact both the validity and reliability of an intervention. Data are valid if they represent what the behavior analyst observes and can subsequently draw conclusions from (Johnston & Pennypacker, 2010). Reliability is the agreement between observers who independently score the same behavior of a subject (Kazdin, 1977). If there is agreement between observers who are collecting data and both observers record the same behavior given its occurrence in that moment in time, this results in increased confidence of data collection. Reliability can be compromised by several factors that include observer awareness, observer drift, the complexity of the behavior/coding system, and observer expectancy (Kazdin, 1977).

Several studies have specifically evaluated the validity of research findings with respect to behavior observation. Hay et al. (1977) recruited teachers and parents and asked them to observe and collect behavior data. Hay et al. found that teachers' and parents' observer reactivity and history with participants impacted data collection agreement between the observers. Despite these factors that influenced agreement, it is important to note that observation agreement is directly related to the interpretation of the target behavior definition. The definition prescribed to the target behavior may be iterative, optimized, and changed over time. Thus, the observers can improve data collection with training if the definition has been updated or if there appear to be other factors impacting poor reliability (reactivity and history with participants). Related to this point, Alvero and Austin (2004) found that an employee who was asked to collect data on a co-worker's behavior had demonstrated poor data collection. The employee was provided with feedback on their data collection and the results showed that the delivery of feedback substantially improved their data collection performance. We encourage observers to take steps aimed to support precise data collection. These steps are for the observer to: (a) identify and describe the target behavior and the events that relate to it; (b) observe the behavior in a setting in which the targeted behavior is most likely to occur; and (c) record when the behavior is observed based on the definition within the context of the occurrence (Baer et al., 2005).

Dimensions of Measurement

Seeing an individual holding a baseball may be a relatively undaunting image for many individuals but if I were to ask you to measure what you see, the task becomes infinitely more difficult. That is because how we measure and what we measure is dependent on the scientific field of interest that is coupled with our specific training. A physicist may ask to weigh the baseball to calculate a mass. A chemist may take apart the ball to analyze the percentage of different materials that create its makeup. The behavior analyst, on the other hand, will be interested in measuring the behavior of the individual in relation to that ball. For example, the behavior analyst may want to know how many times the individual throws the ball or how long it takes them to throw the ball. The behavior analyst may even calculate the accuracy of catching the ball. Therefore, the environment is only important to the extent that it contributes to what we do, and our task as behavior analysts is to quantify what we do as any natural scientist would.

Establishing measurable dimensions of behavior is important for a number of reasons. First, science cannot exist without a quantifiable measure of your dependent variable. Without this, we are left subjectively describing behavioral events based on our own experiences. That may be well and good for the snake oil salesman but we, as scientists, hold ourselves up to a higher standard. The results of a study must be objective and replicable for behavior analysts to come to a confident consensus of an identifiable functional relation. Second, our language lacks precision and accuracy when describing the behavioral change. Of course, our words can convince someone that a change occurred but they cannot visually display the behavioral events in a way that allows an individual to analyze the outcomes for themselves and come to their own conclusions. In other words, the quantifiable measures are an objective translation of the events as they occurred in time. If a behavior analyst assigns a unit value to observed behavior, that value does not change or vary depending on appeals by the untrained observer. Third, measures of behavior are required for clinicians to make treatment decisions, such as when to (a) introduce an intervention, (b) continue an effective intervention, (c) modify a partially effective intervention, and (d) discontinue an ineffective intervention. Conjecture is not enough, especially when the stakes are as high as behavioral interventions developed for vulnerable populations in need of help.

Although recognizing justifications for using measurable dimensions of behavior may be simple enough, identifying *how* to now measure the behavior of interest raises the bar and adds new challenges for the behavior analyst. That is because behavior isn't an object that can be picked up, put down, or inspected with a magnifying glass. Behavior exists within time and we must measure it relative to the moments in which it occurs. Furthermore, the interpretations of a particular outcome are dependent on how you measure the target behavior of interest. For example, a behavior analyst may count how many times a child cries each day and point to fewer instances after the introduction of the intervention as an indication of effective action on their part. However, an astute assistant may notice that the child now cries once a day but the bout is much longer. Thus, for applied behavior analysts, the measure of choice must be representative of a socially meaningful outcome. Below are some of the fundamental dimensions that behavior analysts can use to measure behavior (see also Fig. 19.1). This is not meant to be an exhaustive list, rather the dimensions mentioned are common because they have repeatedly been determined to have particular utility.

Dimension #1: Count

When a response occurs, a behavior analyst can attribute a singular unit to that response and sum up each instance within an observation to establish a count. In order to properly use count to measure behavior, the response must be repeatable. That is, the behavior analyst is interested in identifying how often a response occurs given an environmental change. For example, an observer may count how many problems a student completes on a math homework sheet. Or a driving instructor may count how many times a trainee uses the blinker in a drive around the block. Although a measure of behavior is in its simplest form, count is limited to observational periods that do not vary or if the observation period is irrelevant. Therefore, the count is only really relevant when the issue is the target behavior occurring in the absolute sense (e.g., self-injury so severe it should not be occurring at all regardless of how brief or extended the observation period is). This is rarely the case because the expectation of the behavior analyst is that the target behavior is repeated within a certain period of time. How we interpret the outcomes of interventions is often impacted by the duration of the observation. A child who does 10 jumping jacks during the first observation, 20 jumping jacks during the second observation, and 40 during the third may start to impress the coach who is seeing her data increase with every data point. However, any interpretations of improvements may soon be disregarded by the coach when she finds out that the observation periods have also been progressively increasing from 5–10, to 20 min, providing the student with more time to exhibit more behavior.

Dimension #2: Rate

Rate is the solution to count that reduces the limitation of a measure lacking any relative value. The rate takes into consideration the period of time in which the behavior is occurring. Repeatability is therefore supplemented with properties of temporal locus to define how many times a response occurs given a specified period. To calculate the rate, the count is divided by the duration of the observation. The cycle of choice exists on a continuum from those that are brief (e.g., responses per sec) to those that are extended in time (e.g., responses per month). For example, Jessel et al. (2020) measured problem behavior on the order of minutes and the order of seconds to determine the correspondence between the two evaluations and the fruitfulness of conducting within-session analyses. The authors found that, in some cases, problem behavior can be analyzed on the order of seconds, which can reduce the necessity of extensive assessment periods. This holds practical value for clinicians working with individuals who exhibit dangerous behavior because the rapid assessment period allows the

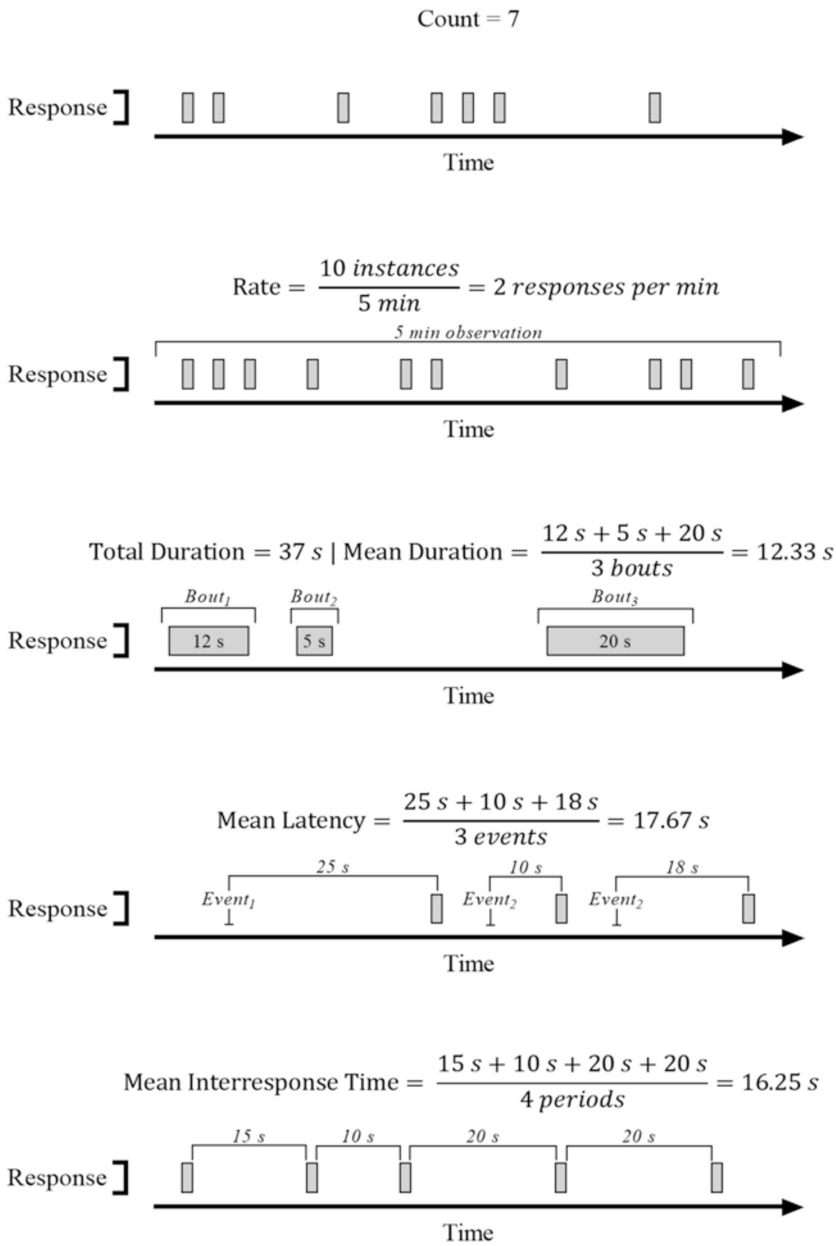

Fig. 19.1 Examples of each dimension of measurement

clinician to move quickly to implement an effective intervention. Other responses may occur across a larger window of time, making using smaller units of measurement inappropriate. For example, the behavior of smoking cigarettes is often measured as responses per day because it is highly unlikely for an individual to smoke multiple cigarettes in a minute, let alone a second (e.g., Garrison et al., 2020; McClure et al., 2018). Therefore, units of time can vary but are dependent on the behavior of interest. The behavior could be physically impossible to exhibit within certain windows of time or the measurement doesn't depict a socially acceptable form of change the intervention is intended to address. To put it another way, you wouldn't use a ruler to measure a room or a yard stick to measure the point of a pencil. The behavior analyst's job is to understand the unit of time that fits the target behavior in the same manner.

Dimension #3: Duration

In some cases, the behavior of interest does not have the properties of repeatability and the behavior analyst is more concerned with temporal extent, or how long the behavior occurs across time. More often this is the case when there are no discrete indicators of the behavior's beginning or end. Duration coalesces behavior into bouts of occurrence and the behavior analyst times how long the bout of behavior occurs. For example, a behavior analyst may try to measure each instance of a hand flick or body rock but the definition of each movement that fits the description of stereotypy may be difficult to reliably measure. Using duration with behaviors such as stereotypy has the benefit of reducing the grey area of every single instance and creates a simplified definition of the behavior being "on" and "off" for a period of time, so to speak. In addition, a soccer coach may be more concerned with how long a player remains active in a game rather than the number of times they kick the ball. Whether an artifact of the difficulty with using measures of repeatability or concerns of social relevance, the duration can be a useful dimension to consider.

How you measure duration can vary in multiple ways. A behavior analyst may be interested in the duration of each bout. That is, the behavior analyst starts and ends the timer with each occurrence and records the bouts separately, potentially calculating the mean duration of bouts per session: $\frac{t\,\text{bout}_1 + t\,\text{bout}_2 + \ldots t\,\text{bout}_n}{n}$. The duration can also be measured cumulatively across the entire session. This would involve starting the same timer with each bout to create one continuous duration of time that can be divided by the session duration to get a percentage of behavior that is occurring across the entirety of the session. Once again, the choice of measure is dependent on the social relevance of the situation. For example, a music instructor may be interested in a percussionist's ability to consistently maintain a drum roll on a snare drum for around 15 s. In such a case, the instructor would want a mean of 15 s across bouts. On the other hand, the trombone player often has to hold notes for extended periods of time and the instructor is more likely to be interested in the total percentage of time across a particular observation.

Dimension #4: Latency

In some cases, it may be important for a behavior analyst to understand when a response occurs relative to some other discrete stimulus. That interval of time between the stimulus being presented and the response occurring refers to latency and can be indicative of response strength, similar to elevated rates of responding. That is to say, if I were to press a button to answer a question on a game show reliably within 5 s that is likely to mean I am confident I have the answer, whereas waiting for 30–60 s would be a clear indication of my inability to answer. An individual may even find a particular event aversive and the latency can be measured to an escape response. For example, Call et al. (2016) presented various instructions to individuals who engaged in problem behavior and measured the latency to problem behavior given each instruction. The authors were able to take the mean latency for each discrete instruction and create a hierarchy of aversiveness depending on how quickly problem behavior occurred in the presence of the selected evocative events. Instructions that evoked problem behavior quicker were determined to be more aversive than those instructions that evoked problem behavior after extended periods of time.

Latency can be quite an efficient measure of behavior because it only requires a single, brief instance of a response to occur. Rate and count both require repeated instances across time and duration requires the response to occur over extended periods of time. This strength can reduce the necessary time required to conduct a session. For example, Thomason-Sassi et al. (2011) compared the use of latency and rate for measuring problem behavior during functional analyses. Using the measure of latency allowed the therapist to discontinue sessions after the first instance because repeated measures were not necessary. However, to calculate the rate, the therapist had to allow problem behavior to continuously occur across a period of time. The difference created a mean of 11 instances of problem behavior observed during the functional analyses using latency and 193 instances when using rate. The time required to collect measures of rate or duration can be problematic when considering severe problem behavior if repeated instances or long exposure could be physically harmful to those involved.

Dimension #5: Interresponse Time (IRT)

The dimension of interresponse time (IRT) shares many similarities with latency. The behavior analyst is measuring a period of time between two events. Where they differ is in what those events are: The distance between a stimulus and a response refers to latency; the distance between a response and a repeated instance of that response refers to IRT. Therefore, IRT is a measure of behavior as it occurs repeatedly in time in relation to itself. This is often referred to as pacing behaviors and is evident when an individual finds themselves stepping to the beat of their favorite song.

In some cases, a fast pace with brief IRTs is expected, such as when a child must repeatedly press a button in an arcade game to beat a boss. In other cases, a slower pace is desired. For example, Wright and Vollmer (2002) attempted to reduce the pace of eating for an adolescent girl diagnosed with developmental disabilities. Initially, the IRTs between each bite were so brief that it could result in dangerous complications during meals (e.g., choking). The authors developed a treatment package that involved response blocking and reinforcement on a differential-reinforcement-of-late-rate (DRL) schedule whereby access to the food was only allowed after a certain period of time had passed since the last bite. The intervention was intended to extend IRTs to a point that allowed the individual to appropriately chew and swallow the food before initiating another bite. The measure of IRT is also commonly used in models of attention-deficit/hyperactivity disorder (ADHD) as an indication of impulsivity. That is, the faster the pace (i.e., briefer IRTs) the more impulsive the individual is, and the slower the pace (i.e., extended IRTs) the more self-control the individual has. Studies measuring IRT often employ response inhibition tasks to determine the level of relative impulsivity among those with ADHD (van Den Broek et al., 1987) or animal models with rats (Orduna et al., 2009).

Combining Dimensions

We identified multiple dimensions that can be used to measure a single response but this does not necessarily infer that the behavior analyst is restricted to measuring behavior in such a limited and regulated manner. Multiple dimensions could be combined to, for example, measure the rate and duration of a tantrum. The behavior of interest may not be easily simplified to a single measure and providing multiple quantifications of behavior change may improve interpretations of intervention outcomes. In addition, a comprehensive treatment package that is intended to produce meaningful change in the behavioral repertoire of an individual is likely to involve the measurement of multiple responses, each utilizing a specific dimension. For example, Hanley et al. (2014) may have been particularly interested in reducing the problem behavior of three individuals diagnosed with autism; however, the authors used multiple measures when evaluating the comprehensive treatment to ensure a more impactful outcome in the child's environment. Hanley et al. taught multiple and increasingly complex communication skills and measured those responses as a rate. In addition, the authors were interested in cooperation with instructions and measured a percentage of compliance within a session. Finally, to ensure the majority of the participants' time was spent engaging in appropriate alternative behavior, Hanley et al. used the duration of reinforcement to measure the total percentage for each session. The combined measures and behaviors painted a quantitative mural of children who were now using developmentally appropriate language to ask for their wants and needs while accepting denials to reinforcers and following adult instructions when those reinforcers are not available. Without the combination of these dimensions, the picture would be incomplete.

Derivative Measures

Derivative measures are graphical representations of data that are transformed from direct measures of dimensional qualities of behavior. Derivative measures are often used to display data in a manner that highlights the salient features of the behavior. Two derivative measures commonly used in applied behavior analysis consist of trials-to-criterion and percentage. Both derivative measures serve distinct purposes when used to interpret behavioral data.

Trials-to-Criterion

Trials-to criterion is a derivative measure used to determine the number of occurrences of behavior required to reach a pre-set level of behavioral performance. The parameters of the pre-set level are often determined using a normative sample and offer insight into the efficiency of interventions for the respective participant. To illustrate this, suppose that a teacher plans to compare the effectiveness of two academic-based interventions on one student who is struggling to read sight words, the teacher chooses to set a criterion based on the performance of other students in the class who had already mastered identifying the sight words, and thus are considered to be the normative sample. The teacher is interested in the child's sight word identification performance (number of trials required) given both interventions with respect to the set criterion determined from the normative sample. The intervention considered to be most *efficient* is the intervention that had met the set performance criterion (often based upon the normative sample) in the least number of trials.

Roncati et al. (2019) evaluated the efficiency of prompt topographies that included both visual and auditory prompts in teaching intraverbals to three children diagnosed with Autism Spectrum Disorder (ASD). Using a trials-to-criterion measure, two types of prompt topographies (echoic and tact) were evaluated to determine which one transferred control to the verbal stimulus in the fewest number of trials. For two participants there was little difference in efficiency between topographies as shown when comparing the number of trials required to meet the set criterion (i.e., trials-to-criterion). For the third participant, the tact prompt appeared to be more efficient requiring less trials as compared to the echoic prompt for the learner to achieve the set criterion.

Trials-to-criterion is an appropriate derivative measure to use to capture the number of opportunities required to achieve a set criterion of a chained skill that requires several responses. For example, suppose, using a behavior chain a child is taught how to turn on a computer and how to navigate to a website. Trials-to-criterion is suitable to use to measure the number of trials needed for the child to independently achieve the chained skill. Additionally, the trials-to-criterion can be used to measure the number of trials needed to demonstrate independence during discrete trial instruction. To illustrate this, suppose a child is learning to identify shapes using discrete trial instruction. Each presentation of a shape is likely to be displayed a set number of times (e.g., 10 times) to promote learning. The set number of times is often referred to as a *block* and the number of trials (or blocks in this case) required to meet the set criterion is measured using trials-to-criterion.

Percentage

Another measure that is considered a derivative is percentage. Percentage is often used when the response of interest is dependent on the number of opportunities presented to respond. Behavior analysts often use percentage as a derivative measure when they are interested in the proportion of responding as it relates to a target response. For example, in discrete trial teaching the teacher may identify a specific target for the learner, run a set number of identical blocks of trials (e.g., 10 trials per block), and calculate the percentage based on correct responses within the block. Percentage is flexible in that it can be calculated for a range of behavior dimensions including frequency or count, duration, and discontinuous measures (see next section in this chapter). The formula used to calculate a percentage is:

$$\text{Response Occurrence} \div \text{Total Opportunities to Respond} \times 100$$

When using percentages, behavior analysts should be aware that upper and lower limit restrictions are placed on the data. For example, drawing on the previous discrete trial instruction example suppose that 10 trials equate to a block. The learner may accurately respond 10 out of 10 times resulting in a percentage of 100%, considered the upper limit. This percentage outcome suggests that optimal learning has occurred, and no further improvement can be made. However, if one, two, three, or more trials were conducted in addition to the initial 10 and the learner responded incorrectly, it would no longer appear that optimal learning had occurred. Rather than reflecting *true learning,* these outcomes are simply an artifact of the upper and lower bounds placed on the percentage derivative. These bounds, both upper and lower, can potentially distort behavior analysts' interpretation of the student's learning outcomes.

Quigley et al. (2018) used percentage to measure the independent play skills of three children diagnosed with ASD. The three teaching strategies that were evaluated included prompting, modeling, and a multi-component approach and all three strategies were compared to determine both the most effective and the most efficient strategy for teaching. The authors used the percentage derivative to show that all teaching strategies were equally effective; namely, all three participants showed an increased percentage of independence with the play response compared to the baseline.

Interval Recording

Interval recording, also referred to as discontinuous recording systems, are data collection methods often used during times when continuous data recording (count, duration, latency, etc.) may be arduous or impractical for the data collector. Interval data recording methods are often selected to record data when the response of interest is not discrete, or there is not a clear beginning and end. Examples of behaviors considered to be non-discrete and suitable to measure using interval recording may include playing with friends, on-task behavior during designated work times, or sleeping. Common types of interval recording include whole-interval recording (WIR), partial interval recording (PIR), and momentary time sampling (MTS). Although differences exist between the three, generally the observation period is divided into time intervals and the responses' occurrence or nonoccurrence is recorded at a designated time indicated by the interval recording method selected. Recently researchers have investigated interval recording accuracy; namely, Falligant and Vetter (2020) assessed the likelihood of false positive outcomes using types of structured visual criteria on two interval recording methods (i.e., momentary time sampling and partial interval recording). Although additional research is needed, findings showed that both interval recording methods likely control for false positive outcomes.

Whole-Interval Recording

Whole-interval recording (WIR) is appropriate to use when the behavior of interest continuously occurs and occurs at such a high rate that makes it is difficult for the data recorder to distinguish between instances. To collect data using WIR, a series of brief time intervals (5–10 s) is partitioned within the observation period. The data recorder pays special attention to whether the target behavior occurs or doesn't occur throughout the *whole* interval. If the behavior had occurred during the entire interval, this is indicated on the datasheet (+), and if the behavior had not occurred during the entire interval, this is too indicated on the data sheet (−). These data are then reported as a percentage of the total, temporally contiguous, intervals in which the target response had occurred during the observation period. Given that the defining feature of WIR is that the behavior must occur throughout the entire interval, WIR is known to underestimate the overall percentage of the behavior's occurrence.

Drawing from a recent study that included WIR, Lichtblau et al. (2018) implemented a biobehavioral treatment that consisted of melatonin and standardizing sleep and wake times aimed to decrease head and mouth touches related to sleep-related trichotillomania and trichophagia. Using a DropCam Pro video camera, 1-min WIR data were recorded on whether the participant's head was visible which indicated that she was sleeping and partial-interval recording (see below) was used to collect data on head and mouth touches. Results showed that the biobehavioral treatment increased the participant's sleep as measured by the percentage of (whole) intervals the participant was asleep per night.

Partial-Interval Recording

Partial-interval data (PIR) is commonly used for behaviors in which there is a clear beginning and end (i.e., discrete). To collect data using PIR, a series of brief time intervals (e.g., 10 s) is partitioned within the observation period (Schmidt et al., 2013). Yoder et al. (2018) found that Poisson-corrected estimates with short PIR intervals were optimal when using PIR recording. At the end of each interval, the data recorder marks if target behavior occurred at *any* point during the interval. If the behavior had occurred at any point during the interval (even briefly) this is recorded on the datasheet (+), and if the behavior had not occurred at all during the interval, this is too recorded on the data sheet (−). These data are reported as a percentage of the total, temporally contiguous, intervals in which the target response had occurred. Since PIR requires that the behavior occurs at least once during the interval, PIR is known to overestimate the overall percentage of the behavior's occurrence but underestimates instantaneous behavior (Bailey & Burch, 2002). A benefit to using PIR is that multiple behaviors can be tracked simultaneously since the data recorder only needs to track if the behavior(s) had or had not occurred.

Pisacreta et al. (2011) used partial-interval recording when they evaluated the 1:1 ratio of praise-to-behavior correction delivered by teachers on students' disruptive behaviors. If an instance of disruption was demonstrated by any student in the class during the designated interval, data were marked indicating its occurrence, and the percentage of intervals with disruption were graphed. Results showed that when teachers delivered praise-to-correction statements on a 1:1 ratio the percentage of disruptions had decreased compared to when teachers delivered praise-to-correction statements on a 1:2, 1:3, and 1:4 ratio.

Momentary Time Sampling

Like other interval recording methods, momentary time sampling (MTS) requires that brief (10 s), temporally equal, and contiguous intervals are partitioned (Schmidt et al., 2013). At the end of the interval, the observer *samples* the participant's behavior and if the target response occurs at that moment it is indicated on the datasheet (+); likewise, if the behavior is not occurring at that moment (the end of the interval) it is also marked accordingly on the datasheet (−) and this process is repeated for the duration of the observation period. Once the observation period is over, percentage data are calculated by the total number of intervals the target behavior had occurred divided by the total number of intervals multiplied by 100. A primary advantage of MTS is that the observer does not have to continuously observe the target behavior throughout the observation period which allows the observer to complete additional tasks while collecting data. This might be beneficial for someone tasked with multiple, simultaneous responsibilities such as an educator who teaches and supervises many students in their classroom. However, because the behavior is sampled at the end of the interval, instances of the behavior might be missed that occurred during the interval. Given this, it is recommended that this method is used for continuous activity behaviors, rather than behaviors that infrequently occur or those with short durations.

In a recent example of a study that used MTS to record instances of the dependent variable, Mendres-Smith et al. (2020) investigated the impact of two individual and combined interventions (i.e., play mat and interaction) along with a modified intervention on negative vocalizations and head elevations. Participants included infants who were experiencing tummy time. Throughout the study the MTS interval was set for 10 s. At the end of the 10 s interval the observer glanced at the mother and infant and recorded whether or not a negative vocalization or head elevation had occurred. Results showed that the modified intervention wherein mothers interacted with their infants using a toy and lying chest-to-chest was most effective.

Permeant Product Recording

In some instances, it is only feasible to measure behavior after it has occurred in the form of a *behavioral product*; however, we recommend when possible to collect data in vivo. Permanent product recording is when a behavior is measured after it has occurred with respect to the behavior's impact on the environment. Though, to record the behavior the observer must ensure that the behavior's effect on the environment lasts long enough for data recording to occur. This type of measurement is in reference to the time the measurement took place and its effect on the environment; for this reason other types of measurement can be coupled with permeant product recording (e.g., count, duration, etc.) to measure the dimensions of the permanent product. Benefits of permanent product recoding include limiting disturbances surrounding other required responsibilities, such as not diverting attention from students when teaching benefiting the one collecting data. There are also instances in which data recording is not accessible. For example, if a behavior analyst were scheduled to provide treatment to one patient and another patient in a different location exhibited a target behavior that had an effect on the environment. The behavior analyst could resort to permanent product recording if there were no other methods available to collect the data. When selecting to use permanent product recording, the behavior analyst should ensure that each instance of the target response always results in the same effect on the environment and that the effect on the environment can only be produced by the target response.

In an effort to foster parent's treatment fidelity with behavioral intervention implementation, Fallon et al. (2016) used an Implementation Planning strategy which was coupled with a Conjoint Behavioral Consultation model and data were collected using permanent product recording. The behavioral intervention parents had implemented was aimed at increasing compliance and decreasing aggression for two children diagnosed with ASD in a home setting. Results showed that following the training model parents' treatment fidelity had increased. However, the authors acknowledged a limitation with using permanent product recording for interpreting study outcomes; specifically, that research observations were not conducted to confirm the accuracy of the data—a primary drawback of using permeant product recording.

Elements of Optimal Behavior Measurement

A humorous tweet illustrates a critical issue commonly faced with those who conduct single-case research and observe behavior data when starting a new research project or clinical treatment (Masson-Forsythe, 2020). Namely, the ability to operationally define and then measure the phenomenon of interest, considered the bedrock of any empirical investigation. The onus is on researchers or clinicians to demonstrate the credibility, or believability, of their data (Johnston & Pennypacker, 2010). Single-case research designs and group designs share a similar concern, the *true* score is never known—rather we are always estimating the *true* score. One way to conceptualize this challenge is by viewing the formula:

$$\text{Obtained Score} = \text{True Score} + \text{Error}$$

This formula highlights that as error is added to the behavior measurement process the obtained score and true score become more disparate, thus resulting is less credible, or believable data. In essence, the obtained score, or datum point, that behavior analysts plot on their time series graph is only believable, or credible, if a justification and data are provided to suggest the error of measurement is minimized.

Two constructs relevant to the current conversation are *reliability* and *validity*. Reliability is often defined as the consistency of the data collected. High reliability in the data collection process for an individual study increases the likelihood the obtained score will closely resemble the true score and will allow the behavior analyst to have greater confidence that changes in the data are due to true changes in the behavior rather than error in the behavior measurement process (Barlow et al., 2009). Validity is often defined as the accuracy of the data collected in measuring, or representing, the phenomenon of interest. High validity in the data collection process for an individual study occurs when other measures of the same phenomenon align with the data collected. A common misconception often held is believing an instrument, or in the case of single-case research a behavior measurement procedure, is reliable or valid. However, the properties of reliability and validity are not inherent to an instrument or behavior measurement procedure but rather are properties of the data, or scores, collected (Wilkinson & APA Task Force, 1999). To unpack this further, this would mean the behavior analyst would need to demonstrate the validity and reliability of the data collected as part of the behavior measurement process for their treatment or experiment, across all included participants. For example, when constructing an operational definition of a target behavior, related literature may be consulted but it needs to be refined for the individual participant(s) participating in the study or treatment to increase the validity in measuring the phenomenon of interest. Another example, when creating the behavior measurement procedures prior literature should be consulted that will increase the likelihood of collecting reliable data, however, reliability data must be provided for the individual experiment across all included participants.

Pertaining to reliability, it is important for behavior analysts to consider multiple aspects. Because direct observation of behavior is the most commonly used behavior measurement approach, researchers demonstrate evidence of reliability by using multiple observers to collect data and results are compared. This demonstrates data collected through the behavior measurement system for the study are consistent across multiple individuals—thus demonstrating evidence of reliability. To maximize the evidence for reliability researchers can include several components. Using observers who are naive to the purpose of the study and which "phase" of the study participants are in (i.e., baseline and intervention) increases the credibility of the data collected and reduces the impact of observer reactivity. Observer reactivity occurs when observer knowledge of study purpose or condition impacts their data collection. Another element that behavior analysts should incorporate is collecting reliability data using two observers throughout the entire length of the study and across all conditions. Observer drift is a term used to describe situations in which observers using the behavior measurement system drift away from the original operational definitions or procedures resulting in data that were not representative of the original purpose.

The relationship between reliability and validity is also important to consider (see Fig. 19.2). As the figure highlights you can collect reliable data that are not valid. For example, two naïve observers may demonstrate high levels of agreement on their measurement of behavior (i.e., reliability), yet if they drifted from the original operational definition, or if the original

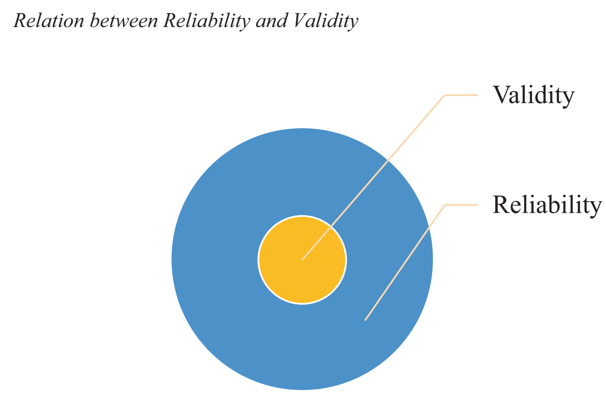

Fig. 19.2 Relation between reliability and validity. (*Note*. This figure highlights the relationship between validity and reliability. The first step is to evaluate whether reliability in behavior measurement is established across all participants, settings, behaviors, etc. The second step is to determine whether the measurement of the behavior validly represents the phenomenon of interest)

operational definition is flawed, these data may not be a valid representation of the phenomenon of interest. Yet, the inverse cannot be true.

Measuring Reliability

The primary method for providing data related to the reliability of the data collected as part of behavior measurement process is through interobserver agreement (IOA). IOA is important to provide evidence that naïve observers used the behavior measurement system yielding high agreement on the occurrence of the operationally defined behavior. However, this evidence is only convincing if researchers select an appropriate method to compute interobserver agreement and provide a justification for this decision. For example, a researcher selecting interval by interval agreement to evaluate IOA should provide a firm reason for why this method is appropriate if scored and unscored interval agreement were not also evaluated (see below).

Methods for Computing Interobserver Agreement

Total Agreement Total agreement can be used for count, duration, or latency behavior measurement systems. To compute total agreement the following steps will be followed:

1. Sum of the count, duration, or latency behavior across the observation intervals for each observer.
2. Use following formula to compute IOA for session: (smaller value/larger value) × 100.
3. Compute mean and standard deviation of observation sessions within phase (i.e., baseline or intervention) per participant.

The primary benefit of total agreement is the ease in computing and conceptualizing the estimated IOA. An important limitation to total agreement is it does not provide any evidence on whether both observers ever agreed when the behavior occurred, or did not occur. See Table 19.1 below for an example. The total agreement IOA would be (5/5) × 100 = 100%. However, a closer look at the data sheet highlights the two observers disagreed on 6 of 10 intervals whether the behavior occurred.

Table 19.1 Frequency count for callouts

	15 s intervals									
	1	2	3	4	5	6	7	8	9	10
Observer 1	1	0	1	0	1	0	1	0	1	0
Observer 2	0	1	1	1	0	0	0	1	1	0

Interval by Interval Agreement Interval by interval agreement can only be used for interval behavior measurement systems. To compute interval by interval agreement the following steps will be followed:

1. Score each interval as agreement (i.e., both observers say behavior occurred or both observers say behavior did not occur) or disagreement (i.e., one observer says behavior occurred and one observer says it did not occur).
2. Sum number of intervals coded as agreement.
3. Sum number of intervals coded as disagreement.
4. Use the formula: [agreements/(agreements + disagreements)] × 100.

A primary benefit of interval by interval agreement is increased precision over total agreement (i.e., described above). If we use data presented in Table 19.2, there were four intervals scored as agreements (i.e., intervals 3, 6, 9, and 10) and six intervals scored as disagreements (i.e., intervals 1, 2, 4, 5, 7, and 8). The interval by interval agreement IOA is [4/(4 + 6)] × 100 = 40%. We can see this differs drastically from the total agreement estimate of 100%. An important consideration to interval by interval agreement is high or low occurrences of behavior may inflate IOA of behavior. See Tables 19.2 and 19.3 for examples. Table 19.2 presents data for a behavior occurring at high frequency and the interval agreement is [8/(8 + 2)] × 100 = 80%. However, a closer look at the data shows the observers never agreed on when the behavior did not occur, they merely agreed on eight intervals that the behavior did occur. Table 19.3 presents data for a behavior occurring at a low frequency and the interval agreement is [8/(8 + 2)] × 100 = 80%. Though a closer look at the data shows the observers never agreed on when the behavior did occur, they merely agreed on eight intervals that the behavior did not occur.

Scored Interval and Unscored Interval Agreement Scored interval agreement focuses specifically on the agreement between observers on when the behavior occurred. Unscored interval agreement focuses specifically on the agreement between observers on when the behavior did not occur. To compute scored interval IOA the following steps will be followed:

1. Identify all intervals where both observed scored the behavior as not occurring, and then "remove" these intervals from your data sheet.
2. Sum all intervals scored as agreement (i.e., both observers scored behavior as occurring).
3. Sum all intervals scored as disagreement (i.e., one observer scored as behavior occurring and one observer scored as behavior not occurring).
4. Use the following formula: [agreements/(agreements + disagreements)] × 100.

To compute unscored interval IOA the following steps will be followed:

1. Identify all intervals where both observed scored the behavior as occurring, and then "remove" these intervals from your data sheet.
2. Sum all intervals scored as agreement (i.e., both observers scored behavior as not occurring).
3. Sum all intervals scored as disagreement (i.e., one observer scored as behavior occurring and one observer scored as behavior not occurring).
4. Use the following formula: [agreements/(agreements + disagreements)] × 100.

Table 19.2 Interval data for talking with peers

	10 s intervals									
	1	2	3	4	5	6	7	8	9	10
Observer 1	X	X	O	O	X	X	X	X	X	X
Observer 2	X	X	X	X	X	X	X	X	X	X

Table 19.3 Interval data for aggressive behavior

	10 s intervals									
	1	2	3	4	5	6	7	8	9	10
Observer 1	O	O	O	O	O	O	O	O	O	O
Observer 2	O	O	X	X	O	O	O	O	O	O

Table 19.4 Desirable and less desirable IOA collection

	Baseline										Intervention									
Sessions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Participant1	X	X	X								X	X	X							
Participant 2	X				X					X	X				X					X

Note. X denotes IOA collected

Scored and unscored interval agreement is ideal to report alongside interval by interval agreement to provide a more precise estimate of the agreement between observers for observing the occurrence and nonoccurrence of the behavior. If we use the data from Table 19.2, the scored interval IOA would be [8/(8 + 2)] × 100 = 80% and the unscored interval IOA would be [0/(0 + 2)] × 100 = 0%. If we use the data from Table 19.3, the scored interval IOA would be [0/(0 + 2)] × 100 = 0% and the unscored interval IOA would be [8/(8 + 2)] × 100 = 80%.

Standards for Acceptable Levels of Collection and Agreement

Similar to other decisions researchers make as part of the scientific process, context matters. We will provide general guidelines for the collection of IOA and thresholds deemed acceptable. If I redirect our attention back to the discussion surrounding reliability, remember that this construct is *not portable*. This means reliability must be established for the data collected as part of the experiment across all participants, conditions, settings, and dependent variables.

It has been recommended to collect IOA on a minimum of 20% across sessions in single-case research (What Works Clearinghouse, 2020) with preference for collecting IOA between 25% and 33% of sessions (Barlow et al., 2009; Kennedy, 2005). However, we do want to emphasize the IOA collected on 50%, 75%, or 100% of sessions is more desirable, though, this may not be feasible because of the required personnel. An additional consideration is to ensure IOA is collected between 25% and 33% of sessions within each phase and across participants. For example, a research team would ensure IOA data were collected across 33% of baseline sessions for participants 1, 2, 3, and 4 and across 33% of intervention sessions for participants 1, 2, 3, and 4. Last, it is important to sample IOA throughout the entire phase of the design to check for observer drift. See Table 19.4 for desirable and less desirable IOA collection. IOA data were collected for 30% of sessions for both participants 1 and 2. However, for Participant 1 IOA data collection was stacked at the beginning of each phase with the last seven sessions not including IOA collection whereas for participant 2 IOA data collection is spread out throughout the length of the phase (i.e., beginning, middle, and end).

Conclusion

Observation is a paramount component to allow for efficient examination and description of behavior, thus found at the core of applied behavior analysis. Keen observation offers applied behavior analysts the capacity to ensure sustained behavior change in their effort to improve the conditions of humanity. In this chapter, the relationship between observation—radical behaviorism—and applied behavior analysis is delineated and explored. Moreover, to provide the reader with the *essentials* of behavior analytic observation, we describe the importance of precisely defining target behaviors, dimensions of measurement, and elements to establish optimal behavior measurement.

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Single-Case Designs

20

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Introduction

Single-case design (SCD), also known as single-subject design, single-case experimental design, or N-of-1 trials, refers to a research methodology that involves examining the effect of an intervention on an individual or on each of multiple individuals. Unlike case studies, SCDs involve the systematic manipulation of an independent variable (IV) (i.e., the intervention) along with repeated measurements of a dependent variable (e.g., a behavior). These designs are especially useful for examining the impact of treatment on an individual's performance of a measurable target behavior over time (McDougall et al., 2006). As such, SCDs are considered an adaptation of interrupted time-series designs and can provide strong evidence for establishing causal inference (Kratochwill et al., 2010). Moreover, each participant serves as his or her own comparison, which allows researchers to control for a variety of confounding variables.

Single-case studies have become increasingly popular in behavioral, educational, and psychological research to examine the effects of interventions among individuals with specific disorders, such as autism and learning disabilities.

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Often, disorders with low prevalence are difficult to study with traditional group designs that require large sample sizes to achieve adequate statistical power (Odom et al., 2005). The goal of a single-case study is usually to determine whether a particular intervention is more effective in changing behavior as compared to a baseline or business-as-usual condition (Kratochwill et al., 2010). Repeated observation in the business-as-usual condition creates a baseline phase, whereas repeated observation in the intervention condition creates a treatment phase (Lobo et al., 2017). Contrasting baseline and treatment phases may result in suggestions of effect, but stronger assumptions require stronger experimental designs. A variety of experimental methods discussed within this chapter can be used to enhance experimental control (Horner et al., 2005), in turn allowing researchers and practitioners to make conclusions about the existence of functional relations.

Research questions should drive the selection of experimental designs. Behavior analysts rely heavily on the trustworthiness of their data to make informed decisions about continuing, adjusting, or stopping interventions. Their research question typically determines which particular method or approach is most appropriate (Kratochwill et al., 2010), although practical and ethical considerations also contribute to design methodology. After a research question or aim has been identified, knowledge of the participants,

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_20

environment, and response classes being measured must be considered. Although experimental design is a process, the purpose of this chapter is to provide enough information to allow for the consideration of the most experimentally sound, appropriate, and feasible research design selection.

In this chapter, we will discuss four of the most common SCDs in applied behavior analysis: reversal (e.g., ABAB), multiple baseline, alternating treatments, and changing criterion designs (CCD). For each design, we present information about its development and applications, defining features, analytic approaches, and limitations. As we are limited to space, we must acknowledge that the scope and depth of this content are not intended to be fully representative of the experimental design and the measurement literature and practices available. However, we hope that the information presented will generate curiosity and motivate the reader to seek further information and/or comprehensive training needed to further advance the science and practice of applied behavior analysis.

History of SCD

Single-case research methodology has been used in the behavioral sciences since the nineteenth century (Onghena, 2005). For example, Hermann Ebbinghaus's classic experiments on memory relied on observations of a single participant (the investigator) over multiple trials and under a variety of conditions. In the early twentieth century, B. F. Skinner (1938) observed the effects of operant conditioning on behavior in experimental studies using nonhuman subjects under highly controlled conditions. Skinner clearly recognized the individuality of organisms and made the following observation: "…instead of studying a thousand rats for one hour each, or a hundred rats for ten hours each, the investigator is likely to study one rat for a thousand hours" (Skinner, 1966, p. 21).

Two decades later, Sidman's (1960) *Tactics of Scientific Research* articulated the necessary elements of single-case methodology for studies of behavior and provided guidelines for researchers. Another influential text was Johnston and Pennypacker Jr.'s (1980) book entitled *Strategies and Tactics of Behavioral Research*, which provided a comprehensive description of behavioral research methods.

For behavior analysts, SCD is foundational to the systematic study of how environmental manipulations influence changes in a living organism's behavior. Experimental research in behavior analysis relies heavily on the use of single cases to determine the relationships between interventions and behavior change, and SCDs continue to be utilized by researchers who are interested in applying behavioral, educational, or psychological interventions at the individual level.

Advantages of SCDs (vs. Group Designs)

In applied research, group designs are often used to obtain a measure of the average overall effect of an intervention on a large sample, such as all first-grade students within a school district or at the classroom level (Alberto & Troutman, 2009). Traditionally, the sample of participants is divided into an experimental group and a control group. Members of the experimental group receive the intervention while members of the control group do not. Measurements of the behavior are made before and after the intervention is implemented, and average changes in the behavior of the two groups are compared. Statistical procedures can determine whether the differences in average scores between the two groups are greater than can be explained by the random assignment of participants to different groups.

In contrast to group designs, SCDs provide a way to evaluate the effect of an intervention on the performance of a single individual or case. Each individual or case is compared to themselves, although the experiment may be replicated with other individuals. SCDs are most noticeably different from group designs in their reliance on baseline logic (Ledford et al., 2019), in which participants serve as their own control to compare differences in responding across conditions. Whereas researchers using group designs primarily rely on statistical procedures to evaluate the effect of an intervention, researchers who utilize single-case designs primarily rely on visual inspection of graphed data.

Single-case designs offer several advantages over group designs for behavior analysts. SCDs reduce or eliminate (a) the need for large numbers of participants with a particular behavior disorder, (b) the ethical problem of withholding treatment from a control group, and (c) the likelihood of obscuring individual responses to treatment by grouping data (Barlow & Hersen, 1984; Poling & Grossett, 1986). Another key advantage of SCDs is their flexibility because the intervention can be adjusted over the course of the experiment in response to the pattern of results (Ledford et al., 2019; Perone & Hursh, 2013). This can be important when "the research topic is novel, when the investigator's ability to exert experimental control is limited by ethical or logistical considerations, and when the goal is to produce an empirically validated therapeutic result for an individual" (Perone & Hursh, 2013, p. 118).

Defining Features of SCDs

Basic Elements

SCDs include at least three main ingredients: a case, an independent variable (IV), and at least one dependent variable (DV). A case refers to the subject of the experiment, such as a single living entity (Critchfield & Shue, 2018) or a group of participants. The IV is a single intervention or set of treatments under investigation systematically manipulated in some way by the researcher to demonstrate experimental control (Horner et al., 2005). The DV is a socially significant, observable, and measurable outcome used to demonstrate causal relations (change in the IV results in a change in the DV). As a simple illustration, suppose a researcher is interested in implementing an intervention to increase the amount of time a young child stays in his seat during a lesson. The intervention involves rewarding the child with stickers for remaining seated. In this scenario, the DV is the amount of time the child remains seated, and the IV is the distribution of stickers as a reward.

In order to quantify, analyze, and infer causal effects, the DV should be operationalized so that measurement is both reliable and accurate. Across time, the effects of repeated systematic manipulation of the IV (conditions over which the researcher has control) are measured by evaluating changes to the DV. In addition, measures are conducted to ensure consistency in intervention implementation (fidelity) and measurement of the DV (inter-observer agreement). Evidence of an effect is confirmed via replication.

Social Validity

One of the seven dimensions of applied behavior analysis is the study of socially significant behavior: "In behavioral application, the behavior, stimuli, and/or organism under study are chosen because of their importance to man and society…" (Baer et al., 1968, p. 92). The acceptability of intervention components, methods of measurement, and experimental outcomes can be equally as relevant to interventionists as a measure of effectiveness, answering "For whom does it work?" and "Will it continue in use when I'm gone?" Behavior scientists can use surveys and choice measures to gather information about the social significance of the research before and after a study (Fuqua & Schwade, 1986). Structured interviews with participants and stakeholders can supplement measures of treatment adherence, attrition (i.e., participant drop-out), and follow-up interviews with participants and primary stakeholders and can supplement information to ensure research methods and designs are aligned with the applied dimension of applied behavior analysis (Baer et al., 1968; Kazdin, 1977; Wolf, 1978).

Internal Validity

Once the research question, IVs, and DVs are identified and defined, the next step is to consider the possible threats to the experiment and plan to prevent or reduce their effects on reliable and valid outcomes. The internal validity of a study is high when we can attribute the effect seen in the data to the intervention, whereas the internal validity is low when there are other plausible explanations for the changes that were observed. Threats to internal validity can be conceptualized as factors that influence the case (i.e., add variability to the data stream) while having nothing to do with the intervention itself. Threats to internal validity that can result in the loss of experimental control include history (e.g., medication changes or illnesses), maturation (e.g., changes in behavior due to developmental growth or learning), instrumentation (e.g., revisions to data collection tools or the use of different observers), and practice effects (e.g., improvement resulting from repeated exposure to test content and procedures). Because of the applied nature of the research, threats to internal validity cannot be completely eliminated, however, the judicious use of SCD features can control these threats and enable single-case researchers to make valid effect inferences, as will be elaborated in the rest of this chapter.

External Validity

External validity considers the extent to which the procedures and results of a study can be generalized across circumstances and individuals. In order to enhance external validity, researchers should describe their participants, interventionists, and research contexts to the extent the results can contribute to answering the question, "For whom and in what context does this treatment work?" External validity can be increased when researchers report participants' socioeconomic status (Fontenot et al., 2019), disability status, and cultural and linguistic background (Li et al., 2017; Wang et al., 2019). In addition, researchers should include as much information about the interventionists, context, and setting of the observations as possible to allow for future replication and meta-analytic research. In addition, planning for maintenance and generalization phases can provide information about the extent to which behavior change persists in other contexts and over time.

Example

If a teacher is interested in studying the effects of a small group vocabulary intervention for dual-language learners, it is important they consider the factors other than their intervention that may affect the child's vocabulary learning. When they design the study to control these factors and limit their effect on the intervention effect inferences, they are enhancing the internal validity of the study. If the intervention was effective, the ability to generalize the suggestion (i.e., external validity) would be enhanced if the teacher included several students, instead of one, and the intervention had similar effects across participants. By conducting a post-study survey of the teacher and/or participants' experience, social validity outcomes such as likeability and feasibility of the intervention can be assessed (e.g., students found the materials to be outdated, teacher reported that the students had difficulty sitting for long periods during administration). When considered together, measures of social, internal, and external validity can enhance data-informed decision making.

Baseline Logic/Experimental Control

Single-case research methodology is founded on baseline logic (Sidman, 1960), which relies on the assumption that a single case under study can serve as its own control. During the baseline phase, repeated measurements of the DV are taken to determine the status of the individual prior to implementing the intervention. As such, the baseline phase is analogous to a control group in group designs. Without intervention, researchers assume that the baseline pattern would remain relatively stable (Engel & Schutt, 2013). This temporal stability assumption is critical because effect inferences are based on comparing what is observed during the intervention to what would have been expected had the baseline continued.

To illustrate, consider the simplest SCD, which is the AB design, or interrupted time-series design. This design consists of repeated measurement of an outcome across two measurement periods: baseline (A) and intervention (B). During the baseline phase, observation and data collection occur prior to treatment or intervention. Dimensions of behavior such as rate, duration, or latency are recorded systematically at specific points in time. These dimensions are measured repeatedly during the A phase until a consistent pattern of responses or stable level of performance is observed. At that point, the intervention is introduced, and the behavior is again measured repeatedly during the B phase. Researchers must ensure that there is treatment integrity so that the intervention is delivered in a fashion consistent with its intent (Morgan & Morgan, 2009). Researchers have recommended a minimum of five data points in each phase (Kratochwill et al., 2010).

Figure 20.1 provides an illustration of hypothetical data from an AB design. Recall the example in which a young child was rewarded with stickers for remaining seated during a lesson. The child was observed at nine time points during the A phase and was not able to stay seated for more than 1 minute at a time. After the intervention was introduced, the child consistently remained in his seat anywhere from 20 to 25 minutes during the B phase.

The primary tool for analysis in SCDs is the visual inspection of data. Graphs, such as the example in Fig. 20.1, enable researchers to detect fluctuations that may be attributable to the intervention. These visual illustrations allow researchers to view the entire process in order to evaluate the treatment effect. Baseline logic is essential in interpreting the graphs. The researcher uses the baseline observations to project what would have happened had they not intervened and then compare intervention phase observations to this projection. When the baseline is stable, as in Fig. 20.1, it is possible to visualize, at least approximately, what would have been observed had there been no intervention, but if there is a lack of experimental control as evidenced by excessive variability and trend in the baseline, any projection becomes so questionable that effect inferences cannot be made. Thus, the design of SCDs hinges on the use of methods that ensure the establishment of stable baselines.

Although adopting methods to establish stable baselines is a necessary step in designing single-case studies, it is not sufficient for making causal inferences. We also need opportunities to see the replication of the effect. Consider the results of the AB design shown in Fig. 20.1. We see a shift in the number of minutes the child stays in their

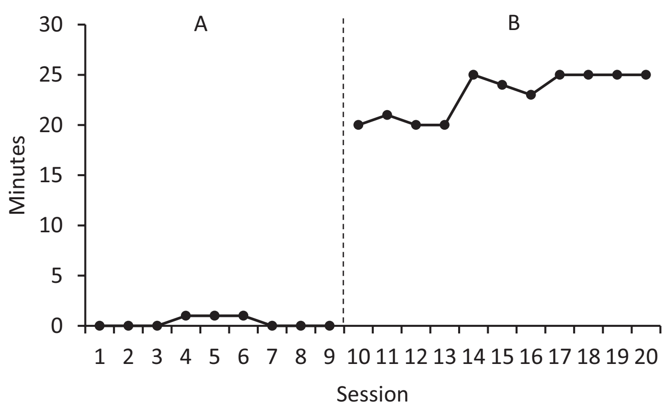


Fig. 20.1 Illustration of an AB design

seat, but it is difficult to know if the intervention caused the change in behavior. Similar to pre-test/post-test group designs, without randomization or replication of the phases, one cannot rule out alternative explanations for the change (or lack thereof). The child could have remained in his seat because he was interested in the lesson or for a variety of other reasons. Thus, the AB design is known to have poor internal validity because changes in the DV could be attributed to extraneous variables rather than changes in the IV (Poling & Grossett, 1986).

Using Single-Case Designs

Given the limitations of the AB design that restrict the ability to make causal inferences, there are many SCDs to consider in response to specific research questions. There are a variety of options to choose from based on the outcome of interest and what the researcher is trying to accomplish. The most common designs are described in detail in the following sections: withdrawal and reversal, multiple baseline, alternating treatments, and changing criterion designs.

Withdrawal and Reversal Designs (ABA and ABAB)

Withdrawal and reversal design[1] methodology was formally introduced in behavior analytic literature in the 1960s (Baer et al., 1968; Sidman, 1960). Traditionally, with both ABA and ABAB designs, treatment is introduced and withdrawn or reversed in a sequence that allows for within-subject comparisons.

An ABA reversal design consists of three measurement periods: baseline (A), intervention (B), and removal of the intervention (A). The difference between this design and an AB design is that measurement of the behavior continues after the intervention ends. The rationale for returning to baseline is to ensure that the behavior change occurring during treatment was attributable to the treatment and not some other variable (Morgan & Morgan, 2009). However, ABA design limitations include only two potential demonstrations of effect as well as ethical concerns about ending a study during a withdrawal phase when an intervention showed desirable effects.

Alternatively, with the addition of another treatment phase, ABAB designs increase the number of potential demonstrations of effect. An ABAB design consists of two baseline phases and two intervention phases and is the most frequently used reversal design. Reversal designs can be used to examine increases in desirable behaviors with intervention (see Fig. 20.2 for an example) or to examine decreases in problem behavior with intervention. As an example of the latter, consider a researcher who wants to reduce the number of times a student calls out in the classroom. During the baseline condition (A), the researcher counts the number of times the student calls out during five 10-minute sessions. The researcher introduces an intervention in which the child receives verbal praise for not calling out. During the intervention phase (B), the child is praised whenever he has not called out at the end of each 10-minute observation period. After this phase, the researcher returns to the baseline condition (A) and the child no longer receives praise for not calling out. When the intervention is reintroduced (B), the child again receives praise at the end of each observation period. If the reintroduction of the intervention results in a significant reduction in calling out, the researcher can feel confident that the intervention was responsible for changing the child's behavior.

ABAB designs are typically dynamic designs, where researchers are responsive to the data they

[1]Reversal designs, first described by Leitenberg (1973) and later reviewed by Wine et al. (2015), originally referred to a type of design in which the effects of one IV on two topographically distinct DVs (DV 1, DV 2) were repeatedly measured across time. The intervention, such as reinforcement, was presented in each phase but was in effect for either DV 1 or DV 2. The purpose of the use is to show changes in rates of responding when an IV is introduced to DV 1 and withdrawn from DV 2, as the rate of responding for each would change across phases when in the presence or absence of the IV. However, the reversal design as described is rarely used in contemporary behavior analytic literature and is often used interchangeably with *withdrawal design*.

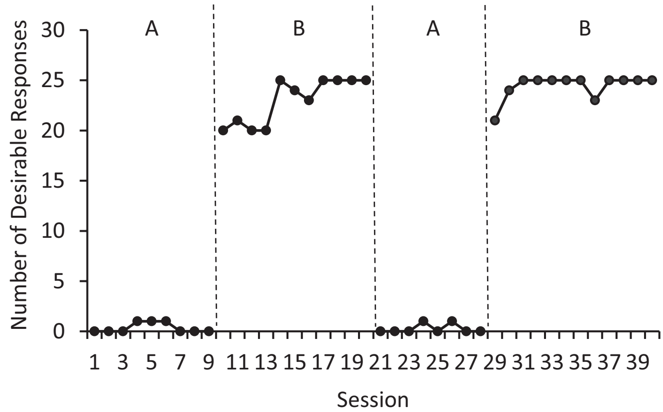


Fig. 20.2 Illustration of an ABAB design

observe and make choices during the conduct of the study that enhances their ability to make effect inferences. For example, suppose that the initial baseline phase (A1) was showing an unexpected therapeutic trend, creating questions about why the behavior was improving, and whether the uncontrolled factors responsible for the change would continue to operate and the behavior would continue to improve or whether the behavior would stabilize at a still problematic level. Given these questions, the researcher would extend the baseline until the behavior stabilized. As a second example, consider a researcher who was conducting an ABAB design where there were clear and immediate shifts in the behavior as the participant transitioned from A1 to B1, and from B1 to A2, but not an immediate shift when the participant transitioned from A2 to B2. In such cases, the researcher would ask why the effect was not immediate and perhaps conclude that some other factor besides the independent variable affected the behavior around the third transition. Because this third opportunity to demonstrate an effect was compromised, there are only two demonstrations of the effect (A1 to B1 and B1 to A2), which is generally not sufficient to demonstrate experimental control. To increase the internal validity of the design and strengthen the argument that the IV is impacting the DV, the researcher could extend the study to include additional phases (e.g., A3 and B3), and if effects were immediate with the transitions from B2 to A3 and from A3 to B3, the intervention effect argument would be bolstered.

Although ABAB designs are typically dynamic as just described, there are contexts where practical circumstances prevent researchers from being able to extend phases or studies. For example, the school year may be ending, or a participant or clinic may limit the number of observations to be collected. In such circumstances, baseline stability cannot be ensured. However, probabilistic control over threats to internal validity can be obtained by randomizing aspects of the design. For example, the time of the transition points could be randomly selected from the fixed study length with some constraints to ensure that phases had some minimum number of observations (Onghena, 1992).

The purpose of reversal designs is to investigate the effect of an intervention for an individual where the target behavior of interest is a reversible behavior. Relative to AB designs, withdrawal designs allow researchers to make stronger assumptions about the effects of an introduced or withdrawn intervention on a reversible outcome of interest. For example, a teacher hypothesizes that listening to classical music makes their students more productive writers. To test whether listening to classical music results in increased writing productivity, the teacher would systematically present or withdraw classical music and measure the number of sentences written by students across time. Reversal designs are not used when target behaviors are irreversible, such as in studies of academic skill acquisition.

With these designs, the outcome of interest is measured consistently across phases to examine differences in responding between conditions. Within each phase (baseline or intervention), the level, trend, and variability of the data are compared to their corresponding conditions (A1 to A2, B1 to B2) and to the alternate conditions (A1 to B1, A2 to B2, etc.). Experimental control is demonstrated by examining the trend, level, and variability of data in each phase and comparing them to each other. In Fig. 20.2, the baseline phases are stable, showing a low level of desirable responding, with no trends, and little variability, with response values ranging from 0 to 1. In contrast, the intervention phases show a much higher level of desirable responses with values ranging from 20 to 25. The immediate shift in response level between adjacent phases, the lack of overlap in data between adjacent phases, and the similarity of patterns (level, variability, and trend) in common phases (i.e., A1 is similar to A2, and B1 is similar to B2), all suggest experimental control. Furthermore, because the effect was replicated in each of the three opportunities provided (i.e., A1 to B1, B1 to A2, and A2 to B2) there is convincing evidence that the intervention impacted the DV. The stability of the data and replication of effects helps to rule out alternative explanations. Put another way, the internal validity is high because there are no plausible rival explanations for the observed effects (e.g., it is not reasonable to attribute the data pattern to maturation, practicing, or some event that happened during the study).

Although visual analysis is the primary tool used to analyze reversal designs, there are other methods that can be used to complement visual analysis. For example, researchers recognize that it takes multiple studies to accrue enough evidence for an intervention to be categorized as an evidence-based practice and that the synthesizing of evidence across studies relies on quantitative summaries of the size of the intervention effect, and thus a variety of effect size measures have been developed for single-case studies. Some effect sizes index the degree of non-overlap between adjacent phases (Parker et al., 2011), others standardize the mean difference between intervention conditions (Shadish et al., 2014), and others index progress toward a goal (Ferron et al., 2020). Furthermore, when designs incorporate randomization to control threats to internal validity probabilistically, randomization tests can be used (Onghena, 1992).

Limitations

Practicality, feasibility, and ethical concerns present limitations to the use of the withdrawal design. In terms of practicality, withdrawal designs are unsuitable for studying behaviors that cannot be unlearned. For example, in measuring the effect of an intervention on alphabet knowledge, withdrawal of the intervention should not result in a student's loss of alphabet knowledge previously acquired. Additionally, this design requires enough data within each phase to evaluate level, trend, and variability, in addition to at least three phase changes to provide sufficient data to assess replications of effect. If barriers such as scheduling difficulties or low-rate behaviors exist, the design may not be feasible for consistent measurement and introduction/withdrawal of intervention. Last, as with any experimental design, a researcher must consider the ethical implications of withdrawing treatment that significantly improves a participant's health and/or quality of life. For example, if a participant engaged in self-injurious behaviors requiring medical attention, it would be inappropriate to remove a successful intervention and return to a condition that resulted in harm to the participant. Instead, other designs should be considered.

Multiple Baseline Design

The multiple baseline design (MBD) is one of the most frequently used designs in the field of applied behavior analysis (Baer et al., 1968). With the aim of investigating the effect of an intervention on a behavior of interest, the MBD involves the sequential introduction of an intervention across two or more behaviors, settings, or individuals in a staggered fashion. As implied by *multiple*, the design typically involves a minimum of three baselines, with graphed data pre-

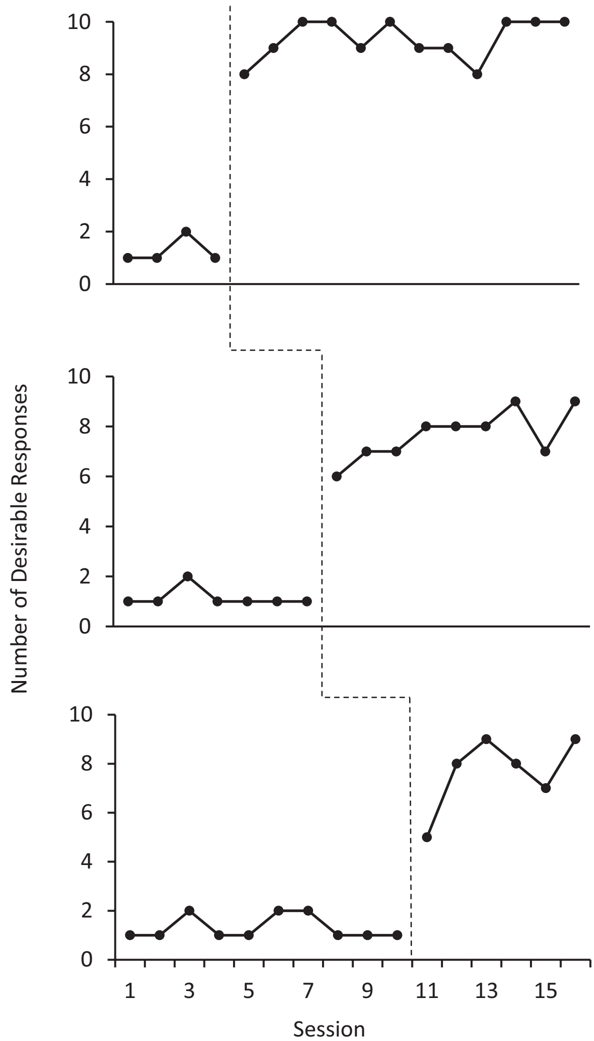


Fig. 20.3 Illustration of a multiple baseline design

sented in stacked graphs, one for each behavior, setting, or individual. Baseline lengths are purposefully varied across cases, so the introduction of the intervention occurs at different times for different cases, as illustrated in Fig. 20.3.

In order to achieve experimental control with the MBD, the baseline phase for each case should be stable. In addition, the baseline for the second case lasts until the intervention phase data for the first case becomes relatively stable. Likewise, the intervention for the third case does not begin until the intervention phase data for the second case has stabilized. The second and third cases act as controls for the first case, and the third case acts as a control for the second case (Engel & Schutt, 2013). This staggered approach allows the researcher to determine if changes in behavior coincide with the intervention for each participant, which makes explanation through history or maturational effects less plausible.

As with the previously discussed reversal designs, MBDs tend to be dynamic, where decisions about when to intervene are made based on an ongoing visual analysis of the data to ensure there is stability in the phases. When practical constraints make response-guided decision-making untenable, probabilistic control over threats to the internal validity of the study can be obtained by specifying baseline phase lengths a priori (e.g., staggered lengths of 3, 5, 7, and 9 data points), and randomly assigning cases to the different baseline lengths. Both probabilistic control over threats to internal validity and control through baseline logic can be obtained by coupling the use of a dynamic response-guided design (i.e., where interventions occur only after baseline stability has been obtained) with random assignment of participants (or behaviors or settings) to tiers of the MBD (e.g., randomly selecting which participant is intervened with first; Ferron & Jones, 2006). The MBD can also have additional features, such as a reversal/withdrawal phase, generalization, or maintenance phase.

The MBD is useful for practitioners and researchers interested in studying the effects of an intervention on more than one case (i.e., participant, setting, or behavior). By removing the requirement to withdraw intervention, the MBD is particularly useful when it is not appropriate to use a reversal design; for example, when the outcome is not reversible (e.g., a learning task) or when reversing an outcome would not be ethical. MBDs can be ideal for the study of intervention effects in very specific populations in a wide range of diverse contexts, such as substance abuse treatment for adults with an intellectual disability (Gosens et al., 2020) or to teaching young children to recycle or compost items (Bolanos et al., 2020).

The observed change in the outcome data are evaluated through visual inspection within and across the MBD graphs. Starting with the examination of within-case responding, researchers look for patterns of stable responding during baseline and a marked change in level, trend, and/or variability once an intervention is introduced. For example, in Fig. 20.3 we see for each case an immediate shift in the number of desirable responses with the initiation of the intervention. In addition to this horizontal within-case analysis, we conduct a vertical across-case analysis to see at the time of intervention if there is a shift in behavior only for the case starting the intervention. For example, at the time of the first intervention in Fig. 20.3, we see that while case 1 responds to the intervention, both cases 2 and 3 show no appreciable change. Similarly, when case 2 begins intervention, there is no change in the behavior of case 3. The magnitude and immediacy of change in the DV after the introduction of the IV, and the number of replications of a similar effect across cases, greatly enhance causal assumptions from visual inspection of the MBD graphs.

The visual analysis of MBDs can be complimented with statistical analyses to index the size of effects (e.g., Ferron et al., 2020; Parker et al., 2011; Shadish et al., 2014), or to model the variation in effects over time and across cases (Moeyaert et al., 2014). Furthermore, if the design is both dynamic and randomized, masked visual analysis methods can be used to make probability-based inferences (Ferron & Jones, 2006). If the design is randomized and fixed (not dynamic), randomization tests can be used to make probability-based inferences (Koehler & Levin, 1998).

Limitations

Intervention effect inferences for a specific individual (or behavior or setting) are weaker in MBDs than in ABAB reversal designs, because there are not multiple demonstrations of within-case effects. Rather the causal relations must be inferred through the replication across participants (behaviors or settings) coupled with the comparisons of data patterns across tiers in the MBD. Additional limits to using the MBD involve practical considerations, such as time and resources needed to plan and implement the design in an applied setting. In addition, staggered baselines introduce ethical concerns related to withholding a potentially effective treatment from some participants for an extended time.

Variations

There are variations in the MBD, which include multiple probe and delayed multiple baseline designs. In multiple probe designs, the observations are made intermittently, as opposed to continuously, and thus multiple probe designs are MBDs with planned missing data. Delayed multiple baseline designs are MBDs in which baselines do not start concurrently for all cases. Both designs purposefully address known barriers to consistent and continuous measurement across cases for the duration of a study. Having knowledge of the behavior, participant, and/or research context, a researcher may select a multiple probe design because of ethical concerns about repeated measurements in extended baseline or practical concerns (e.g., barriers to scheduling observations in an applied research setting). In applied research contexts where there are limited resources (e.g., public-school classroom) or when an additional setting, subject, or behavior becomes available after the study has begun, a delayed multiple baseline design may be most appropriate. However, due to the non-concurrent method of at least some of the data collection, these two MBD variations may lead to weaker effect inferences, particularly when measuring a highly variable behavior.

Alternating Treatments Design

An alternating treatments or multi-element design requires the systematic and rapid alternation of two or more interventions over time while consistently measuring their effects on a DV. Introduced only one at a time, the interventions must be different enough from one another to ensure that the changes in the DV are related to the presentation of the specific levels of the IV. The decision to include specific features within an alternating treatments design (ATD) is driven by the study research questions. When designing a study to examine the extent to which different treatments result in different DV responses, compared to no treatment at all, the research aims necessitate the inclusion of a baseline condition. When theory and prior research support the assumption that compared treatments will affect the DV, researchers may forgo a baseline phase and focus on comparing outcomes across different intervention phases. Similarly, the presentation sequence of treatments is driven by research questions. In some alternating treatments designs, the alternation between conditions is systematic, such that the B phase always follows the A phase yielding a sequence of ABABABABABABAB; however, it is better to randomize the order of treatment for each pair of observations, which could lead to a series of ABBABAABBABAAB or BABAABBABA ABAB.

Different treatments have different symbols or markers to allow for visual inspection of their unique impacts on the DV. Lines connect only those data points representing the same treatment condition over time.

Alternating treatments designs are ideal for situations in which there are multiple treatment options available, but a researcher wants to select the treatment having the largest effect on the measured behavior or outcome. Thus, unlike reversal and multiple baseline designs that address the question of whether an intervention is effective, ATDs address the question of which intervention is most effective. For example, Blair et al. (2018) used an alternating treatments design to examine the differential effects of two different prompt fading techniques (most-to-least verbal versus most-to-least physical) on learned behaviors for two participants. The comparison of the different prompt fading procedures was achieved by studying interventions that were topographically distinct, to rule out participants' failure to discriminate between the two interventions and reduce the risk of multiple treatment interference. ATDs are typically used for the study of reversible behaviors and have been used in the study of variable behavior when phase extension to achieve stable responding is untenable (e.g., setting or time constraints unpermitting). The ATD can also be used for component analyses. Component analyses involve testing the effects of individual ingredients of a treatment package and exploring their impact on efficacy. A component analysis can help interventionists design more parsimonious treatments as necessary to ensure the intervention package includes only the necessary components.

Similar to outcome analyses of a withdrawal design, visual analysis of an ATD looks for consistent differential responses between conditions

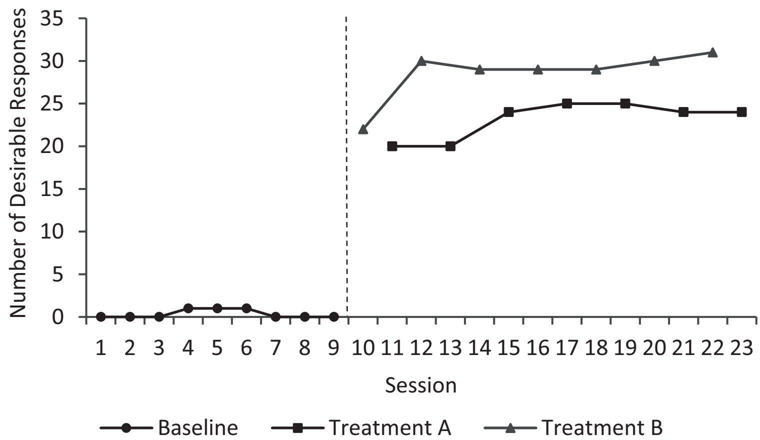


Fig. 20.4 Illustration of an alternating treatments design

in order to make inferences about functional relations. However, inferences about causation are stronger in ATDs than withdrawal designs because they offer more demonstrations of differences in treatment effects over time. By experimentally and systematically alternating quickly between different treatments, the rate, level, and variability of observations for each treatment can be compared over time and to one another. As seen in Fig. 20.4, observations corresponding to each treatment are connected to create a data path, thus allowing one to examine the within-condition level, trend, and variability (pattern of responding) for treatments A and B, as well as comparing each data path to the other.

In addition, the ATD works well with both visual and supplemental statistical analyses. For example, when researchers randomize the presentation of each treatment over time, which serves to further reduce threats to internal validity, randomization tests can supplement the visual analyses (see Craig & Fisher, 2019; Kratochwill & Levin, 2010; and Weaver & Lloyd, 2019 for methodological procedures using randomization in ATD).

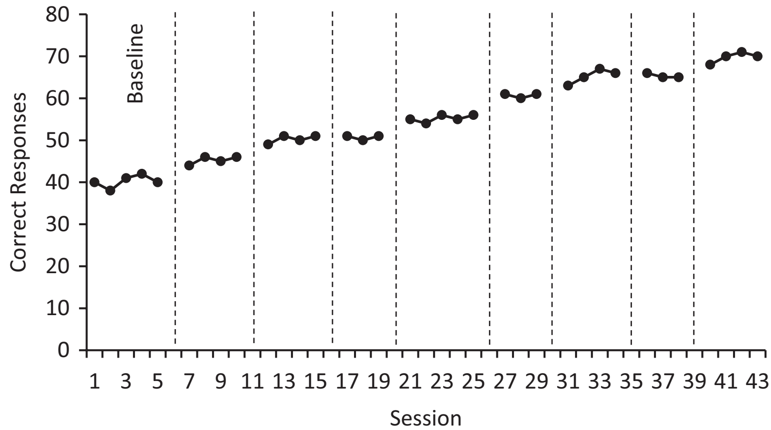
Limitations

The lack of a baseline in the comparison of two different treatments can be a limitation of this design, unless the research question is to compare those treatments only to one another. The potential for carry-over effects must be considered when selecting an ATD. If the treatments are not distinctly different from one another, experimental control is threatened by a responder's failure to discriminate between interventions and/or the influence of multiple treatment interference. The result can be a carry-over of treatment A effects to the next observation in the treatment B condition.

Changing Criterion Design

Starting with a pre-specified and socially significant outcome, changing criterion designs (CCDs) allow for the measurement of stepwise changes in the rate, duration, or accuracy of a specific response as it moves toward the intended outcome or goal. CCDs begin with an initial baseline phase, and when stable responding is present, additional phases are introduced over time to shape the outcome toward a predetermined goal. In many applications of CCDs, each phase is only as long as necessary for responding to stabilize at a criterion before a new phase with a new criterion is introduced. Researchers have recommended three to four changes in the criterion level (Gast & Ledford, 2014; Klein et al., 2015). The design can be used to explore a gradual shift or shaping of a DV over time and across different criterion-based conditions. Graphically, the data cluster around a criterion set by the researchers and modeled on the y-axis, as illustrated in Fig. 20.5. As the magni-

Fig. 20.5 Illustration of a changing criterion design



tude of the criterion changes over time, the intended result is an incremental change in the DV yoked to the set criterion.

Unlike MBDs, individual participants move through phases based on their individual response to treatment—staggered baselines are unnecessary. Unlike withdrawal designs, there is no requirement to return to previous criteria/phases to provide replications of effect. However, internal validity may be strengthened with the addition of baseline or reversal conditions over time presented in a stepwise manner. For example, a researcher may introduce a phase with a previously met criterion to examine persistence or maintenance effects, whether or not the DV returns to response levels corresponding to the former criterion. Additional methods to increase the internal validity of CCDs include changing the distance between criterion levels, varying the lengths of phases, and including randomization (Ferron et al., 2019; Onghena et al., 2019).

Changing criterion designs (CCDs) have been used for the study of interventions to shape specific behaviors and to evaluate performance management outcomes. They have been described as a variant of the MBD "in which different criterion levels are introduced in a time-lagged fashion" (Ledford et al., 2019, p. 42). CCDs are often used when a "target behavior requires considerable skill or has not previously existed at all in the client's repertoire" (Morgan & Morgan, 2009, p. 161). In other words, this design can be especially useful when stepwise changes are more reasonable because the behavior is not expected to change quickly. In the measurement of academic behaviors, CCDs are compatible with fluency training for discrete skills like spelling, decoding, and math facts. They can be used to increase the frequency of behaviors (e.g., amount of time spent exercising) or reduce the frequency of behavior (e.g., number of cigarettes smoked). In order to reach a criterion level of performance, gradual stepwise changes in these behaviors (exercise or smoking) would be expected and desirable. The advantages of this design are that it requires only one participant, behavior, and setting; the treatment does not have to be withdrawn; all participants receive treatment after a brief baseline period; and treatment efficacy is clearly demonstrated when performance closely matches the criterion (Byiers et al., 2012; Poling & Grossett, 1986).

Primary analyses, like with other SCDs, are visual, where researchers examine level, trend, and variability within phases, and look for changes across phases that correspond to the changing criterion. To supplement visual analysis, non-overlap indices have been proposed as a way to quantify the change in behavior, and the percentage of conforming data (PCD) is often utilized to index the percentage of data points within each intervention phase that fall within a specified range (McDougall, 2005). In addition, randomization tests are available if randomization is included in a fixed-length CCD (Onghena et al., 2019), and masked visual analysis procedures can be used when randomization is included in a dynamic CCD (Ferron et al., 2019).

Limitations

A limitation of this design is that the intervention must address a performance deficit, not a skill deficit, as the CCD requires the response to be within one's preexisting behavioral repertoire. When the behavior does not closely parallel the criterion levels, interpretation can be difficult. Because the behavior changes slowly over time, brief reversals to a prior criterion are advised to ensure that the intervention caused the changes rather than maturation (Ledford et al., 2019). Additionally, Hartmann and Hall (1976) have recommended that subphases should differ in length but be long enough to ensure that changes are not naturally occurring.

Summary

Single-case design is a useful approach for studies of behavior in which there is interest in the individual effects of the intervention. In addition, SCDs are well-suited for behavioral, educational, and psychological research contexts, where obtaining large samples is not feasible. With its focus on individual change over time, SCDs can provide important information about the effectiveness of interventions on behavior. This chapter provides an introduction to the most common SCDs by describing their purpose, analytic approaches, and limitations. Examples of each SCD are illustrated to give the reader an idea of research questions that may be appropriate when considering each approach. While there are many variations and adaptations of the designs presented in this chapter, this overview does not allow for more thorough descriptions of additional SCDs such as the repeated acquisition design (Spencer et al., 2012) and SCDs that combine design elements (e.g., combined MBD and ATD elements within a single study). Readers who are interested in detailed coverage of these designs are encouraged to review more comprehensive texts (e.g., Gast & Ledford, 2014).

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Stimulus Preference Assessments

21

Cammarie Johnson and Richard B. Graff

The use of effective reinforcers is paramount to the effective treatment for individuals with intellectual or developmental disabilities (IDD) and is critical to both increase new skills and decrease interfering or dangerous behavior (Fisher et al., 1996; Karsten & Carr, 2009). Reinforcers, however, are both idiosyncratic and potentially ephemeral, which can make their identification challenging.

Reinforcement is a process defined by the effect of specific consequences that follow specific responses: If the probability of a specific response increases when specific consequences follow that response, a positive reinforcement effect is demonstrated, and that specific consequence is shown to be a reinforcer. A basic building block to developing effective treatment, therefore, is to identify stimuli and events that when incorporated strategically into programming efforts (i.e., delivered contingent on target behavior or noncontingently) will function as reinforcers and produce meaningful behavior change.

Over the past few decades, much behavior analytic research has focused on how to identify reinforcers effectively and efficiently for individuals. Because reinforcers cannot be identified a priori (i.e., before they are delivered contingently and their effect on behavior is observed), behavior analysts have focused on methods that may predict which stimuli and events will function as reinforcers. Methods have focused on identifying individually preferred stimuli as probable reinforcers. Preference for specific stimuli or events is demonstrated by an individual's behavior to obtain access to or maintain access to that stimulus or event. The identification of preferred stimuli, therefore, can be observed directly and separately from the reinforcing effect those stimuli have on a particular response. In subsequent evaluations, preferred stimuli have been reliably shown to function as reinforcers.

The research on stimulus preference assessments (SPA) has led to a robust technology for individually delivered assessments to (1) identify preferred stimuli that will function as reinforcers for individuals, and in particular for individuals with severe and profound disabilities who may be unable to communicate their preferences, and (2) validate that preferred stimuli function as positive reinforcers.

In this chapter, we review research on stimulus preference assessments in four sections.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_21

In the first section, we start by reviewing the different methodological arrangements by which preference has been assessed, placing special emphasis on four of the most researched methods: single-stimulus (Pace et al., 1985), paired-stimulus (Fisher et al., 1992), multiple stimuli without replacement (MSWO; DeLeon & Iwata, 1996), and free-operant (FO; Roane et al., 1998) preference assessments. Next, we report on the types of stimuli that have been evaluated for preference and how these stimuli and other variables may affect outcomes. Then, we review the research on criterion validity (using different reinforcer assessments) of different preference assessment methods; test–retest reliability and preference stability when the preference assessment is repeated; and social validity of the preference assessment outcomes. We end this section with recent research on more efficient stimulus preference assessment methods. In the second section, we review reinforcer assessments. We start by reviewing their purpose to validate the predictions of the stimulus preference assessment. Then we discuss the different arrangements used in reinforcer assessments and how, based on the arrangement used, the assessment results indicate the assessed stimuli's absolute or relative reinforcer effects. In the third section, we review the research on different methods of training non-behavior analysts, such as therapists and parents, to use stimulus preference assessments. Specifically, we review behavioral skills training (BST), pyramidal training, self-instruction, video modeling, and telehealth methods. In the last section, we end with recommendations and considerations related to best practices in using stimulus preference assessments.

Stimulus Preference Assessment Methods

Behavioral researchers have developed numerous methods of identifying potential reinforcers. These methods can be categorized as either indirect or direct assessments.

Indirect Assessments

Early attempts to identify preferred stimuli (i.e., an item that an individual chooses to engage with that *may* function as a reinforcer) involved indirect assessments, such as the use of staff or parent report or checklists. For example, Cautela and Kastenbaum (1967) developed a reinforcer survey that asked respondents to rate how pleasurable the client found various stimuli (e.g., from "not at all" to "very much"). Stimuli that received the highest ratings were hypothesized to function as reinforcers (although no direct test of reinforcer effectiveness was conducted). In a similar study, Atkinson et al. (1984) developed a reinforcer checklist to identify potential reinforcers for children with autism. Parents and staff members were asked to develop a list of potential reinforcers, and respondents rated each potential reinforcer on a 4-point scale; this process was repeated 1 month later. The researchers found that the checklist had acceptable test–retest reliability. A high correlation between staff and parent opinion was also observed. No attempt was made, however, to determine if any of the items functioned as reinforcers.

Indirect preference assessments are relatively quick and easy to implement, but their results typically correspond poorly with the outcomes of more systematic assessments (e.g., Cote et al., 2007; Green et al., 1988). More recently, indirect preference assessments have been used in concert with direct assessments, as a way to determine the stimuli to be directly assessed (e.g., Fisher et al., 1996).

Fisher et al. (1996) sought to determine if adult opinion had beneficial effects when attempting to identify preferences. Six parents of children with IDD were given an experimenter-generated list of items and asked to predict preference rankings (from most preferred to least preferred). Parents were also provided with an interview form called the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD). The adults were asked to generate a list of items that they thought their child preferred and rank those items from most to least preferred. The predicted rankings based upon the experimenter-generated list and the parent-generated list were compared, and direct preference assessments and reinforcer assessments were conducted. The authors found that the parent predictions based upon the RAISD were more accurate than those based upon the experiment-generated list of items. Thus, although caregiver report alone may not necessarily identify an individual's most preferred items, using caregiver opinion to generate the array of items to be used on a direct preference assessment can be an important aspect of the assessment process.

Direct Assessments

Prior to 1985, most researchers and clinicians relied on indirect assessments; however, there were some early attempts to use more systematic methods to identify potential reinforcers. Witryol and Fischer (1960) identified potential reinforcers by the method of paired comparisons. A pool of stimuli was identified, and then objects were presented two at a time, with the order of pairings presented to minimize position bias and order effects. The authors found that some stimuli were selected more often than other items. Another early attempt to systematically identify potential reinforcers was conducted by Rynders and Friedlander (1972). Preference for three different visual stimuli was assessed by placing three touch-sensitive panels in front of each participant. When a panel was pressed, the corresponding visual stimulus was presented. The researchers recorded the total number of panel presses for each stimulus, as well as the total duration that each panel was pressed. Although only a small number of stimuli could be simultaneously evaluated, the direct measurement of differential responding and total duration of engagement per stimulus represented a significant improvement over indirect methods of preference assessment. Other researchers also measured the duration of engagement with stimuli that were directly presented to individuals to identify potential reinforcers (e.g., Favell & Cannon, 1977).

Despite the earliest attempts by researchers to systematically identify reinforcers, it was not until 1985 that Gary Pace and his colleagues developed what is now considered by many behavior analysts to be the first systematic stimulus preference assessment (Pace et al., 1985; see Box 21.1). Prior to the start of the single stimulus (SS) preference assessment, Pace et al. selected items thought to produce various forms of sensory stimulation. Across a series of trials, stimuli were presented one at a time to participants with IDD. Approach responses (e.g., moving hand or body toward the item) were recorded, and preference hierarchies were established by calculating the percentage of approach responses for stimuli. Stimuli were considered high preference (HP) if they were selected on 80% or greater of trials, and stimuli were considered to be nonpreferred (sometimes referred to as low-preference, or LP) if they were selected on 50% or less of the trials. The authors found that different preference hierarchies were established across participants. Subsequent reinforcer assessments (to be discussed later in this chapter) demonstrated that, in general, the contingent presentation of HP stimuli was associated with higher response rates than the contingent presentation of nonpreferred items. Thus, HP stimuli were more likely to function as reinforcers than nonpreferred stimuli. One potential drawback to the SS assessment was that some participants approached most of the stimuli as they were presented, suggesting that some participants preferred all stimuli equally.

To address the issue of potentially approaching all stimuli equally using the SS assessment, Fisher et al. (1992) developed a paired-stimulus (PS) assessment (see Box 21.2). On each trial, two items were placed in front of the participant, who could only approach one item. Across a series of trials, each stimulus was paired with every other stimulus an equal number of times, and each item was placed on the participant's left- and right-hand side an equal number of times. The mean percentage of approach responses to each stimulus was calculated and preference hierarchies were established. Fisher et al. compared preference hierarchies generated from an SS assessment (Pace et al., 1985) to hierarchies generated from a PS assessment, and

Box 21.1

Pace, G. M., Ivancic, M. T., Edwards, G. L., Iwata, B. A., & Page, T. J. (1985). Assessment of stimulus preference and reinforcer value with profoundly retarded individuals. *Journal of Applied Behavior Analysis*, *18* (3), 249-255. https://doi.org/10.1901/jaba.1985.18-249

Purpose: To determine if a paired stimulus arrangement will better predict reinforcing stimuli than the Pace et al. (1985) single-stimulus arrangement.

Participants: 4 children (2-10 years old) with moderate to profound intellectual disabilities.

Design: Nonexperimental design (Phase 1).

Dependent measure: Percentage of trials each stimulus was approached.

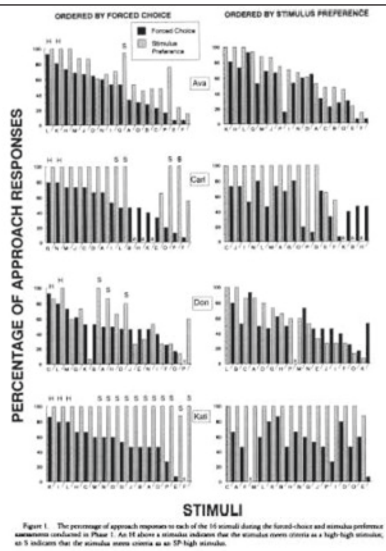
Stimuli assessed: Same as Pace et al., 1985, except swivel rocker replaced swing.

Procedures (Phase 1): Preference Assessment
Single stimulus (SS): Similar to Pace et al. (1985) except each session had 5 trials with each of 4 stimuli presented 0.7 m in front of participant (in a counterbalanced order).

Paired stimulus (PS): Same general procedures as SS (Pace et al., 1995) except two stimuli presented 0.7 m apart in each of 120 trials; each stimulus was paired once with every other stimulus.

Approach to stimulus → 5 s access and removal of other stimulus

Approach to both stimuli → blocked
Nonapproach within 5 s → prompted to sample each stimulus for 5 s, then represented both stimuli



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Interpretation of results:
PS arrangement shows rank order (black bars); SS does not (gray bars). Both assessments identified the same 9 preferred stimuli (H or High-High); the SS arrangement identified 19 additional stimuli as preferred that were not similarly identified in the PS arrangement (S or Sp-High).
Used ≥ 80% approach as an index of preference (same as Pace et al., 1985) and ≤ 60% as an index of nonpreference (Pace et al., 1985, used 50%).

Procedures (Phase 2): Reinforcer Assessment

Participants: same as Experiment 1.

Design: ABA reversal design with baseline, concurrent operants, baseline phases.

Dependent measure: Percentage of time spent in-chair (or in-square) with the chair (or square) associated with the different stimuli.

Stimuli assessed: 2 High-High stimuli (next to one chair, or in one square) and 2 Sp-High stimuli (next to another chair, or in another square).

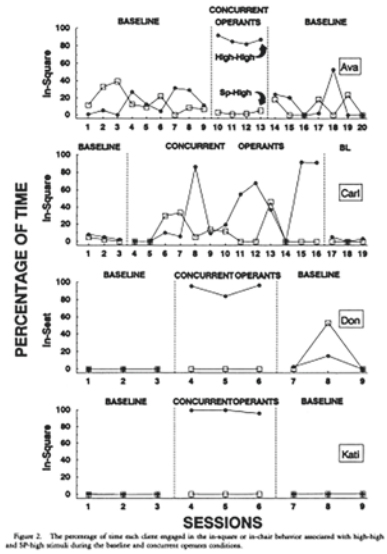
Procedures:

Consequences for in-chair (or in-square) behavior:

<u>Baseline</u>: Therapist present, but no interaction with participant; no stimuli present.

<u>Training trials</u> (no data): 10 trials per session. Criteria to move to next phase = 8/10 trials without prompts for 3 consecutive sessions. Not in-chair (or square) for 5 s → sequential prompts (verbal, gestural, physical) every 5 s. In-chair (or square) → either High-High or Sp-High stimuli (randomly alternated across trials) available for 10 s.

<u>Concurrent operants</u>: Therapist present, but no interaction. When participant is in Chair (or Square) 1 → access to 2 High-High stimuli; when in Chair (or Square) 2 → access to 2 Sp-High stimuli. When participant leaves chair (or square) for 3 s → stimuli returned.



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Interpretation of results:

Longer durations of time in-chair (or in-square) associated with High-High stimuli than with in-chair (or square) with Sp-High stimuli when these two sets of stimuli were concurrently available, or with either chair (or square) in baseline when no stimuli were available. PS assessment showed better predictive validity than the SS assessment and can identify more (relatively) preferred stimuli that function as more (relatively) potent reinforcers.

Box 21.2

Fisher, W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, *25* (2), 491-498. https://doi.org/10.1901/jaba.1992.25-491

Experiment 1 Purpose: To assess approach responses as an index of stimulus preference.

Participants: 6 children (3-18 years old) with profound intellectual disabilities.

Design: Nonexperimental design.

Dependent measure: Percentage of trials each stimulus was approached.

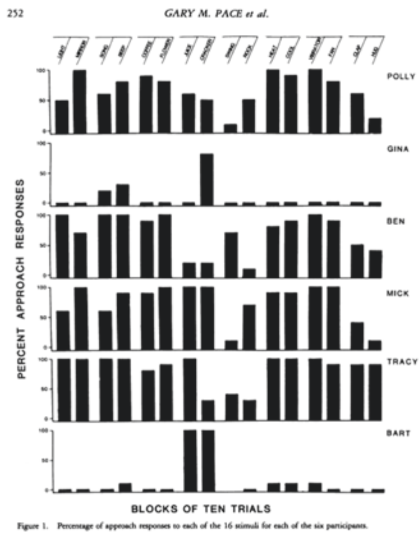
Stimuli assessed: visual: mirror, light; auditory: song, beep; olfactory: coffee grounds, flower; gustatory: juice, graham cracker; tactile: vibrator, fan, heat pad, cool block; vestibular: swing, rock; social: clap, hug.

Procedures:

Each of 16 stimuli was presented singly for 5 s and typically 20 cm from participant (i.e., a trial, 1-2 trials/stimulus per 20-trial session, and a total of 8 sessions).

Approach to stimulus → another 5 s access

Nonapproach → stimulus was removed and presented again for 5 s with prompts to look at stimulus and then presented again (without prompts) for 5 s



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Interpretation of results:

Differential approach behavior across stimuli that was idiosyncratic to each participant.

Used ≥ 80% approach as an index of preference and ≤ 50% as an index of nonpreference.

Experiment 2 Purpose: To assess the reinforcement value of preferred and nonpreferred stimuli.

Participants: same as Experiment 1.

Design: Reversal design with baseline, preferred, nonpreferred conditions.

Dependent measure: Percentage of correct responses to vocal requests. Responses were identified for each participant (e.g., Look, raise hand) that occurred at low rates.

Stimuli assessed: For each participant as identified in Experiment 1: preferred stimulus, nonpreferred stimulus.

Procedures:
Vocal requests (paired with a motoric gesture of the response) were provided in 10 trials/session. Incorrect or no response within 5 s were followed by a 10-s intertrial interval (ITI). Consequences for correct responses differed across conditions:

Baseline: Correct response → 10-s ITI

Preferred stimulus: Correct response → preferred stimulus provided for 5 s

Nonpreferred stimulus: Correct response → nonpreferred stimulus provided for 5 s

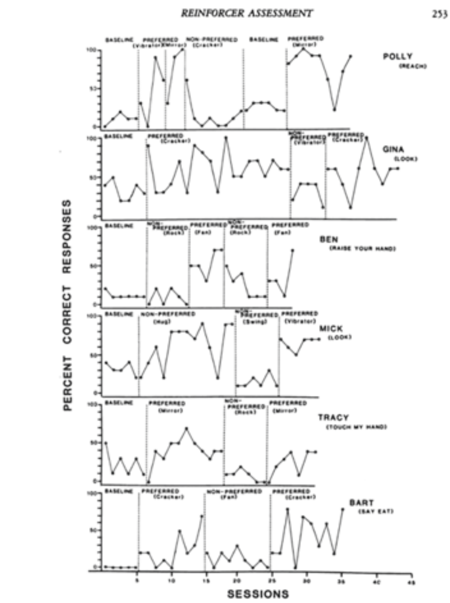

Figure 2. Percentage of trials each child engaged in the target response during baseline, preferred, and nonprefe conditions. Specific stimuli and target responses are indicated for each child.

Interpretation of results:
Preferred stimuli functioned as reinforcers as evidenced by increased correct responses when preferred stimuli were made contingent (preferred condition) than when no consequences (baseline) or nonpreferred stimuli (nonpreferred) were available.

found that all items classified as HP (selected on 80% or greater of trials) on the PS assessment were also classified as HP on the SS assessment. However, stimuli judged to be moderate to low preference (60% or below) on the PS assessment were frequently classified as HP on the SS assessment. Subsequent reinforcer assessments demonstrated that stimuli identified as HP on both assessments (high-high stimuli) were associated with higher response rates on a simple task than items ranked as HP on the SS assessment but moderate or low preference (SP-high stimuli) on the PS assessment. These findings suggest that the PS assessment may measure preference more precisely than the SS assessment. Although the PS assessment may be an effective method to identify preferences, the authors noted that the PS assessment took more time to implement than the SS assessment.

In an attempt to develop assessment methods that required less time to implement than a PS assessment, researchers began to develop procedures to assess multiple stimuli simultaneously (e.g., DeLeon & Iwata, 1996; Windsor et al., 1994). DeLeon and Iwata (1996) developed the multiple stimuli without replacement (MSWO) assessment (see Box 21.3). At the start of each session, multiple stimuli were placed in front of the individual, who was instructed to select one, and the individual was given that item for a short period of time. Then, the selected item was not replaced in the stimulus array, and the positions of the remaining stimuli were changed. The individual then selected from the remaining items until all items had been selected or the individual stopped selecting items. Each individual participated in several assessment sessions, and preference hierarchies were established by calculating the percentage of approach responses per stimulus across all sessions. These preference hierarchies were directly compared to hierarchies generated by a PS assessment. The authors found that both methods generated similar preference hierarchies, but the MSWO assessment was completed in approximately half the time that it took to complete the PS assessment.

Whereas many stimulus preference assessment (SPA) procedures measure approach responses to stimuli presented across a series of trials, several researchers have measured preference for stimuli by measuring the duration of engagement with stimuli. Roane et al. (1998) developed a brief, duration-based, free-operant (FO) preference assessment, in which multiple stimuli are placed on a tabletop, participants are free to engage with any of the items for a specified period of time (e.g., 5 min), and duration of engagement with each object is measured (see Box 21.4). Preference hierarchies are established by ranking items according to the duration of object manipulation for each stimulus. The authors found that items engaged with for the longest durations were more likely to function as reinforcers than items that were manipulated at shorter durations. The authors suggested that the brief FO assessment potentially had advantages over the traditional approach-based assessments: (a) it was quicker to administer, which potentially allowed for more frequent assessments; (b) stimuli were never withheld or withdrawn, which might evoke problem behavior in some individuals; and (c) although not specifically acknowledged by the authors, the FO assessment allows for the assessment of larger items that cannot be easily presented and removed in tabletop assessment trials (e.g., television and computer). One potential limitation to the FO assessment is that an individual may engage with only one item during the 5-min assessment, and thus, fewer potential reinforcers might be identified. Subsequent researchers attempted to overcome this potential limitation by restricting access to items once a clear preference had been identified, which can potentially yield a more distinct preference hierarchy (response-restriction analysis; e.g., Hanley et al., 2003).

Box 21.3

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis*, *29* (4), 519-533. https://doi.org/10.1901/jaba.1996.29-519

Experiment 1: Preference Assessment

Purpose: To compare multiple-stimulus-without-replacement (MSWO) and multiple-stimulus (MS) arrangements (Windsor et al., 1994) to the paired stimulus (PS; Fisher et al., 1992) arrangement.

Participants: 7 adults (25-45 years old) with profound developmental disabilities.

Design: Nonexperimental design.

Dependent measures: (1) Percentage of trials each stimulus was selected (physical contact with item); (2) duration of each assessment type.

Stimuli assessed: 7 items per participant (a few of which were based on observation or caregiver report; most were arbitrarily selected).

Procedures

Prior to the assessment, participants had access to all stimuli assessed. Across all assessment types, the first stimulus touched within 30 s was made available for 30 s (leisure item) or until consumed (edible item). There were 5 consecutive sessions of each assessment type, with the order counterbalanced across participants.

MSWO: 7 stimuli in a straight line 5 cm apart; Participant told to select one. Selected stimuli were not replaced in subsequent trials and remaining items were rotated (left item moved to right-most position and equally spacing all items). Session continued until all stimuli selected or no selection in 30 s.

MS: Same as MSWO, except selected stimuli were returned or replaced.

PS: 2 stimuli per trial in a predetermined order such that every stimulus was paired once with every other stimulus for a total of 21 trials/session. No selection within a trial was followed by the next trial.

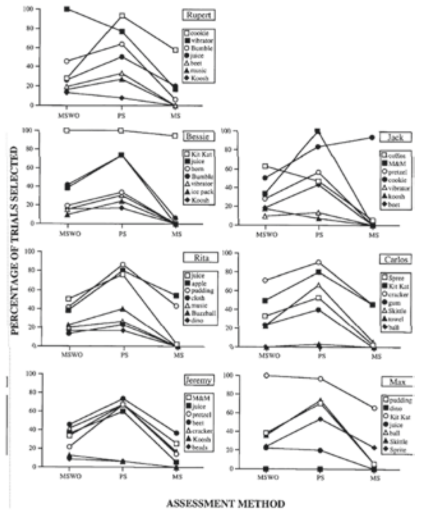

Figure 1. Percentage of trials on which stimuli were selected, when available, by 7 participants for all three assessment methods: multiple stimulus without replacement (MSWO), paired stimulus (PS), and multiple-stimulus with replacement (MS).

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Interpretation of results:

Good correspondence across assessments for top-ranked stimuli: (1) The same stimulus was identified as the most highly preferred across all 3 assessment types; (2) The MSWO and MS both matched the PS assessment by identifying the 2 or 3 of the 3 most selected stimuli for all participants; (3) Kendall rank-order correlation coefficients means were .61 for MS/PS and .72 for MSWO/PS; (4) Kendall's correlation of concordance was higher for MSWO and PS (.81 and .83) than MS (.56).

Difference in mean duration of assessment administration: MS and MSWO required less time (16.5 and 21.8 min) than PS (53.3 min).
Fewer total items selected in MS than MSWO or PS. Continuous availability of most-preferred stimuli in MS may have masked preference for other items and resulted in false negatives with the MS. Alternatively, the PS/MSWO may have resulted in false positives by providing more opportunities for selections of all stimuli (purpose of Experiment 2).

Experiment 2: Reinforcer Assessment

Purpose: To determine if stimuli never selected in the MS but selected in the MSWO and PS assessments would function as reinforcers.

Participants: 4 participants from Experiment 1.

Design: Reversal design with baseline and reinforcement phases (3 participants).

Dependent measure: Responses per minute (responses varied by participant such as putting blocks in a can, pressing a switch that activated a light, etc.).

Stimuli assessed: 2 High-High stimuli (next to one chair, or in one square) and 2 Sp-High stimuli (next to another chair, or in another square).

Procedures: 10-min sessions. Responses were in participants' repertoires or shaped (i.e., Carlos, Phase 1). Phase changes occurred after stable responding was shown.

Baseline: Experimenter prompted response (if necessary); provided no consequence for responses.
Reinforcement (fixed ratio, FR, 1): Experimenter delivered 1 stimulus contingent on each response.

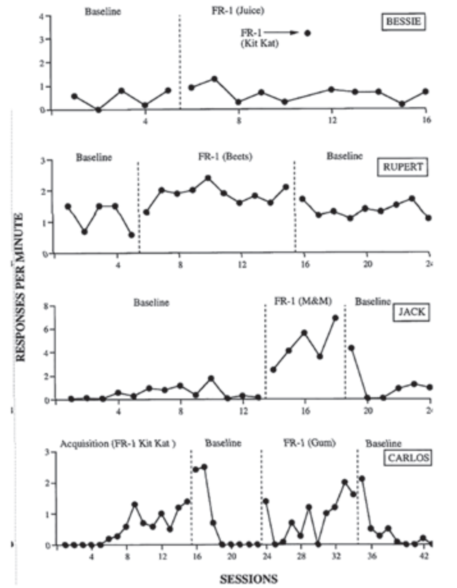

Figure 2. Results of reinforcer potency evaluations for four stimuli selected by participants during the PS and MSWO assessments but not during the MS assessment.

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Interpretation of results:
The MSWO produced the same beneficial outcome of the PS: it identified a hierarchy of stimulus preferences, including some that were not identified by the MS that functioned as reinforcers (3 of 4 stimuli assessed). In addition, the MSWO took much less time to complete.

Box 21.4

Roane, H. S., Vollmer, T. R., Ringdahl, J. E., & Marcus, B. A. (1998). Evaluation of a Brief Stimulus Preference Assessment. *Journal of Applied Behavior Analysis*, *31* (4), 605-620. https://10.1901/jaba.1998.31-605

Experiment 1 Purpose: To evaluate the utility of a brief, free-operant multiple stimulus assessment in identifying differentially preferred stimuli that functioned as reinforcers.

Participants: Free-operant (FO) stimulus preference assessment: 10 individuals (3-37 years old) with severe intellectual or developmental disabilities. Reinforcer assessment (RA) A: 6 of the individuals; B: 4 of the individuals.

Design: FO assessment: Nonexperimental; RAs: concurrent operants.

Dependent measure: Percentage of 10-s (partial) intervals. FO assessment: manipulation of each stimulus RAs: time in-square (or in-workstation, RA-B).

Stimuli assessed:
FO assessment: 10-11 caregiver- or staff-nominated stimuli across the following categories: food, drink, leisure/play, auditory, tactile, social attention (therapist present).

RA-A: preferred stimulus (most intervals of manipulation in SPA) vs no stimuli (control).

RA-B: preferred stimulus vs. nonpreferred stimulus (never or rarely manipulated in FO assessment).

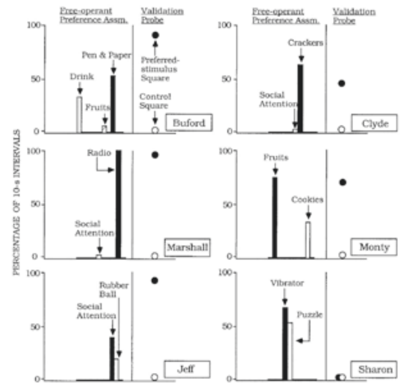

Figure 1. The percentages of 10-s intervals of item manipulation and in-square behavior during the free-operant preference assessments and validation probes of Reinforcer Assessment A of Experiment 1.

Interpretation of FO assessment and RA-A results:
At least one preferred stimulus was identified for each participant (Figures 1 and 2). 5 participants spent more time in the square with the preferred stimulus than no stimulus; 1 participant spent no time in either square.

Procedures:

<u>FO assessment</u>: Stimuli arranged in a circle on a table. Pre-session exposure to each stimulus (participant manipulated or therapist modeled). During FO assessment, participant could manipulate some, all, or no stimuli during 5-min session. (Food/drink was replenished as needed.)

<u>RAs</u>: Two equal areas (squares or stations) were demarcated, and each contained one stimulus (or no stimulus in RA-A). Sessions lasted 10 min. Pre-RA-A training provided instructions and exposure to contingencies.

At start of <u>RA-A</u>, participant stood equidistant from each area, was given instructions, and had access to areas/items. Mid-session, the stimuli were switched to the other workstation (to control for position) and the procedures were repeated. 1 FO assessment and 1 RA session.

During <u>RA-B</u>, the same task was available at each workstation, therapist provided 3-step prompting hierarchy, and the station-designated stimulus (placement randomized across sessions) was provided for 15 s upon each prompted or unprompted task completion. 1-2 FO assessments and 2 RA sessions/ day for up to 5 days.

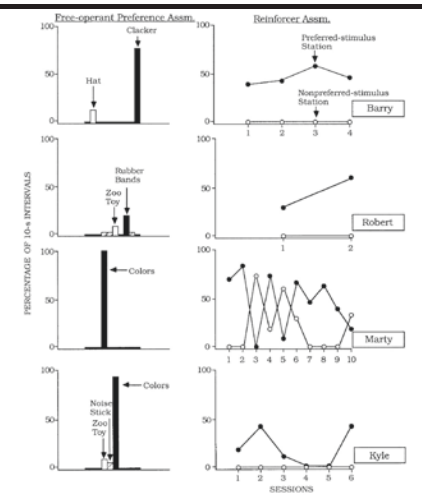

Figure 2. The percentages of 10-s intervals of item manipulation in each participant's initial free-operant preference assessment and the percentage of 10-s intervals spent at the preferred or nonpreferred station in Reinforcer Assessment B of Experiment 1.

Interpretation of RA-B results:

3 participants allocated all responding to workstation with preferred stimulus; 1 participant shifted responding between workstations but completed more tasks in station with preferred stimulus.

Stimulus Selection for Direct Assessments

Determining the stimuli to be assessed is an important part of the assessment process. It is important to recognize that preference measures do not provide information regarding absolute preference levels, but rather relative preference levels (e.g., Graff & Larsen, 2011; Roscoe et al., 1999). The most and least preferred stimuli identified in a preference assessment, therefore, are bound by the actual stimuli assessed. For example, an item may be ranked as most preferred on one preference assessment, and then ranked as least preferred on another assessment that included different stimuli.

The main goal of a SPA is to identify stimuli that will function as reinforcers, thus, careful consideration should be given in the selection of stimuli to assess. Whereas some SPA procedures have used a standardized pool of stimuli for all participants (e.g., Fisher et al., 1992; Pace et al., 1985), or a combination of standardized stimuli and participant-specific stimuli based on caregiver reports of preferred stimuli (e.g., DeLeon & Iwata, 1996), the most effective way to meet the assessment purpose is to assess only stimuli that are likely to be preferred for an individual participant. This can be accomplished by conducting an indirect assessment, such as RAISD (Fisher et al., 1996), and then including the caregiver-nominated stimuli in the direct assessment.

Although many SPA procedures involve presenting tangible stimuli on the tabletop and measuring approach responses or duration of engagement with items, some items are difficult to present (e.g., large leisure items, community locations, or social stimuli). Alternative procedures have been developed to address this issue. A verbal PS preference assessment (e.g., Cohen-Almeida et al., 2000; Kuhn et al., 2006; Tessing et al., 2006) is an alternative method that is similar to the PS assessment (Fisher et al., 1992). On each trial of a verbal PS assessment, the clinician asks, “Do you want X or Y?” and the participant selects the preferred stimulus by vocally stating the name of one of the items or activities. Preference hierarchies are established by calculating the percentage of vocal selection responses for stimuli. Verbal preference assessments can identify effective reinforcers if participants have auditory-visual conditional discrimination skills (e.g., Conyers et al., 2002), and have been effectively used to identify preferences for tangible stimuli (e.g., Tessing et al., 2006), social stimuli (e.g., Kuhn et al., 2006), and preferred and non-preferred staff (Jerome & Sturmey, 2008). Pictorial preference assessments can also be useful to assess preferences for items that are difficult to present. On a pictorial PS preference assessment (e.g., Graff & Gibson, 2003; Heinicke et al., 2016), across a series of trials, pictorial representations of stimuli are presented two at a time; individuals can approach (i.e., select) only one picture on a trial. Approach responses are recorded. Preference hierarchies are established by calculating the percentage of approach responses per stimulus. Certain visual conditional discrimination and matching skills are likely necessary to identify reinforcers using pictorial preference assessments (e.g., Clevenger & Graff, 2005; Conyers et al., 2002). Pictorial preference assessments have been used to identify preferences for a variety of stimuli such as recreational activities such as riding a bike or playing basketball (e.g., Hanley et al., 1999), social stimuli (e.g., Kelly et al., 2014; Morris & Vollmer, 2019), preferred break environments (Castelluccio & Johnson, 2019), and preferred content on electronic devices (e.g., Hoffmann et al., 2019).

Preference assessments using video stimuli have become more prevalent in preference assessment literature recently. Video SPAs are similar to pictorial preference assessments, but instead of placing two or more pictures in front of a participant, two or more video clips of individuals engaging with a stimulus are displayed on tablets or laptops, and the individual selects the video clip of the item with which they would like to engage. Snyder et al. (2012) conducted tangible PS assessments and video PS assessments with six children with autism. A comparison of preference hierarchies showed that the highest and lowest preference leisure items were the same for most participants. Other studies have examined the use of video stimuli in multiple stimulus without replacement (MSWO) preference assessments. Brodhead et al. (2016) compared tangible and video MSWO preference assessment hierarchies for four individuals with special needs. The authors found that preference hierarchies were similar for three of four participants.

Variables that May Affect Direct Assessment Outcomes

There are several variables that may affect selection responses and preference hierarchies, including the magnitude of stimuli assessed (duration of access to leisure stimuli and social attention, amount of edibles), number and types of stimulus classes assessed, and whether or not the stimulus selected can be accessed immediately or after a delay.

Several researchers have evaluated the effects of magnitude on preference assessment outcomes. Steinhilber and Johnson (2007) conducted MSWO assessments and subsequent reinforcer assessments with two individuals with autism spectrum disorder (ASD) under two conditions. In one preference assessment condition, selection responses resulted in 15-s access to a leisure item; in the other condition, selection responses resulted in 15-min access to that item. Different preference hierarchies were established across the two conditions. In other words, stimuli that were most highly preferred with brief access were less preferred with extended access and stimuli that were most highly preferred with extended access were less preferred with brief access. The researchers concluded that the duration of access to items influences preference for those items. Researchers have also demonstrated that children with IDD displayed preferences for longer durations of social interactions versus shorter durations of social interactions (e.g., Trosclair-Lasserre et al., 2008). Paden and Kodak (2015) evaluated the effects of magnitude on preference with four individuals with autism spectrum disorders. During preference assessments using edible items, participants could choose between a larger magnitude of edible items or a smaller magnitude of edibles. All participants preferred the larger magnitude of edibles.

Early preference assessment research included multiple categories of potential reinforcers such as edibles and nonedibles that provided different sensory consequences (e.g., Fisher et al., 1992; Pace et al., 1985). DeLeon et al. (1997) evaluated the effect of combining stimuli from edible and nonedible categories in preference assessments. They conducted one SPA with only edible items, and another with only leisure items, with 14 individuals with IDD. Then, the most preferred items on each assessment were combined on a third assessment. For 12 of 14 participants (86%), an edible item ranked first on the combined assessment, and for 11 of 14 participants (79%), edible items ranked first and second. Although some leisure items were judged to be highly preferred when presented alone, the food items displaced the leisure items when combined, resulting in the leisure items appearing to be less preferred. The finding that edible items may displace nonedible items in preference assessments has been replicated by a number of researchers. Bojak and Carr (1999) conducted separate edible and leisure assessments with four individuals with severe intellectual disabilities, and then conducted a combined assessment, using the top 4 ranked items from the edible and leisure assessments. For all participants, the edible items were ranked first through fourth, while the leisure items were ranked fifth to eighth. Fahmie et al. (2015) found that for eight of 12 individuals with IDD, edibles ranked first to fourth and leisure items ranked fifth to eighth on a combined edible/leisure preference assessment; for two additional participants, edibles held three of the top four ranks. On the other hand, some researchers have found lesser degrees of displacement of leisure items by edible items (e.g., Conine & Vollmer, 2019; Sipila-Thomas et al., 2021), particularly when the duration of access to leisure items was increased (e.g., Clark et al., 2020). Although less frequent, the displacement of edible items by leisure items has also been noted for some individuals (Sipila-Thomas et al., 2021). Displacement effects can also occur when using only one category of stimuli. For example, when conducting a preference assessment with only edible items, the inclusion of sweet items such as candy may displace preference for fruits and vegetables for some individuals (e.g., Livingston & Graff, 2018).

Studies demonstrating displacement effects may have clear implications for clinicians. After clinicians classify items as moderate or low preference, they may fail to use these items in behavior programs. After demonstrating that displacement effects can occur when different categories of stimuli are included on a SPA, DeLeon et al. (1997) conducted reinforcer assessments in a second experiment and found that the leisure items identified as less preferred on the combined assessment functioned as reinforcers. One question raised by the findings of DeLeon et al. (1997) was whether or not items ranked low on a SPA would function as reinforcers if all items came from the same stimulus modality (e.g., all leisure items or all edible items). Several studies evaluated this possibility. Taravella et al. (2000) conducted PS assessments with two individuals with disabilities. Nine or 10 nonfood items identified for each participant were assessed in a "complete array" PS assessment, which used the procedures described by Fisher et al. (1992). Preference hierarchies were established, and the five items ranked as least preferred were assessed in a "partial-array" PS assessment. For both participants, at least one item classified as moderately preferred or low preference on the complete array was now classified as HP based upon the results of the partial array; thus, the relative preference value of stimuli changed, based upon the composition of the preference assessment array. Subsequent reinforcer assessments demonstrated that for both individuals, the top-ranked item from the partial array assessment, which was initially classified as a moderate or low preference on the complete array assessment, functioned as a reinforcer. Other researchers have also demonstrated that stimuli classified as LP on one assessment were then classified as HP on another assessment, and stimuli initially classified as LP were found to function as reinforcers (e.g., Graff & Larsen, 2011). Thus, it seems clear that SPAs generate a relative preference hierarchy in which the value of one item can only be judged as HP or LP in the context of the alternative items, and that in some cases, LP items may be effective reinforcers.

The fact that LP items can function as reinforcers may be an important finding for clinicians, as it suggests those items may still be used effectively in behavioral programming. However, it is likely that not all stimuli classified as LP will function as reinforcers, and it is not clear from previous research whether the contingent presentation of LP stimuli consistently results in levels of responding similar to those generated by HP items. Nonetheless, the possibility of "low-preference" stimuli functioning as reinforcers may be of particular interest to (a) clinicians who require access to multiple effective reinforcers at a time, (b) clinicians who work with individuals who exhibit restricted preferences, and (c) clinicians who encounter ethical concerns with delivering HP stimuli on a continuous basis (e.g., weight gain, age-appropriateness of materials, problem behavior occasioned by the presentation of stimuli, problem behavior occasioned by the removal of stimuli).

Another variable that can influence preference hierarchies involves delayed access to an item following a selection response, or when access to an item following a selection response is not possible. For example, if a pictorial preference assessment were to be used to assess preference for community-based activities (e.g., different restaurants), it would not be practical to provide access to the selected community activity on every trial of the assessment. Researchers have found that delayed access to selected items or no access to selected items can influence the results of preference assessments (e.g., Groskreutz & Graff, 2009; Heinicke et al., 2016). For example, Hanley et al. (1999) conducted pictorial preference assessments under two conditions. In one condition, making a selection response led to access to the selected item; in the other condition, selection responses resulted in no programmed response. The researchers found that in most cases, distinct preference hierarchies were established when selection responses resulted in access to the item; when selections resulted in no consequence, preference hierarchies were typically not differentiated.

Concurrent Validity, Test–Retest Reliability and Stability of Preference, and Social Validity

The outcomes of many SPA methods have been evaluated for concurrent validity and reliability. Concurrent validity is the extent to which the outcomes obtained from one assessment protocol are similar to the outcomes obtained from another assessment protocol that is considered valid (Brown et al., 2011). Reliability is a measure of consistency or the extent to which the results can be reproduced given the same conditions (Sidman, 1960). Concurrent validity increases our confidence that a new method is effective, and reliability is essential if we are to have confidence that our assessment results will be informative in the future and not just at the moment of the assessment.

Concurrent Validity

When new preference assessment methodologies are first researched their results are almost always compared to the results of a more researched method. For instance, when the PS was first developed, Fisher et al. (1992, see Box 21.2) used the same stimuli that were used by Pace et al. (1985, see Box 21.1) and compared the results with the PS to those obtained with the SS method for four participants. The SS arrangement identified 28 HP stimuli whereas the PS arrangement only identified nine HP stimuli across participants. Importantly, those nine stimuli were also identified as HP with the SS arrangement. This finding provided support that PS preference assessment outcomes had concurrent validity (and subsequent reinforcer assessments confirmed that these nine stimuli were more efficacious as reinforcers than the other 19 identified by the SS assessment). A similar tactic was used when the MSWO (DeLeon & Iwata, 1996) and FO (Roane et al., 1998) were first developed, and when verbal, pictorial, and video stimuli were first used in SPAs (e.g., Cohen-Almeida et al., 2000, Graff & Gibson, 2003; Morris & Vollmer, 2019; Snyder et al., 2012). Concurrent validity with previous assessments was shown with each of these newer assessment methods.

Test–Retest Reliability and Stability of Preference

The reliability of a direct SPA method is assessed through test–retest measures in which the results from one administration are typically compared with the results from another administration of the same method with the same individual (Brown et al., 2011). Two different outcome measures have been evaluated for reliability: HP stimuli and the ranks of all assessed stimuli.

When an assessment identifies HP stimuli, that assessment can be repeated to see if the same stimuli will be identified as preferred (either the same most highly preferred stimulus, or the same stimuli that meet an established criterion of selection responses or duration of interaction). When the assessment yields a hierarchy of preference, the assessment can be repeated and reliability is measured by the extent to which the obtained ranks for all assessed stimuli are comparable and is typically analyzed using statistical tests, such as the Spearman rank-order correlation coefficient. This statistic yields a coefficient value, r_s, which represents the magnitude of correlation between two variables. Coefficient values range from −1 to +1, whereby −1 represents a perfect negative correlation, 0 represents no correlation, and + 1 represents a perfect positive correlation between ranks. We are usually interested in positive correlations between administrations, and the closer the score is to 1, the more stable the results are and this stability is also used as a reliability measure of the data. Generally, an r_s score of 0.5–0.7 is indicative of a moderate positive correlation, a score of 0.7–0.9 is indicative of a high positive correlation, and a score of 0.9–1.0 is indicative of a very high positive correlation (Mukaka, 2012).

A potential problem with measuring the test–retest reliability of SPA data is that preferences are not always static, but instead may vary depending on the context and are influenced by motivating operations such as deprivation and satiation (Gottschalk et al., 2000; Hanley et al., 2006). When test–retest reliability is not shown, we are usually unable to parse out whether these incongruent results are a direct result of a less reliable assessment, or if they are a direct result of naturally occurring preference shifts. All SPA results are influenced by the current motivational status of the individual, and when a SPA is repeated there is always the potential for a shift in preference due to a change in the current motivational status, and shifts in preference can confound the test–retest reliability measure. Because of this inherent threat to internal validity, the best way to determine if one SPA method is more likely to provide reliable outcomes would be to control all variables—subject, motivational, and stimuli—except the assessment methods. Verriden and Roscoe (2016) did just this; they compared the correspondence of assessment results for six individuals with autism spectrum disorders (ASD) or traumatic brain injury across six administrations of each of four major assessment methods and found that PS and MSWO had higher correspondence across administrations (as measured by the Spearman rank-order correlation coefficient and Kendall rank coefficient of concordance) as compared to RR and FO methods. The finding of increased consistency across administrations of the PS and MSWO as compared to other methods was also reported by Kang et al. (2013) in their review of SPAs.

Test–retest measures are also used to evaluate the stability or instability of preferences across different time spans for specific stimuli and stimulus categories, and for ranked hierarchies of stimuli. From a practical perspective, preference stability can inform clinicians how often preference should be assessed (Butler & Graff, 2021). The stability of preferences has been assessed across as few as 2 or as many as 16 assessments (Hanley et al., 2006), ranging from daily administrations (Kelley et al., 2016) to 20 months between administrations (Zhou et al., 2001).

The stability of preferences has been evaluated across different time spans. Ciccone et al. (2007) compared the stability of preferences for edible stimuli in eight individuals with IDD. They found greater stability in the outcomes from assessments that were conducted 6 months apart than those conducted 12 months apart, suggesting that the amount of time between SPA administrations (or between SPA administration and programmatic applications of the SPA outcomes) is a critical variable. In a recent study, Butler and Graff (2021) conducted monthly PS assessments for edible, leisure, and social attention stimuli over a one-year period with four individuals with autism. Short-term stability was assessed by comparing the results of month-to-month assessments, and long-term stability was assessed by comparing the results of the first and last preference assessments, conducted 12 months apart. The average short-term stability score across participants was greatest with edible items ($r = 0.79$), then leisure items ($r = 0.66$), and finally social attention stimuli ($r = 0.50$). Average long-term stability scores across participants were 0.63 for edibles, 0.19 for leisure items, and 0.33 for social stimuli. These findings suggest that, for some participants, stability of preference decreases over time and most notably with leisure items.

The stability of preference has also been evaluated for HP stimuli and for stimuli assigned to all ranks (i.e., preference hierarchy). Zhou et al. (2001) evaluated the stability of preferences for leisure stimuli in 22 individuals with IDD given two administrations of a single-stimulus variation of a duration-based SPA (DeLeon et al., 1999) 12–20 months apart. Whereas the median rank-order correlation coefficient for the 15 stimuli was only 0.11, greater stability was shown among the five top-ranked stimuli. Other studies have also reported increased stability with the highest-ranked stimuli (e.g., DeLeon & Iwata, 1996; Lee et al., 2010).

Social Validity

Despite the prevalent use of SPAs in behavior-analytic, peer-reviewed research, the use and acceptability of SPAs in clinical settings are less common. In a survey of professionals working with individuals with IDD, Graff and Karsten (2012b) found that SPAs were less likely to be implemented in public schools than in other treatment settings and attributed these findings at least in part to the lack of "buy in" by teachers and school administrators. Surprisingly, there are very few published social validity measures on the outcomes generated by SPAs by "the specific consumer or representatives of the relevant community" (Wolf, 1978, p. 209). In a notable exception, Castelluccio and Johnson (2019) found in a post-experimental survey that clinical staff, who were not involved in the research, either somewhat or strongly agreed that the preference assessment outcomes were beneficial to the programming for the participants. Further, the clinical teams elected to incorporate the identified HP break environments into participants' programming.

Efficiency Measures

Preference assessments can be time-consuming, particularly when one considers all of the component responses: gathering a pool of stimuli, conducting the preference assessment, summarizing and analyzing the data, communicating the results, and incorporating these results into ongoing education or treatment. In a survey, 81% of behavior analysts reported that time was an obstacle to their routine use of SPAs (Graff & Karsten, 2012b).

Of the direct SPAs reviewed in this chapter, the FO takes the least amount of time to administer. A defining characteristic of this duration-based procedure is that each session is 5 min. The session duration of selection-based assessments such as the SS, PS, MSW, and MSWO is not similarly defined; instead, session duration is influenced by the number of stimuli assessed, the number of times each stimulus is presented and the arrangements of those presentations, and the prescribed post-selection stimulus access time. DeLeon and Iwata (1996) completed a PS, MSW, and MSWO assessment for seven adults with IDD using the same seven edible and leisure items. They found that the MS and MSWO took considerably less time (16.5 and 21.8 min, respectively) as compared to the PS assessment (53.3 min[1]). Conducting one of the direct assessments, therefore, can take between 5 and 60 min.

Recent research efforts have focused on how valid preference assessment outcomes can be achieved in fewer trials by reducing the number of stimuli assessed or the number of times each stimulus (or stimulus arrangement) is presented. Reducing the number of trials will reduce the amount of time a SPA takes to complete.

The PS assessment is arranged such that each stimulus is paired once with every other stimulus and the validity of this assessment might be compromised if this was not done; therefore, the best way to decrease the time of a PS assessment is to reduce the number of stimuli assessed. Reducing the number of stimuli will reduce the number of trials necessary to pair each stimulus with every other stimulus and therefore take less time. For instance, it takes 240 trials to conduct the assessment with 16 stimuli (Fisher et al., 1992), but only 42 trials with seven stimuli (DeLeon & Iwata, 1996). At face value one might have some concerns including fewer stimuli in a preference assessment; however, when the assessed stimuli are individualized and based on indirect assessments, the literature supports that SPAs can identify HP stimuli that serve as efficacious reinforcers.

The MSWO uses only seven stimuli and is arranged with five sessions of seven trials each. Each session starts with the full stimulus array (but presented in different orders). The use of five sessions appears to be arbitrary as it would take seven sessions to have each stimulus in each position once in an effort to control for position biases. Researchers have evaluated if fewer than seven trials per session or fewer than five MSWO sessions would yield valid outcomes (e.g., Carr et al., 2000; Graff & Ciccone, 2002; Higbee et al., 2000; Richman et al., 2016).

In post hoc analyses of MSWO assessments with 15 individuals with IDD, Graff and Ciccone (2002) found that the same HP stimulus was identified in the first three trials as in a full seven-trial session 93% of the time (25 of 27 cases) and that when the first three trials were evaluated across all five sessions, the same HP stimulus was identified 81% of the time (22 of 27 cases). In post hoc analyses by Richman et al. (2016), outcomes derived from three sessions of an MSWO were significantly and positively correlated with the outcomes derived from full, five-session assessments for nine adults with intellectual disabilities.

[1]Other reported estimates of PS assessment administration time have been under 22 min (Roane et al., 1998).

Other researchers have directly evaluated a brief MSWO, comprised of three sessions. Carr et al. (2000) conducted a three-session MSWO assessment with three young children with ASD using eight stimuli and evaluated the brief MSWO's predictive validity of lower, moderately, and higher-ranked stimuli in a multielement design. Subsequent reinforcer assessments confirmed that the three-session MSWO accurately predicted efficacious reinforcers for all three participants. Higbee et al. (2000) also conducted three-session MSWO assessments using seven stimuli and found in subsequent multielement reinforcer assessments with the top-ranked stimulus (or one of the stimuli tied for top rank) that the brief MSWO predicted effective reinforcers for seven of nine adults with intellectual disabilities.

Most recently, Conine et al. (2021) conducted post hoc analyses on 147 MSWO assessments across 49 participants to determine the correspondence on the outcomes based on the first or first two sessions to those obtained in three sessions (i.e., brief MSWO). The results showed a strong correlation between the hierarchies obtained given one, two, and three sessions, but not on the HP stimulus. The authors suggest that the predictive validity of the one-session MSWO, therefore, depends on the intended purpose and use of the results. If the purpose is to identify a relatively more and relatively less preferred stimulus to use in differential reinforcement procedures, then a one-session MSWO may be appropriate, but if the purpose of the MSWO is to identify the most highly preferred stimulus to use in a particular contingency, then a three-session MSWO will likely be more appropriate.

Based on the data currently available, the brief (three-session) MSWO appears to be a valid and more efficient preference assessment method than the five-session MSWO. Both Carr et al. (2000) and Richman et al. (2016) report that the brief MSWO takes about 5 min, which represents a considerable time saving from the more than 20 min administration time reported for the full MSWO (DeLeon & Iwata, 1996), and makes the brief MSWO as efficient as the FO assessment.

Reinforcer Assessments

Reinforcer assessments serve one main purpose: they provide evidence for the predictive validity of the preference assessment. Predictive validity is a measure of the extent to which the outcomes of a method predict future behavior (Brown et al., 2011). The predictive validity of SPAs has been measured largely through reinforcer assessments. Reinforcer assessments measure the effect of an assessed stimulus on behavior.

A reinforcer effect is shown when the level of behavior increases as a function of a particular contingent stimulus on that behavior, and this is often demonstrated with replicability in an experimental design so that we have confidence that the contingent stimulus is responsible for the behavior change. Reinforcer assessments can measure either an absolute or a relative reinforcer effect of particular contingent stimuli.

Absolute Reinforcer Effect

In a single-operant reinforcer assessment, a single reinforcement schedule is arranged for emitting a specific response, and frequently, the response is a simple one that is already in an individual's repertoire (e.g., Roscoe et al., 1999). Responding is first measured in a baseline phase (A), where no stimulus is delivered for responding. Then, during the reinforcement phase (B), the stimulus is provided when the response requirement is met. If the frequency of responding is higher during reinforcement phases than during baseline phases, the stimulus is considered a reinforcer, and the higher the frequency or rate of responding, the more potent the reinforcer is judged to be. One consideration in evaluating reinforcer strength is that, because phases in single-operant reinforcer assessments are often relatively short (e.g., 5 min), ceiling effects may occur. Nonetheless, single-operant reinforcer assessments can provide a measure of absolute reinforcer strength. Single-operant reinforcement assessments have typically shown that HP stimuli almost always function as reinforcers and LP stimuli sometimes will (e.g., Roscoe et al., 1999). Lee et al. (2010) evaluated each assessed stimulus in a single-operant ABAB reinforcer assessment and calculated the percentage change between reinforcement and baseline. They found concordance of reinforcer effects and preference ranks for one individual with IDD, and partial concordance for the other, with disagreements shown with less preferred stimuli.

Multielement (sometimes referred to as multiple-schedule) reinforcer assessments have also been used to evaluate absolute reinforcer effects. In these arrangements, baseline sessions (no contingent stimulus) and sessions with one (i.e., most preferred) or more (i.e., moderately or lowest preferred stimulus) reinforcement conditions are randomly alternated. This design allows for visual inspection to detect not just the absolute reinforcement effects of preferred stimuli, but the relative reinforcement effect of each stimulus when multiple stimuli are included. For example, Carr et al. (2000) used a multielement design to evaluate the predictive validity of a brief MSWO assessment for three students with ASD. They measured the number of correct responses on individualized curricular targets in baseline (no stimulus contingent on correct responses) and then in three different reinforcement conditions each with a different stimulus from the preference assessment: the top-ranked stimulus (first), a moderately ranked stimulus (fourth or fifth), and the bottom-ranked (eighth) stimulus. The absolute reinforcer effect was shown for each stimulus by comparing the number of correct responses in each reinforcement condition to the baseline. Contingent delivery of the top-ranked stimulus functioned as a reinforcer for all participants with accuracy levels above baseline. Contingent delivery of the moderately ranked stimulus functioned as a reinforcer for two of three participants, and contingent delivery of the bottom-ranked stimulus had only a modest reinforcement effect for one participant with no reinforcer effect for the other two participants. Relative reinforcer effect was also shown for each contingent stimulus by comparing the number of correct responses in each reinforcement condition to each other. For each of the three participants, the effect of each of the contingent stimuli was orderly without any overlapping data points and in line with the hierarchy indicated by the preference assessment: highest levels of accuracy were shown with the top-ranked stimuli, middle levels of accuracy with the moderately ranked stimuli, and lowest levels of accuracy with the bottom-ranked stimuli.

More recently, behavior analysts have used progressive ratio (PR) assessments to evaluate reinforcer potency (e.g., Roane et al., 2001). A PR assessment is a type of single-operant assessment, but the response requirement to access reinforcement systematically increases within a session. For example, a participant may need to emit two responses to obtain the reinforcer initially, then four responses, then six responses, etc. The session ends when responding stops, and the last reinforcer schedule achieved, called the breakpoint, determines the reinforcer value. If Stimulus A has a breakpoint of 20, and Stimulus B has a breakpoint of 10, Stimulus A is considered the more potent reinforcer. Morris and Vollmer (2020) used PR assessments to evaluate the predictive validity of the rank ordering of stimuli generated by SPAs (i.e., SPA hierarchy, not just HP or LP). PR assessments were conducted with each stimulus in the SPA and were used to assign ranks to all stimuli (stimulus with the highest average break point was assigned Rank 1, stimulus with the next highest break point was assigned Rank 2, etc.). They then calculated rank-order correlation coefficients of SPA and PR assessments. They found that SPAs yielded valid hierarchies (an average rank-order coefficient of 0.7 or greater) for approximately half of the eight children with ASD who participated.

Relative Reinforcer Effect

Relative reinforcer effects, on the other hand, are shown when the effect of a contingent stimulus is shown *at the same time as* the effect of no contingent stimulus (or a different and presumably unpreferred or less preferred stimulus). Relative reinforcer effects are often used when a preference assessment identifies a hierarchy of preferences (e.g., PS or MSWO) and serves to provide predictive validity for that hierarchy (i.e., a preference hierarchy would be validated if the top-ranked stimulus in a preference assessment was shown to be more effective as a reinforcer than a mid- or bottom-ranked stimulus).

Relative reinforcer effects have been assessed with a variety of experimental arrangements, most notably concurrent-operants paradigms (e.g., Fisher et al., 1992; Roscoe et al., 1999) and concurrent-chain arrangements (e.g., Castelluccio & Johnson, 2019; Steinhilber & Johnson, 2007). Concurrent-operants arrangements measure free operant responding among two or more alternatives. For example, Fisher et al. (1992) used a concurrent-operants arrangement within a reversal design with two chairs (or squares) present and each chair (or square) had different stimuli available. Throughout each reinforcement session, participants could move from chair to chair and the dependent measure was the percentage of time spent in each chair (or in-square). A reinforcement effect was seen if time in chair (or square) increased when stimuli were available compared to when no stimuli were available. Relative reinforcer effect was measured by the amount of time a participant allocated to each of the chairs (or squares).

Concurrent-chain arrangements, on the other hand, measure restricted operant responding among two or more alternatives. In one example, Castelluccio and Johnson (2019) used a concurrent-chain arrangement with two to three cards depicting multitask sequences, each associated with a different break environment (or no break). Selecting a card with one of the task sequences (initial link) produced the materials to complete those tasks and completing the tasks in the specified order was reinforced with access to the associated break environment. Dependent measures included initial-link selections and task-sequence completions. A reinforcement effect was seen when there were more selections and completions of task sequences associated with a contingent break than with no break; relative reinforcement effects were shown as more selections and subsequent schedule completions were allocated to the initial link associated with the most highly preferred than with the least preferred break environment when they were both available.

Teaching Others to Conduct Stimulus Preference Assessments

Several methods for training inexperienced staff to conduct SPAs have been evaluated by researchers: behavioral skills training, pyramidal training, self-instruction packages, video modeling, and telehealth.

Behavioral Skills Training

Behavioral skills training (BST) has been shown to be an effective and efficient method to teach individuals how to accurate conduct SPAs. Typically, individuals are provided with training materials, and the trainers demonstrate how to implement the procedures. Trainees then conduct the procedures and are provided feedback on their performance. Lavie and Sturmey (2002) trained three teacher assistants, who had no previous experience identifying potential reinforcers, to conduct PS preference assessments. First, a task analysis of the target steps required to perform a preference assessment was created. Participants were given a checklist describing each target skill and a trainer verbally described each skill on the list. Participants then watched a videotaped model of the skills being performed. Next, participants conducted the assessment with clients, and the trainer observed and provided performance feedback. Training continued until participants conducted the SPA with 85% accuracy; all participants met mastery criteria following approximately 80 min of training. Other researchers have also found that trainees can master the skills required to implement SPAs in a relatively short period of time when using behavioral skills training (e.g., Roscoe et al., 2006; Roscoe & Fisher, 2008).

Pyramidal Training

In an attempt to improve the efficiency of SPA training procedures, Pence et al. (2012) used pyramidal training to train 27 teachers and clinicians to conduct PS, MSWO, and FO assessments. Three trainers were given copies of preference assessment protocols, data sheets, protocols for training the assessments, and instructions on how to provide feedback. Following training, the three teachers (Tier 1) trained a group of six teachers and clinicians (Tier 2) using the same training methods. Next, five Tier 2 individuals trained a group of 18 preschool teachers (Tier 3). Following training sessions, generalization sessions occurred in teachers' classrooms. Pyramidal training was effective to train three tiers of professionals to conduct all three assessments.

Self-Instruction

Researchers have also become interested in developing protocols that could be successfully implemented in the absence of an expert trainer. Graff and Karsten (2012a) evaluated the effectiveness of an antecedent-only self-instruction packet to train inexperienced staff to conduct and interpret the results of PS and MSWO preference assessments. A multiple-baseline across assessment types was used to evaluate the effectiveness of enhanced written instructions (EWIs). During baseline sessions, 11 teachers were given the methods section from the seminal journal article with a blank sheet of paper and instructed to conduct the assessment. Next, participants were given a self-instruction packet containing EWIs. The self-instruction packet provided instructions for completing each assessment without the use of technical jargon. The step-by-step instructions for conducting and scoring the assessments were supplemented with diagrams and pictures; no performance feedback was provided. Several target responses were assessed for each participant: stimulus presentation, positioning of stimuli, post-selection response, response blocking (if necessary), trial or session termination, data recording, data summary, and interpretation of preference assessment results. Accuracy for conducting both PS and MSWO assessments was low during baseline sessions. After being provided with the EWIs, all participants met the mastery criterion, suggesting that inexperienced staff can be trained without the use of expert-led training. In addition, participants successfully learned how to score the assessment and interpret the findings, in the absence of any performance feedback. Other researchers have also found the use of EWIs to be effective for training inexperienced individuals to conduct SPAs (e.g., Shapiro et al., 2016).

Video Modeling

The use of video modeling (without the addition of corrective feedback) to train inexperienced staff to conduct SPAs has been evaluated by several researchers. Weldy et al. (2014) trained nine inexperienced staff to implement a brief MSWO assessment and a brief FO assessment using video modeling. Participants viewed a PowerPoint presentation that demonstrated how to conduct both preference assessments. The researchers found that all participants accurately implemented both assessments after 60–90 min training with video models. Similarly, Rosales et al. (2015) evaluated the effects of video modeling plus embedded instructions to train three inexperienced staff to implement PS, MSWO, and FO assessments. Videos showed correct implementation of the target skills for each assessment with embedded written instructions, which provided explicit information for completing each target skill. Participants could watch and rewind the videos for an unlimited amount of time before conducting the assessment. The results showed that video modeling was effective in training staff to implement preference assessments. Other research has demonstrated the effectiveness of video modeling with voiceover instructions to teach inexperienced individuals to accurately implement SPAs (e.g., Bovi et al., 2017; Lipschultz et al. 2015). Some researchers have combined multiple strategies to teach inexperienced individuals how to conduct SPAs. For example, Hansard and Kazemi (2018) developed a video self-instruction package that used written instructions combined with voice-over instructions and video modeling of each step in the procedure. They found that participants were able to accurately implement the assessment, score, and interpret the results.

Telehealth

Recently, researchers have found that preference assessment procedures could be trained via telehealth. Higgins et al. (2017) implemented a training package via telehealth that was comprised of a self-paced multimedia presentation (that combined written material plus video models) plus video feedback and role-plays with immediate feedback. All participants implemented the procedures with high accuracy, demonstrating that BST could be delivered via telehealth. Inexperienced individuals have also learned how to conduct brief MSWO assessments via telehealth with real-time feedback on their performance (Ausenhus & Higgins, 2019).

Summary and Recommendations

When implementing behavior analytic programs to decrease problem behavior and to increase adaptive skills, it is critical that effective reinforcers are used. Over the past 40 years, behavior analysts have developed a variety of methods to identify potential reinforcers, and the development of procedures to effectively and efficiently identify preferences has accelerated in the past 20 years. In this chapter, we have reviewed much of this research and its implications.

The experimental literature on SPAs demonstrates that many different types of stimuli can be evaluated by measuring either approach responses or duration of engagement. SPAs have been used successfully in many different settings, including preschools (e.g., Hanley et al., 2007), inpatient units (e.g., DeLeon et al., 2001), residential schools (e.g., Cohen-Almeida et al., 2000), group homes (e.g., Conyers et al., 2002), sheltered workshops (e.g., Worsdell et al., 2002), early intervention day programs (e.g., Carr et al., 2000), and public schools (e.g., Mueller et al., 2001). Additionally, SPAs have been used to identify reinforcers for individuals with varying diagnoses such as intellectual disabilities (e.g., Pace et al., 1985), developmental disabilities (e.g., DeLeon & Iwata, 1996), visual impairments (Paclawskyj & Vollmer, 1995), schizophrenia (e.g., Wilder et al., 2003), emotional/behavior disorders (e.g., Paramore & Higbee, 2005), attention deficit hyperactivity disorder (e.g., Northup et al., 1996), and adults with dementia (Lucock et al., 2020). Thus, the extant literature on SPAs confirms that the procedures are applicable to a wide range of settings and participants.

Recommendations

In conclusion, based on the research literature just reviewed, we make six recommendations regarding SPAs.

Recommendation 1

SPAs should be conducted when developing or revising reinforcement-based programming. There are several situations when it may be especially important for clinicians to conduct SPAs. For example, when one begins working with a client, conducting SPAs to identify potential reinforcers may be an important first step in the development of effective behavioral programming. With established clients, there may be times when progress has slowed or stopped. When this occurs, conducting reinforcer assessments with previously identified preferred stimuli and SPAs with new stimuli to identify additional potential reinforcers is warranted. In addition, clients who are receiving intensive behavioral programming (e.g., individuals in residential placements who may be receiving behavioral programming during all waking hours) may satiate if the same stimuli are used as reinforcers across the day. Conducting SPAs to increase the pool of potentially reinforcing stimuli for different categories of stimuli (edibles, leisure items and activities, and social stimuli) would be beneficial to clients in such situations. Finally, for clients who receive behavioral programming for prolonged periods of time, it may be important to conduct SPAs occasionally to determine proactively (i.e., before deleterious changes in problem or adaptive behavior) if the preference for items has changed.

Recommendation 2

SPAs should be conducted or supervised by individuals knowledgeable on the extant preference assessment technology. To increase confidence that preference assessments provide clinicians and practitioners with valid and functional outcomes, several factors should be considered. It seems obvious that individuals attempting to conduct SPAs should have adequate knowledge of the procedures. Yet, in one recent survey of over 400 educators and clinicians who conducted preference assessments, 50% of respondents reported a lack of knowledge of preference assessment procedures. Twenty-eight percent of individuals with a degree in behavior analysis reported that the topic of SPAs was not covered in their college coursework, and 19% of Board Certified Behavior Analysts® reported a lack of knowledge of SPA procedures (Graff & Karsten, 2012b). Several studies have demonstrated that when individuals have not been trained on conducting SPAs, they do not implement procedures accurately (e.g., Graff & Karsten, 2012a; Lavie & Sturmey, 2002; Roscoe & Fisher, 2008).

Recommendation 3

Use SPA methods that best match the client's skills and reinforcer needs. Individual participant variables must be considered when conducting which SPA to conduct. Several recommendations have been made to aid clinicians in obtaining valid preference hierarchies (DeLeon et al., 2014). Most SPAs require that an individual have intact motor skills in order to make a selection response. If the individual has severe physical disabilities and cannot physically approach stimuli, clinicians should consider using microswitch technology to identify preferred stimuli (e.g., Wacker et al., 1985). In addition, clinicians might consider identifying behaviors that may be correlated with "happiness," and then expose the individual to a series of stimuli, to determine if any function as reinforcers (Green & Reid, 1996). All SPAs in which more than one stimulus is presented on a trial require that the participant be able to scan a visual array and make a selection response. If scanning is not in an individual's repertoire, clinicians should consider conducting SS assessments (Pace et al., 1985); reinforcers that are identified could then be used to teach scanning skills. If the individual can make valid choices when two items, but not more, are presented on a trial, a PS assessment (Fisher et al., 1992) should be conducted, as long as the individual does not display position biases. If position biases are noted when conducting a PS assessment, clinicians could attempt to change the positions of the items in the array (e.g., from side-by-side to top-to-bottom). This may or may not be successful, as some participants may continue to select items solely based on their position in the stimulus array. Some clinicians have overcome position biases by developing an immediate history with arrays that include non-preferred or less-magnitude items in the preferred position (e.g., Bourret et al., 2012). If the individual can accurately scan larger stimulus arrays and not attempt to select items that remain on the tabletop between trials, clinicians should consider conducting MSWO assessments (DeLeon & Iwata, 1996), as MSWO assessments may be faster to complete than PS assessments. Both PS and MSWO assessments require the participants to return a selected item after it is consumed, but for some individuals, terminating reinforcement may be associated with an increased probability of problem behavior. For these clients, a FO assessment (Roane et al., 1998) could be used, as the FO has been shown to be associated with less problem behavior when assessing preferences for tangible items than PS or MSWO assessments (e.g., Kang et al., 2011).

If practitioners are attempting to identify preferences for complex stimuli, stimuli that cannot be placed on the tabletop, or social stimuli, they should consider using verbal, pictorial, or video-based preference assessments. Before using these assessments, however, it is important to determine if the individual possesses the presumed prerequisite skills. This task could be done by conducting specific discrimination tests with the stimuli to be assessed (e.g., Clevenger & Graff, 2005), or by using a general discrimination skills assessment such as the Assessment of Basic Learning Abilities (ABLA; Kerr et al., 1977) or the New England Center for Children- Core Skills Assessment (Dickson et al., 2014).

Finally, the duration of access in the SPA should match the duration of access in the natural environment. Steinhilber and Johnson (2007) found differential preference hierarchies depending on the duration of access. If the stimulus will be used contingently on correct responses in discrete trial instructional settings, potential reinforcers should be evaluated in the context of a SPA with brief access such as 10–15 s; on the other hand, if the stimulus will be used contingently on more effortful responses such as those shown with greater PR break points, one should consider evaluating potential reinforcers in the context of a SPA with more extended access that matches what the reinforcement interval will be in the natural environment.

Recommendation 4

SPAs across different categories of stimuli should be conducted that incorporate caregiver-nominated items and are ecologically valid. Before conducting SPAs, clinicians must decide which stimuli to include. If a clinician is working with a new client and has limited information about the individual's reinforcement history, a starting point is to conduct the RAISD (Fisher et al., 1996) or another structured caregiver survey. Before conducting preference assessments, clinicians must be sure that their clients have previously interacted with items to be assessed. If unsure, clinicians should expose the client to the items before starting the assessment. For individuals who have previously participated in SPAs, clinicians should consider adding novel stimuli into the stimulus pool. In general, clinicians should conduct separate SPAs for each category of stimuli (e.g., edibles, activities, and social).

Clinicians conducting SPAs should consider the "ecological fit" of stimuli when deciding which items to include in a SPA (DeLeon et al., 2014). For example, if reinforcers are to be presented frequently, relatively inexpensive items may be the most practical. In the Graff and Karsten (2012b) survey of SPA practices, 38% of respondents reported that a barrier to conducting SPAs was the amount of money available to purchase reinforcers. Similarly, clinicians should also consider what the duration of reinforcer access will be. For example, different stimuli should be assessed if potential reinforcers will be delivered on a rich schedule, such as during discrete trial instruction, than if potential reinforcers will be delivered after more prolonged and effortful behavior such as a multi-task hygiene routine. In the first example, reinforcers should be those that are easily dispensed and consumed quickly so as not to disrupt the instructional session (e.g., brief social attention, an edible). In the latter example, there may be more latitude in how easily the reinforcer can be delivered, particularly if tokens are used and the token exchange can occur when the reinforcer is available, and the reinforcer access time may be more prolonged (e.g., video game, time on iPad®). DeLeon et al. (2013) suggested that clinicians conduct a sequence of preference and reinforcer assessments to address the issue of ecological fit. First, the authors suggest that preference and reinforcer assessment be conducted for social stimuli. If social stimuli function as reinforcers, they should be used, as they are quick and easy to deliver. If social stimuli do not function as reinforcers, leisure items and other non-edible tangible stimuli should be assessed. DeLeon et al. suggest that edible items be the last category of stimuli that should be assessed. Oftentimes, edible stimuli are most preferred by clients (e.g., Fahmie et al., 2015), but edible items may be difficult to deliver in certain situations (e.g., delivering candy to a child as a reinforcer for brushing their teeth), and the repeated delivery of food over long periods of time may impact on a client's health.

Recommendation 5

To the extent possible, minimize motivating operations that may affect SPA outcomes. Previous research has demonstrated that motivating operations can influence preference assessment outcomes (e.g., Gottschalk et al., 2000; Hanley et al., 2006; McAdam et al., 2005). Thus, clinicians should monitor or control the amount of presession access individuals have to the items being assessed. Although some studies have regulated the amount of presession access to items by providing pre-measured portions of all items, an easier method to control presession access may be to simply refrain from delivering any of the assessed items for a period of time just prior to conducting the assessment. Chappell et al. (2009) found that for two of three individuals with ASD, abolishing effects of presession access to edible items abated after 20 min. This finding should be considered tentative as it has not been replicated by other researchers or across other stimulus categories. Until additional research is conducted to better determine the necessary length of the presession deprivation period, restricting access to items for 1 hr prior to an assessment seems a reasonable guideline. In addition to controlling access to the specific items being assessed, it may be helpful to control for the delivery of items that are similar to those being assessed. For example, if gummy bears are to be included in an edible preference assessment, gummy bears and other gummy items (e.g., gummy worms) should be restricted, as these items could be considered substitutable.

Recommendation 6

When possible, provide access to selected items immediately and when this is not possible, consider pre-assessment reinforcement schedule thinning or the use of arbitrary reinforcers during the SPA. In general, following selection responses with the delivery of the corresponding item increases the probability of generating a valid preference hierarchy. This may not be possible when assessing preferences for some complex stimuli using verbal, pictorial, or video-based assessments. When it is not possible to deliver an item immediately following a selection response, it is suggested that schedule thinning be used to potentially increase the accuracy of preference assessment results (Heinicke et al., 2016). Although not extensively evaluated, it is possible that providing periodic access to arbitrary reinforcers between trials may reduce the possibility that participants may stop responding because approach responses are not reinforced.

Summary

In summary, identifying preferred stimuli is a critical function of behavior analysts working with individuals with IDD. In this chapter, we have reviewed the research on different SPA methods and outcomes and hopefully provided the information necessary for others to select the optimal assessment procedure to identify effective reinforcers to be incorporated into clinical practice.

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Establishing Performance Criteria for Skill Mastery

22

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What Are Performance Criteria?

Applied behavior analysis (ABA), as a field, focuses on addressing socially significant behaviors through the implementation of effective behavior analytic interventions (Baer et al., 1987). The functional extension of effectiveness of treatment procedures within the therapeutic context to the natural environment is a central goal of ABA (Stokes & Baer, 1977). Within skill acquisition programming, the basic structure of instruction includes clear antecedents, opportunities for the learner to respond, and feedback on responses (Skinner, 1968). This may involve a child with autism responding to repeated opportunities to tact colors, college students responding to quizzes, or youth learning accurate sports behaviors. In each case, the respective instructor continues with teaching until the learner's behavior meets a predetermined criterion used to evaluate sufficient skill proficiency, often labeled a *mastery criterion* or *performance criterion.* This is systematically done such that behavior continues to occur, or maintains, in the presence of naturally occurring antecedents and consequences, outside of contrived analogue teaching conditions. This process has often been labeled as *programming for maintenance,* or more accurately, *response maintenance* (as discussed in the section "Terminology Considerations").

The use of instructor-determined performance criteria that serve as discriminative stimuli for terminating a teaching phase is a widely adopted practice and has a long history in the field of behavior analysis. In fact, the first article printed in the *Journal of Applied Behavior Analysis* includes a reference to the discontinuation of programmed treatment once a satisfactory rate of behavior was achieved (Hall et al., 1968, pp. 2–3). In 1997, Sayrs and Ghezzi noted the rapid growth in the reporting of mastery criteria in the *Journal of Applied Behavior Analysis* between 1968 and 1995. Around this same time in 1996, 53% of articles in the *Journal of the Experimental Analysis of Behavior* included a report on mastery criteria (Rehfeldt & Ghezzi, 1996). Early treatment manuals (e.g., Lovaas, 1981) also included recommendations for adopting performance criteria such as 9 out of 10 consecutive trials correct as indication to move onto the next step of training. More recently, clinical survey data (Love et al., 2009; Richling et al., 2019) suggest the wide adoption of evaluative performance criteria. These studies report that all survey respondents indicated utilizing criteria of various types, such as those based on a percentage of trials correct or a consecutive number of trials

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_22

correct. As such, it is apparent that the use of performance criteria has a long-standing history and has become ubiquitous within the field of ABA.

Contemporary Use of Performance Criteria

Recently, researchers and clinicians have referred to predetermined performance goals as *mastery criteria.* Many performance criteria rules appear to come from clinical manuals or supervisors and seem to be accepted as universal rules (e.g., 80% correct responding or above for three consecutive sessions); however, these rules have little scientific support. The selection of performance criteria is undoubtedly nuanced and should be tailored to each unique behavioral target and each unique client. That is, the selected goal should be directly tied to how exactly this particular behavior is expected to occur, by this particular individual, in a particular natural context(s), at a particular time(s), in a particular way. For example, it may be the learner is expected to pass a written exam with a grade of B or better, requiring 80% accurate response on test items within a certain period of time. As such, the acceptable level of responding would need to be 80% accuracy or higher and occur at a certain rate of responding, to account for the timed test conditions. Performance on both of these features (i.e., accuracy and speed) of the response would need to be measured and observed in order to determine whether an intervention has been effective. In another case, it may be that an individual on a behavior analyst's caseload is being taught to cross the road safely. In this case, it would be important for the behavior analyst to require 100% accuracy with respect to safe behaviors while also ensuring programming is conducted such that behavior is likely to maintain 100% accuracy for a long duration of time post-training. There is less clinical need to require such stringent criteria for other topographies of behavior such as tacting animals, for example.

It is important we also recognize that for the above examples, it is possible a higher level of performance criteria must be established during teaching sessions in order to achieve desired levels of behavior which are expected to occur at a later time, accounting for behavioral deterioration over time. That is, there may be decreases in the accuracy and/or speed after a certain period has elapsed since the previous teaching session. Thus, the behavior analyst must also determine and assess what constitutes an effective teaching criterion that can reliably produce the desired response maintenance performance expectations at a later time during which the behavior actually needs to occur. In other words, we need to determine functional relations between performance criteria during teaching—when we reinforce correct responses and provide assistance as needed—and the resulting performances after teaching are done and the learner is expected to perform under more naturalistic conditions and rates of reinforcement. In behavior analysis, this initial teaching criterion has typically been referred to as the mastery criterion, or the criterion at which the learner must perform under teaching conditions before progressing to maintenance probe conditions. While these initial goals are important to indicate movement to the next phase of treatment, it is important to highlight here that the overall goal of demonstrating effectiveness does not end at the point of achieving a mastery criterion. Effectiveness is only demonstrated when the behavior occurs in the desired context following the termination of treatment. Only then might we consider the skill mastered. We discuss this and related issues with terminology in the following section.

Terminology Considerations

First, as pointed out by Cooper et al. (2007, p. 616) there is a need to distinguish between the terms *maintenance* and *response maintenance.* Response maintenance has been defined as *the degree to which* a behavior persists over time when all or part of the intervention variables responsible for training the behavior are no longer present (Freeland & Noell, 2002; Stokes & Baer, 1977). As such, it refers to a measurement of the occurrence of behavior and has also been referred to as behavioral persistence or durability. Maintenance, however, does not refer to the behavior, but to the environmental stimulus conditions. Maintenance is utilized to describe a condition in which all or part of the treatment has been removed, albeit often with the intent of observing a potential degree of response maintenance. As such, response maintenance is best conceptualized as a dependent variable and maintenance as an independent variable. Thus, a primary goal of ABA interventions is the demonstration of a predetermined acceptable level of response maintenance, not merely the implementation of maintenance procedures.

Second, the term *mastery criterion* also warrants further discussion. As it stands, a mastery criterion has been loosely defined as "a specific guideline for performing a skill such that if the guideline is met, the skill is likely to be mastered" (Martin & Pear, 2007, p. 223) or as "performance requirements for practicing a skill such that if the criteria are met, the behavior has been learned" (Martin & Pear, 2007, p. 343). Fuller and Fienup (2018) highlight circumstances under which this term is used to describe performance criteria that do not meet this definition. For example, the authors state that once responding meets a predetermined level of accuracy, an instructor may move to a less restrictive prompt level, which does not suggest mastery, but rather behavior meeting an acceptable criterion given the current context. This highlights one of several problems with the current use of the term mastery criterion, namely the inclusion of the term *mastery*, itself.

Colloquially, mastery typically refers to the possession or demonstration of an exceptional skill or technique and one who can perform at this level may be referred to as a master of that skill or subject matter. Keeping this definition in mind, it is odd to refer to the minimally acceptable levels of performance as *mastery*. This is particularly curious when we consider this in some contextual scenarios. Oftentimes, a mastery criterion might be set at 80% correct (McDougale et al., 2019). If one were to go to work wearing 80% of their clothing, do we consider them a master dresser? Or if someone stops at 80% of stop signs while driving, would we label them a masterful driver? However, within behavior analysis, mastery typically refers to a level of performance indicating a behavior has been sufficiently learned. This gives rise to another question, what do we mean by "learned" (as well as "sufficient"). As behavior analysts, we may use the term *learned* to indicate observation of the behavior being evoked at acceptable levels in the presence of given contextual discriminative stimuli. However, *learned* does not necessarily mean the behavior has been acquired by the individual such that it will occur at the same levels ad infinitum.

To this point, as suggested by Fuller and Fienup (2018), there is a problematic underlying assumption inherent in mastery criteria. That is because behavior meeting this criterion functions as a discriminative stimulus for the teacher to engage in another behavior (e.g., decrease prompt level or introduce new targets), there is an implied expectation that behavior will maintain once the current instructional behaviors are terminated. The problem here, however, lies in the lack of literature supporting this assumption of maintenance following achieving specific performance criterion levels (Fuller & Fienup, 2018; Richling et al., 2019).

Now, let us look at the point during the training context at which the term mastery is typically utilized (i.e., after behavior is observed to occur at initial performance criteria levels under teaching conditions) and why this is problematic. Consider the possible response deterioration that is likely to occur following the removal of teaching procedures as described earlier. If deterioration in responding occurs, we may not label this mastery; it is just the first step in a series of teaching milestones toward a terminal goal. If the term mastery is used at this point in teaching, it may indicate to the therapist that their job is done, when that is far from the case.

Within precision teaching literature, specific attention is paid to performance standards and empirically associated learning outcomes (Kubina & Starlin, 2003). Fluency aims are conceptually similar to mastery criteria. Within this area of research, the assumption is that performance occurring within a certain frequency range will be associated with retention and other extended learning outcomes (Kubina & Starlin, 2003). These learning outcomes include other behavioral measures such as retention across time, endurance of performance for a duration of time, performance in the presence of distractions, and application of a previously learned component in the context of learning a new composite skill (REAPS) (Binder, 1996; Haughton, 1984). These terms refer to various dimensions of performance (beyond a percentage of correct responses) that are expected to be observed before a skill is considered sufficiently learned. The importance placed on these other demonstrations of performance within the precision teaching literature highlights the need for adopting and clearly outlining the various dimensions of performance and milestones required for truly demonstrating mastery.

Mastery Redefined as a Collective of Multiple Performance Criteria

For the reasons outlined in the previous section, we have adopted the term *performance criteria* as an umbrella term encompassing individual criteria applied at separate learning goals. The term *mastery criterion* is reserved for describing the final milestone of having achieved all individual performance expectations. These individual performance criteria may include the initial acquisition criterion (e.g., 100% correct responding across three consecutive sessions), a fluency or rate criterion (e.g., 100% correct responding at a rate of 20 responses per minute), a response maintenance criterion (e.g., retained performance at 90% correct responding after a period of one month), and a generalization criterion (e.g., 90% correct performance in the natural environment, two additional novel settings, without the presence of the instructor, and in the presence of two novel individuals). If necessary, supplemental performance criteria may be adopted for the particular skills and expectations in the natural environment. For example, one may also require performance in the presence of distraction or for a duration of time without a decrease in rate. These features of performance might be expected, for example, for professional athletes or individuals taking long standardized tests. Throughout the remainder of this chapter, we will utilize the terms as described in this section. In the next section, we will address each of the abovementioned performance criteria in more detail.

Dimensions of Performance Across Which Criteria Can Be Applied

As suggested at the beginning of this chapter, conventional wisdom assumes a simple approach to the application of mastery criteria. The majority of practitioners and researchers within the field of ABA rely on percentages of correct responses as the standard for determining the mastery of any given skill (Richling et al., 2019). It is worth noting most of this work involves young children with developmental delays who are learning basic academic and social responses. Once an individual performs a task with 90–100% accuracy, it is typical to label the task as "mastered." What we will soon find, however, is that the application of mastery criteria is much more nuanced and complex.

Mastery encompasses several individual components for which a criterion should be uniquely established. As described in the previous section, we conceptualize mastery as a set of performances, comprised of acquisition, fluency, maintenance, and generalization (Fig. 22.1).

The initial stage of teaching requires the implementation of strategies to produce a response that was not previously in a learner's repertoire, also known as the acquisition stage. When a target behavior is in the acquisition stage, that is, the skill has yet to be performed successfully, acquisition criteria should be applied to determine when the intervention should be faded or terminated. The most commonly used dimension of acquisition criteria within ABA instruction is the level of accuracy during a session. Instructors administer a block, or set number, of teaching trials. Typically, practitioners and researchers report a percentage of correct responses across all trials within the session.

Fig. 22.1 The four pillars of mastery including acquisition, fluency, maintenance, and generalization for which instructors should establish a unique criterion for each

Higher percentages tend to lead to more durable responses as more time passes (Richling et al., 2019).

Another dimension of acquisition criteria identifies the frequency of observations at which the level of accuracy occurs. Practitioners and researchers typically establish a range of one to three consecutive sessions in which a predetermined accuracy level must be observed before they signal the termination of an intervention (Richling et al., 2019). To date, there have been no published studies systematically comparing the effectiveness of different frequencies of observation for producing subsequent response maintenance.

Selecting the right criterion for acquisition is nuanced. Many different variables should be considered during this process. Such variables include the type of novel skill that is targeted, the intervention procedure being used, and the skills the individual who is undergoing instruction possesses. For example, a 90% acquisition criterion may be adequate for an individual who is learning how to spell but certainly not adequate for an individual who is learning to stop at a stop light. An acquisition criterion of five consecutively correct responses to emit letter sounds may be appropriate for a student who demonstrates bidirectional naming (Miguel, 2016) but not for a student who does not demonstrate the ability to learn language incidentally. Bearing in mind all the nuances of skill acquisition, criterion selection needs to be a carefully thought out process.

The parameters of acquisition, which include the level of performance and frequency of observations should also be applied to the assessment of maintenance and generalization across settings and multiple instructors. For example, an instructor may establish a level-based criterion across two or more instructors to assess for the generalization across instructors. An instructor may also establish a level-based criterion across two or more settings to assess for the generalization across settings.

Performance criterion may be applied to a whole session/set of operants or to individual operants. Thus, identifying the unit of analysis when determining performance criteria is important (Wong, Bajwa et al., 2022). Level of accuracy may be conceptualized as a session-based unit of analysis. That is, the emphasis is on the overall accuracy within a session, and the criterion is applied to a set of operants rather than a single operant. This particular method of analyzing performance raises some important issues. ABA instruction within educational settings typically uses discrete trial instruction (DTI) that relies on teaching multiple operants or skills (a set of operants or skills) within one session. If a session contains 20 trials, there are usually four or five operants included in a teaching set. When performance criteria are applied to the session as a whole and the established criterion is less than 100% accuracy, errors centered on certain operants may be overlooked. For example, during tact instruction for four novel stimuli in a 20-trial session, a 90% correct criterion allows a student to respond incorrectly one or two times. Sometimes those two incorrect responses may fall on only one operant. Thus, the student responded correctly only three out of five times (60% accuracy) to one operant. The 90% correct criterion across one session hides this fact and assumes the student has acquired the entire set.

Another major issue with this method of analysis is that it affects the efficiency of instruction. Oftentimes, the raw data of skill acquisition programs show that students acquire a few operants in a set quickly, while needing additional sessions to acquire the remaining operants. Because the acquisition criterion is not met due to the pattern of errors for the remaining operants, the instructor delivers unnecessary instruction for the same set of operants until the set-based criterion is achieved. Thus, Wong, Bajwa et al (2022) proposed a unit of mastery analysis that is applied to individual operants rather than a set of operants. When the unit of analysis is at the individual operant level, the acquisition of discrete novel skills is not affected by other skills that are taught within the same set. Similarly, trial-based criteria that identify acquisition in terms of the number of correct *consecutive* responses can be used instead of set-based criteria. For example, an instructor may determine an adequate point to terminate a shoe-tying intervention when the child independently emits three consecutive correct shoe-tying responses. Approximately 28% of ABA practitioners and 18% of ABA researchers utilize trial-based criteria (McDougale et al., 2019; Richling et al., 2019).

The nuanced and diverse nature of selecting appropriate performance criteria is further complicated as we considered areas of practice outside of autism and developmental disabilities. The following section identifies the various areas in which performance criteria have historically been adopted. After reviewing this literature, we will return to a discussion of a standardized model for selecting performance criteria across a wide variety of practice areas.

Review of Literature Targeting Performance Criteria

Performance Criteria with Individuals with Autism Spectrum Disorder and Developmental Disabilities

ABA treatments are highly effective for teaching individuals with developmental disabilities, intellectual disabilities, and autism spectrum disorder (ASD) novel and socially significant skills. Individuals who receive ABA services are typically expected to achieve an established performance criterion for each skill they are taught. Love et al. (2009) surveyed 200 professional supervisors of Early Intensive Behavioral Intervention programs to identify different aspects of their teaching procedures. Over 60% of the respondents used a performance criterion that was either a certain percentage of accurate trials across multiple sessions or a certain percentage of trials across multiple therapists. Almost all the respondents (98%) included teaching procedures that promoted maintenance and generalization of the target skills.

Performance criteria are ubiquitous within ABA research. However, as ABA services have grown in scale, the standards to which skill is deemed learned or mastered varies across researchers and practitioners. Richling et al. (2019) conducted an online survey to gather information on common clinical practices as they relate to skill acquisition and mastery criteria. Approximately 200 BCBAs (Board Certified Behavior Analysts) and BCBA-Ds (Doctoral Level Board Certified Behavior Analysts) who serve individuals with ASD and intellectual disabilities responded. Similar to the results of Love et al. (2009), 68% of the clinicians used a session-based mastery criterion that was a certain percentage of accurate trials and 57% of those clinicians applied that mastery criterion across multiple sessions with additional variables. Only 35% of clinicians reported that they utilized a percentage of correct trials across multiple sessions. A small minority of clinicians (28%) used a certain number of consecutively correct responses to determine mastery and only 4% of clinicians used an established rate of correct responses per unit of time to determine mastery. There were also varied responses regarding the percentages used to determine mastery. Of the respondents who indicated that they applied a certain percentage of correct trials across multiple sessions, 52% of them used an 80% criterion. A smaller percentage of clinicians (28%) used a 90% criterion, and 7% of the clinicians used a 100% criterion. No clinicians applied a mastery criterion that was less than 80%. Richling et al. (2019) also sought to gain insight into the primary information source clinicians based on their mastery criterion. The primary source for the selection of mastery criteria for 44% of the respondents was a personal supervised experience. That is, many of the clinicians applied a particular mastery criterion because their supervisor directed them to do so. The second highest percentage of respondents (20%) reported that employer policies and requirements dictated their selection of mastery criterion. Sixteen percent of the respondents reported that graduate school training determined the established mastery criterion. A smaller percentage of respondents (10% and less) referenced continuing education programs, regulatory requirements, and funding sources as the primary information source for the mastery criterion.

To extend upon the responses that were submitted by the BCBAs and BCBA-Ds, Richling et al. (2019) conducted two additional experiments to systematically evaluate the most commonly reported mastery criterion level (80% across three consecutive sessions) with a 60% mastery criterion across three consecutive sessions and a 100% mastery criterion across three sessions on response maintenance. Four children with developmental disabilities were taught receptive identification skills and expressive identification skills (tacting). The results of Experiments 2 and 3 demonstrated that the only mastery criterion that produced reliably durable maintenance results (>70% accuracy) was the 100% mastery criterion across three sessions. A fourth experiment included a 90% criterion across three consecutive sessions in the comparison with an 80% and 100% criterion across three consecutive sessions. The results showed that even a 90% mastery criterion failed to produce durable maintenance responses. The 100% mastery criterion was the only criterion that predicted maintenance responses at or above 70% accuracy during 1-week follow-up sessions.

A similar study conducted by Fuller and Fienup (2018) demonstrated slightly different results. The authors investigated the effects of three skill acquisition mastery criteria (50% accuracy across one session, 80% accuracy across one session, and 90% accuracy across one session) on response maintenance and skill acquisition rate for students learning vocal and written spelling responses. The authors found differentiated maintenance responses across all three acquisition criteria and 90% accuracy across one session reliably predicted higher accuracy in responses 3–4 weeks following the completion of the acquisition phase. The highest acquisition criterion produced the most durable maintenance responses similar to the results demonstrated by Richling et al. (2019). However, in contrast to the findings of Richling et al. (2019), Fuller and Fienup (2019) found that a 90% performance criterion across one session was stringent enough to predict durable maintenance responses. One exclamation for the durable maintenance responses produced by the 90% criterion in Fuller and Fienup (2018) is that more instructional trials were used during the acquisition phase (20 trials) compared to 10 trials in Richling et al. (2019). Another reason for the discrepancy may be due to another instructional design component in which additional targets were taught after the initial acquisition of a set in Richling et al. (2019). Further, it is possible that the specific prompting procedure used in combination with particular mastery criteria may produce varying results. Longino et al. (2022) demonstrated that a 90% across three sessions criterion may be sufficient when employed in combination with a most-to-least prompting hierarchy rather than the least-to-most procedure adopted by Richling et al. (2019). Unlike Richling et al. (2019), Fuller & Fienup (2018), and Longino et al. (2022), Pitts and Hoerger (2021) reported that only small decreases in maintenance we observed following the employment of an 80% or above for three sessions criterion. However, these authors opted to provide reinforcement for correct responses during maintenance probes, which was not consistent with the aforementioned studies and may have resulted in the contrasting results. These various aspects of instructional design certainly warrant further research. New single-subject research in this area has been emerging to accomplish this goal over time. To help bridge the gap, Wong, Fienup et al. (2022) conducted a systematic analysis of the use of various forms of performance criteria on maintenance and found that even as specific procedural details varied, greater maintenance was observed with higher levels of a performance criterion.

McDougale et al. (2019) conducted a descriptive analysis to compare the performance criteria utilized by practitioners (Richling et al., 2019) with the performance criteria reported in articles published by behavior analyst researchers in three major journals between 2015 and 2017. Overall, the results showed many commonalities among the type of performance criteria utilized during skill acquisition interventions across both clinicians and researchers. The results show that the most utilized type of performance criterion was the session-based percentage of correct responses. There were differences in the level of accuracy. Among researchers, a 90% accuracy criterion was more widely used, and among clinicians, an 80% accuracy criterion was most widely used. With regard to the frequency of sessions observed at the established performance criterion, researchers favored a fewer number of consecutive sessions at 90% accuracy. As mentioned above, clinicians widely adopted an 80% accuracy across three consecutive sessions as mastery. The differences in performance criteria used between researchers and clinicians may be a result of different terminal goals of the researchers and the clinicians. Clinicians may operate within the constraints of the educational goals outlined in a learner's Individualized Education Plan and may have time limits to achieve the goals. In contrast, researchers may aim to achieve a greater difference in behavior change from baseline, and thus apply a higher, more stringent criterion for skill acquisition. Researchers may also have more flexibility and fewer time constraints compared to clinicians. An alarming finding from McDougale et al. (2019) is that greater than 50% of the research articles analyzed failed to include follow-up probe sessions to assess for maintenance of the skill.

Performance Criteria with School-Aged Children

In regular education settings, one common performance criterion is the use of fluency-based measures of performance. While many of the performance criteria discussed thus far relate to accuracy, fluency adds a time component. For example, one might define math fluency in terms of the number of math problems solved correctly within a minute or reading fluency as the number of words read accurately per minute. Indeed, whole systems of allocating educational services have been built on the notion of academic fluency benchmarks serving as indicators of (1) which children would benefit from universal educational services (tier 1), (2) which children require more intensive, small group instruction (tier 2), and (3) which children require highly individualized and possibly one-on-one instruction (tier 3). Called multi-tiered systems of support (MTSS; Jimerson et al., 2016), educators use student performance data—primarily measures of fluency—to make decisions about the appropriate educational support—whether the current instruction is effective or whether teaching tactics need to change.

MTSS begins with universal academic assessments of academic fluency, or curriculum-based measurement (CBM; Jimerson et al., 2016; Cummings & Petscher, 2016). The assessments include having children read, complete math problems, and write using materials from the school district's curriculum. Educators time the assessments and then calculate fluency. For example, a teacher or school psychologist may provide first graders with grade-level appropriate reading passages and ask the child to read the text aloud. The educator times the reading and marks which words were read incorrectly and then calculate words read correctly per minute (WRCPM) based on either the first minute of reading or based on reading the whole passage. The educator can then compare one child's reading fluency to peers and district norms to decide who should continue receiving current instruction (which should be empirically supported), who needs additional help, and who needs individualized services.

In one study, Ivarie (1986) utilized fluency-based measures to teach fourth-grade students concepts of Arabic and Roman numerals. The researchers manipulated the required fluency—either 70 correct responses per minute or 35 correct responses per minute—and observed that fourth graders who were taught to a higher fluency criterion maintained the skill longer and at a higher level than those whose criterion was set lower. These outcomes suggest faster fluency is associated with better educational outcomes. Additionally, they suggest that applying a more stringent teaching criterion produces better outcomes, which is similar to those effects found with a percentage correct criterion (Fuller & Fienup, 2018; Richling et al., 2019).

Another common performance measure in regular education settings is academic achievement—or scores on standardized assessments (Jimerson et al., 2016). Academic achievement tests (e.g., Woodcock-Johnson Tests of Achievement) involve an educator or school psychologist following a manual that includes academic antecedents related to reading, writing, and math to students, measuring responses to those antecedents, and providing no performance feedback. A test involves subtests which evaluate different aspects of an academic content area. For example, reading achievement often includes tests of letter identification, letter sounds, reading fluency, and reading comprehension. Achievement tests result in standard scores based on the child's grade and age. Standard scores are set such that the 50th percentile is a score of 100. The testing developer administers the test to many thousands of students at different educational levels and across different racial and economic groups to produce norms. Then, the educator can use software to evaluate how an individual student's academic achievement compares to other children in the same grade to make decisions about the type of instruction one requires to continue making academic gains.

While academic achievement tests are commonly used in practice for diagnosing learning disabilities, the use of academic achievement assessments for ongoing performance evaluation is limited (Jimerson et al., 2016). First, the tests are not designed to be administered frequently. Second, achievement tests are a general assessment across a number of academic areas that may not map onto specific educational goals that teachers are targeting. Thus, achievement assessments are only loosely related to performance on specific academic skills and the instruction going on in one's school. For these reasons, we suggest using CBM fluency measures and district norms to assess student performance on an ongoing basis in regular education settings. For more information on academic skills, refer to Chap. 55.

Performance Criteria with College Students

A number of studies have examined how altering performance criteria with college students affects student learning, generalization, and response maintenance. One of the first studies was conducted by Johnston and O'Neill (1973). The experiment was conducted within the context of Keller's Personalized System of Instruction (PSI; Keller, 1968), which includes weekly units composed of learning materials (e.g., readings) and terminal quizzes. In his original conception, Keller (1968) required 100% accuracy on a terminal quiz in order to move from one unit to the next. Thus, PSI is "mastery" based and progression through a PSI course requires meeting criteria during a particular unit. Johnston and O'Neill (1973) examined the effects of different performance criteria assigned to the unit quizzes. Students experienced different criterion levels (low, medium, and high, defined specifically as a rate of correct responding on unit quizzes, with a minimum rate of correct and a maximum rate of incorrect). The researcher found, not surprisingly, that student performance changed as a function of the minimum criterion. That is, when the criterion was high, students performed better than when the criterion was low, revealing a positive linear relationship between criterion and performance.

After the publication of Johnston and O'Neill's (1973), two additional studies examined criterion effects, also within a PSI context. Semb (1974) extended this area of research by examining low and high criteria for short and long assignments. In Semb's study, participants completed four units, all with quizzes, and a cumulative "review" exam that covered content across the four units. There were three experimental conditions: 100% criterion applied to each unit quiz (short assignment, high criterion), 60% criterion applied to each unit quiz (short assignment, low criterion), and 100% criterion only applied to the cumulative exam (long assignment, high criterion). Semb found that students in the short assignment, high criterion condition performed at a much higher level than peers in other conditions, suggesting the strength of breaking learning into small chunks and requiring 100% performance criteria to move from one unit to the next. This four-unit structure extended across the semester, repeating itself a few times. In this study, short assignments were individual units and mastery of each unit was required to move on to the next. There were two variations of short assignments, one which required 100% performance on each unit quiz and the review exam in order to progress through the course, and another which required 60% performance on each unit quiz and the review exam to progress. Semb also reported on response generalization and maintenance as some questions from the unit quizzes were replicated on the cumulative exams or modified. Again, participants in the short assignment, high criterion condition fared the best on generalization and maintenance questions.

Carlson and Minke (1975) further extended this area by examining different criterion levels, specifically 80% and 90% criterion levels. The authors observed that students repeatedly re-took unit quizzes following failure and this sometimes led to withdrawal from courses. Carlson and Minke compared 80% and 90% criterion levels to an ascending criterion that began with a low criterion (60%) and the criterion *ascended* every few units until the criterion was 90% near the end of the semester. Overall, the researchers found that students in the 80% criterion condition scored the highest grades in the class and passed a higher number of quizzes. Students in the 90% criterion condition did well, but less well than students in the 80% and ascending criterion conditions in terms of how many units the students completed. This study questioned the specific criterion requirements for college students completing PSI, but nonetheless demonstrated the need for relatively high-performance criteria.

More recently, this phenomenon was examined with a new type of performance: derived relations. Derived relations (see Sidman, 1994; Rehfeldt, 2011; Brodsky & Fienup, 2018), or inference making, begins with teaching overlapping conditional relations that result in multiple types of inferences, such as bi-directional relations (symmetry, if A goes with B, then B goes with A) and novel associations (equivalence, if A goes with B and A goes with C, then B and C go together). Fienup and Brodsky (2017) conducted an evaluation of this paradigm and studied how performance criteria during training affected the emergence of symmetry and equivalence relations. College students learned neuroanatomy classes that included the names of brain structures (A stimuli, e.g., Amygdala), a picture of the structure (B stimuli), a statement about the function of that structure (C stimuli), and a statement about the result of damage to that structure (D stimuli). Teaching involved conditionally relating the A stimuli to the B, C, and D stimuli in consecutive phases. There were three performance criterion conditions. In the first condition, during each conditional relation, there were blocks of 12 trials and the criterion was 100% during a single block of trials. In the second condition, trials were repeatedly administered until a participant responded correctly to 12 consecutive trials. Both of these conditions constituted "stringent" criterion conditions. The third condition was the less stringent condition and required a participant to respond correctly to six consecutive trials. Fienup and Brodsky evaluated the performance criteria by examining tests of symmetry and equivalence and found that only stringent criteria reliably produced inferences, regardless of whether the criterion was evaluated in blocks or consecutive trials.

Collectively and across different measures, the research suggests that college students learn more and retain the information longer when high levels of performance criteria are applied to skill acquisition. This has been found across fluency (Johnston & O'Neill, 1973) and percentage correct (e.g., Semb, 1974) measures of performance. This includes a broad array of outcomes, such as initial performance (Johnston & O'Neill, 1973; Semb, 1974), generalization (Semb, 1974), response maintenance (Semb, 1974), and inferences (Fienup & Brodsky, 2017).

Performance Criteria in Sports

The evaluation of skill acquisition is fundamental in behavioral analytic research in sports performance (see Chap. 47). Evidence-based practices in behavioral sport psychology began in the late 1960s and early 1970s with the implementations of reinforcement contingencies (Rushall & Pettinger, 1969), self-monitoring tactics (Rushall & Siedentop, 1972), and behavioral assessments (McKenzie & Rushall, 1974) in sport settings. Since then, the body of research on behavioral interventions within the athletic industry remains relatively small. The results of the research that exist suggest that behavior analytic procedures are beneficial in improving performance in a variety of different sports such as football, gymnastics, tennis, figure skating, soccer, and golf (Barker et al., 2020).

The interventions used in sport-related performances rarely implement singular components. Instead, several strategies or components are typically combined into a treatment package. As the body of research continues to grow, it is important to evaluate each individual component, and the performance criterion is an important one. Martin and Thomson (2011) outline several stages of mastery based on the instructional hierarchy model within behavioral sport psychology. Under this model, an individual begins at the acquisition phase, in which the target skill is learned and performed in response to key discriminative stimuli. As soon as an individual acquires the target skill, the next stage of mastery is focused on fluency. Speed and accuracy are essential during this stage (Binder, 1996; Martin & Thomson, 2011). That is, the individual performs complex behavioral chains so accurately and fluently that an observer may characterize the performance as effortless and automatic. The acquisition and fluency of an acquired skill under practice conditions must extend to more naturalistic settings during the maintenance stage of sports mastery. Target behaviors are under different discriminative stimuli that resemble game-like conditions. This eventually extends to the generalization and adaptation of the skill, in which the individual performs the target behaviors under completely novel conditions and is capable of responding to complex and changing situations.

The complex nature of mastery in sports performance suggests the need for precise criteria to address acquisition, fluency, maintenance, and generalization. Behavioral researchers who implement interventions for enhancing sports performance typically apply performance criteria in three forms, percentage of accurate responses, number of accurate responses in succession, and rate of accurate responses. However, it is worth to note that reports of performance criteria are often missing from the published studies that were reviewed.

Level-based performance criteria combined with a particular frequency of observations component were applied and reported in a variety of different behavioral interventions including behavioral coaching packages, goal setting, oral feedback, and public posting (Brobst & Ward, 2002; Stokes et al., 2010; Tai & Miltenberger, 2017; Ward & Carnes, 2002). The instructors all established a percentage of 90% or 100% acquisition criteria. The rationale for the particular level of performance criteria that was established varied between studies. Some instructors justified their level of performance criteria to be adequate based on precedents set by existing literature on the same sport and on their personal expertise of the sport (Brobst & Ward, 2002), while other instructors allowed their participants to establish their own personal performance criteria (Ward & Carnes, 2002).

Another dimension of performance criteria utilized in behavioral sports research is the number of correct consecutive responses. An intervention package called teaching with acoustic guidance (TAGTeach) was implemented with an adult novice golfer who learned a series of target skill sets that comprise the full golf swing (Fogel et al., 2010). Each skill set consisted of small component skills. During the intervention, the introduction of each component skill was contingent on the participant's emission of six independently correct responses to the previous skill in the chain. Assessment of maintenance responding was conducted following the sixth session of the intervention. The researchers also assessed for the generalization of skills to a different golf club. Similarly, a chaining-mastery procedure was implemented with little league baseball players (Simek & O'Brien, 1988). Each task of the chain had a predetermined criterion of a number of consecutive correct responses or a certain number of correct responses out of the total number of opportunities given.

Fluency criteria have also been applied to interventions within behavioral sports research. Pocock et al. (2010) targeted two roller skating skills by implementing a precision teaching methodology (Lindsley, 1971). Because precision teaching emphasizes fluent behavior, the researchers applied a criterion that targeted the rate of responding. The criterion was established based on the behaviors of a model exemplar who was not included in the study.

A limitation of performance criteria in behavioral sports research is that some movements are fluid and require precise body movements and positioning (e.g., gymnastics). A standard criterion that is typically used in say, academics may not be as viable with sports because near flawless performance (90–100% accuracy) may be difficult to achieve for even the most elite athletes. Establishing a performance criterion of 90% or 100% accuracy may also be problematic because participants have reported feeling emotionally distressed when their performance criteria were not achieved (Brobst & Ward, 2002). It is important to consider alternative means of signaling the termination of intervention, including the establishment of more modest levels of performance criteria dependent on the participant's skill levels or criterion that is based on a percentage of improvement from previous performances.

Performance Criteria in Organizational Behavior Management (OBM)

Organizational behavior management (OBM) is an approach that applies behavioral principles to increase the effectiveness and efficiency of workers in organizational settings within a wide range of disciplines such as government, industry, business, and human service. There is an emphasis on the implementation of practical interventions to change behavior. Like treatments in ABA research, OBM interventions have predetermined performance criteria to signal the termination of an experimental condition. Some widely used strategies in the human service sector include checklists, providing feedback, trainings or workshops, applying self-monitoring techniques, goal setting, and rewards (VanStelle et al., 2012). These strategies have the aim of improving the accuracy of treatment implementation (procedural integrity) and staff performance.

Many OBM studies related to human service published between 2010 and 2016 in JABA and BAP utilize a percentage of correct responses to signal the termination of an intervention or treatment (Gravina et al., 2018). The following studies applied an 80%, 90%, or 100% accuracy criterion across single or multiple sessions.

Casey and McWilliam (2011) implemented a checklist-based training procedure to help teachers and staff decrease student transition times within a classroom setting. The training was stopped if the staff members performed at least 80% of the checklist task most of the time for three consecutive sessions. In this study, the experimenters also conducted maintenance probes following the end of the training. Ditzian et al. (2015) also applied an 80% accuracy criterion for their feedback-based intervention to improve proper door closing of therapy rooms. The experimenters determined that 80% accuracy across two consecutive sessions was appropriate to stop the intervention. Graff and Karsten (2012) implemented an instructional package that included enhanced written instructions and written instructions with data sheet to increase the accuracy implementation of stimulus preference assessments for simulated consumers. The performance criterion was 90% accuracy across two consecutive sessions. The experimenters also conducted generalization probes with real consumers. Lambert et al. (2013) trained staff at a community residential facility to conduct trial-based functional analyses. In order for the training to conclude, the staff members were required to implement all trial types with 100% accuracy. Nabeyama and Sturmey (2010) also applied a 100% correct response to all target actions during a behavioral skills training program for staff. Additionally, the experimenters established an additional criterion for intervention enhancement if the staff members that included increased opportunities for training and rehearsing. The instructor also included modeling correct responses. These extra components were implemented if the staff members performed less than six target components correctly within the first two sessions of the intervention.

For interventions that target treatment fidelity, the research in OBM shows that a criterion of 80% or more is necessary before the training should be concluded. However, it is important to evaluate which percentage level is appropriate for different types of target skills. For example, interventions that target client safety should have a performance criterion of no less than 100% accuracy because client well-being and safety are at stake. In addition to the utilization of a percentage of accuracy for performance criterion, the number of sessions where performance is observed at a certain level is another aspect of the criterion. Typically, the number of observations range from one session to three consecutive sessions with an accurate performance at a certain percentage. Studies in OBM research also assess for response maintenance or generalization of the target skill across settings or people (Casey & McWilliam, 2011; Graff & Karsten, 2012; Nabeyama & Sturmey, 2010; Nigro-Bruzzi & Sturmey, 2010; Parsons et al., 2012). Response maintenance and generalization are crucial in the discussion of mastery.

A Model for Establishing Performance Criteria

A model for selecting performance criteria requires nuance and consideration of the learning context, educational goals, and type of learner. In some cases, the literature supports a specific model and in other cases, additional research is needed before clear, research-based suggestions can be made. When working with school-aged children in regular education settings, performance can be assessed using frequent curriculum-based assessments of fluency (e.g., reading, math, writing). Comparing an individual child's fluency to district or national norms should indicate to the teacher the child's current proficiency given the instruction and instructional modifications can be made as necessary (Cummings & Petscher, 2016). With college students, there is compelling evidence that performance criteria drive performance and, thus, performance criteria should be set as high as experts believe is necessary. In any given college class, this could involve setting performance criteria at a value such as 80% accuracy or 100% accuracy and providing additional instruction until the performance criterion is met.

Skill Acquisition for Learners with Disabilities

Much of ABA is conducted with young children with disabilities who require intensive, deliberate, and individualized instruction. At this point, there is too little research to suggest specific performance criteria guidelines with the exception that acquisition criteria should be set high (e.g., a high level of accuracy). Beyond establishing high levels of performance, the specific component of performance criteria should be individualized, just as the specific learning objectives are individualized. Indeed, this same approach has been argued for selecting other instructional components such as prompts (Seaver & Bourret, 2014; Cengher et al., 2016; Cengher et al., 2018; Schnell et al., 2020) and error correction procedures (Carroll et al., 2018). The impetus for individualized assessments is the fact that when comparing different instructional components, it is often the case the effects are idiosyncratic: no specific component that works best for all learners, but often there are components that are reliably better for a single learner. While the performance criterion data published thus far show consistency in terms of the need for high acquisition criteria (e.g., Richling et al., 2019), the research has been conducted with a narrow range of children and response types (e.g., tacts and sight words). A deeper understanding of learner characteristics and response characteristics will undoubtedly bring nuance to our understanding of how to tailor performance criteria. While we await such data, a framework for assessing learner-specific criteria is useful.

Determining Goals of Instruction

Prior to directly comparing performance criteria, one should begin by asking questions to help guide their own analysis. The first question is, "What are the goals of teaching?" Answers range from generalized responses that are not affected by context, teacher, or specific stimuli to durable responses that maintain over time after instruction has ceased. Answering this question sets up one's dependent variables. For example, if one is interested in promoting durable responses that maintain for at least a month, the appropriate dependent variable—or performance outcome variable from an analysis—to study. If one is interested in both response maintenance and generalization, then one should measure both.

Level of Performance for Specific Behaviors

After determining the desired effect of one's teaching, one should ask "What are acceptable levels of behavior?" There is not necessarily an agreed upon standard for what is an acceptable level of behavior and consensus may vary as a function of the skill being taught. For example, when teaching a child to tact colors, 100% performance may not be necessary; however, if teaching a child to look both ways before crossing a street, any performance level below 100% may be wholly unacceptable due to dangerous outcomes. Another manner of developing appropriate performance criteria is through social validation (Van Houten, 1979). In this approach, intervention targets are developed based on normative sample data or by observing competent individuals. For example, if one is trying to teach toy play to infants at risk for delayed motor development, social validation may involve defining what constitutes toy play for an infant and collecting data on the duration of toy play with several typically developing infants to derive an intervention goal for the infant you are working with. Social validation focuses on appropriate levels of behavior, rather than trying to fit behavior on a scale of percentage correct out of 10 opportunities.

An Experimental Approach to Establishing Individualized Performance Criteria (Approach 1 of 2)

Once a clinician has determined the goal and acceptable performance, she has a refined dependent variable—or outcomes variable. This is now the benchmark by which to compare the effects of different performance criteria. All that is left to do are some minor experimental preparations followed by a comparison of teaching responses to predetermined performance criteria and examining which produces the intended outcomes. To experimentally establish performance criteria, one must teach independent, but equally different targets. Cariveau et al. (2020) provide guidance on this process, but the basics are controlling for effort and difficulty. For instance, if your client is learning sight words, one would select two sets of sight words that are from the same grade level and have the same number of syllables and letters. By equating targets, one is in a better position to attribute the effects of the performance criteria to the criteria you implemented, and not that the sets of stimuli are simply more or less difficult. In the same vein, one should teach using the same procedures (e.g., using or not using error correction, prompt fading, etc.), regardless of performance criterion. After one sets up two or more conditions that should produce the same learning, they can assign one performance criterion to one set of stimuli and one to another set of stimuli and begin teaching. After the client's behavior meets the acquisition performance criterion, the therapist now tests for other relevant performances, such as response generalization and response maintenance. Performance of the behavior under different conditions (generalization) and after teaching has been terminated (maintenance) now serves as the indicator of which acquisition performance criterion produces the intended effects. If one acquisition performance criterion produces the intended effects, but the other does not, then the answer of which is more appropriate is clear. In the case where both performance criteria produce the intended effect, then the therapist should look back at the acquisition data and if one condition produced the quicker acquisition, then that should be the performance criterion moving forward. If both performance criteria fail to produce the intended generalization and maintenance effects, then the therapist should look to strengthen the performance criteria (higher level of performance, higher frequency component, across more instructors) or examine whether there are more effective teaching tactics.

A Naturalistic Approach to Establishing Performance Criteria (Approach 2 of 2)

Some therapists may not have the resources to conduct individualized evaluations. In this case, a more naturalistic evaluation is appropriate, although this comes with less confidence in the outcomes. In this case, the therapist should establish an acquisition criterion that appears reasonable based on the goals of instruction (e.g., 90–100% accuracy across two consecutive observations). Next, the therapist should establish acceptable generalization and maintenance performance criteria. From this point, the therapist simply teaches new behavior as she normally does until the acquisition criterion is met and then tests to see if the generalization and maintenance criteria are also met. If the generalization and maintenance criteria are met, this provides preliminary evidence that the acquisition criterion is sufficient to produce all of the intended effects of instruction. If the criteria are not met; however, the therapist should change the acquisition criterion in specific ways to produce better outcomes. For example, if the maintenance criterion is not met, consider a higher level of performance for the acquisition criterion and consider applying the criterion across a greater number of sessions or across multiple days (e.g., first-session of the day). If the generalization criterion is not met, consider adding a component that the acquisition criterion must be met across two or more instructors or two or more sets of stimuli (see Chap. 15).

Future Directions and Concluding Remarks

This chapter outlined some of the historical and contemporary treatments of performance criteria, highlighted related terminological issues, outlined a variety of areas of research utilizing performance criteria, and provided a potential model for selecting performance criteria for individual clinical use. As mentioned in the introduction of this chapter, many of the recommendations made here are speculative and constitute best practices based on scientific deduction and clinical recommendations. However, there is a need for further research evaluating performance criteria as independent variables which function in coordination with other training procedures and may directly impact response maintenance and other learning outcomes. Without a solid evidence base from which we can derive distinct rules regarding which performance criteria to use universally, we must be mindful to not fall victim to engaging in clinical lore practices. Instead, we can mitigate some of this risk by intentionally engaging in critical consideration of performance criteria on a case-by-case basis. In addition, we can supplement our confidence by engaging in individual assessment of the impact of specific performance criteria and directly measure-related learning outcomes using rigorous single-case designs (see Chap. 20) rather than adopting train-and-hope strategies.

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Evaluating Physical Activity Levels

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Introduction

Physical activity (PA) includes "body movements produced by skeletal muscles that result in energy expenditure" and may include light, moderate, and vigorous intensities; exercise is PA that is designed specifically to enhance health and physical fitness (p. c-3, Physical Activity Guidelines Advisory Committee [PAGAC], 2018). Engaging in moderate-to-vigorous physical activity (MVPA) is associated with weight loss and reduced risk of obesity in all age groups, as well as decreased risk of dementia, cancers, heart disease, and diabetes in adults, and improved attention and academic performance in children. Research also shows improved sleep and mental well-being as immediate effects of PA in adults. In addition, decreases in sedentary behavior (i.e., waking behavior such as sitting and lying), even if just to engage in light activity, also reduce mortality, type 2 diabetes, and certain types of cancer (PAGAC, 2018). There have also been calls for physicians to prescribe exercise and physical activity as medical treatment to treat muscular pain, anxiety, stress, and cardiovascular, metabolic, pulmonary, and neurological diseases (Pedersen & Saltin, 2015). The World Health Organization (WHO, 2018) estimates that physical inactivity can account for up to 3% of national health care costs, with total indirect and direct costs exceeding INT$ 68 billion per year.

The PAGAC report summarizes research on the specific types of PA that produces physical and mental health benefits and provides PA recommendations echoed by the Centers for Disease Control (CDC, 2020b) and is consistent with those of the World Health Organization (WHO, 2020a). School-aged children should engage in 60 min. of MVPA per day, including vigorous activity and bone- and muscle-strengthening activities three times per week. Adults should engage in 150–300 min of MVPA per week, or 75–150 min of vigorous PA, including 2 days a week of muscle strengthening. Adults older than 64 years should additionally include activities to improve balance. These recommendations should also be followed by children and adults with disabilities to the extent that they are able. It should be noted that although the recommendations target MVPA specifically, any PA over sedentary behavior is beneficial, and bouts of MVPA of any length are beneficial (PAGAC, 2018).

Minimizing the duration of inactivity and sitting may even be as important as meeting PA minimum guidelines. Engaging in long durations of this sedentary behavior (e.g., sitting at a computer, watching television) may attenuate the benefits of PA. Pandey et al. (2016) performed a meta-analysis

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_23

examining the relationship between sedentary time and cardiovascular disease risk and mortality. The nine studies included 720,425 participants and revealed a sedentary "dose-effect" relationship to cardiovascular risks. Those who were sedentary for at least a threshold of 10 h per day had higher risks that were not completely mitigated by the duration of PA levels. In a separate meta-analysis including 1,005,791 individuals, Ekelund et al. (2016) found that television viewing durations interacted with PA levels for all-cause mortality. Watching television for more than 5 h a day increased the risk of all-cause mortality in the most active individuals by 16% and in the least active individuals by 100%.

Many individuals would benefit from physical activity interventions, whether due to sedentary behavior, pre-existing medical conditions, or a failure to engage in recommended levels of PA. The WHO (2018) estimates that 23% of adults and 81% of adolescents fail to meet their global recommendations for physical activity. The prevalence of inactivity varies by global region, with the lowest levels of sedentary behavior in Southeast Asia, and the highest levels in Europe, North America, South America, the Eastern Mediterranean, and the Western Pacific Regions. In 2018, 54% of US adults engaged in minimum aerobic activity guidelines, with an increase of 0.9% per year since 2008. Though the increasing trend is encouraging, a quarter of US adults (25.4%) live sedentary lives, and most individuals (72%) do not engage in recommended muscle-strengthening exercises (CDC, 2019b). The WHO has set a goal to reduce the prevalence of physical activity by at least 10% by 2025, and 15% by 2030. However, the global pandemic in 2020 has likely interrupted progress in addressing physical inactivity globally due to social restrictions.

Closely associated with levels of physical activity is obesity. Obesity is typically defined by body mass index (BMI) calculations, see Eq. (23.1) (CDC, 2020a).

$$\mathrm{MI} = \mathrm{Weight}(\mathrm{kg}) / \left[\mathrm{Height}(\mathrm{m})\right]^2 \quad (23.1)$$

This equation is used for both adults and children. For adults, obesity is indicated by a BMI of 30 or more, and the category of overweight includes BMI ≥25 and < 30. Adult athletes may have high BMIs that do not indicate obesity due to a higher proportion of muscle than non-athletes. For children aged 2–19, BMI levels categorized as obese are dependent on age and gender norms; having a BMI in the 95th percentile for age and gender group would indicate obesity (CDC, 2020a). Globally, it is estimated that 13% of adults are obese, and 39% are overweight (WHO, 2020b). Rates of childhood overweight and obesity are lower, but are still alarming, with 18% of children aged 5–19 considered overweight, and 6% (girls) to 8% (boys) aged considered obese (WHO, 2020b). The United States has even higher rates of obesity in adults (<42%) and children (<18%) according to the CDC (2020a). Individuals with disabilities are experiencing even higher rates of obesity: 22% of children between 2 and 17 years with a disability are obese (CDC, 2010); whereas 30% of children with autism spectrum disorder (ASD) specifically are obese, which can be attributed (at least partially) to significantly lower levels of engagement in PA by children with ASD (Srinivasan et al., 2014). In addition, 36% of adults with a disability are obese (CDC, 2010). Impaired motor skills may account for the low levels of PA that are often observed among this population. Social and behavioral challenges may also limit the types of activities that are available or preferred, and a lack of adequate recreational and/or familial resources to support sustained PA has been commonly cited (Bremer et al., 2016; Hallett, 2019; Sorensen & Zarrett, 2014; Srinivasan et al., 2014).

Research in applied behavior analysis has focused on aerobic PA, which targets cardiovascular fitness. This chapter will review the behavioral literature on the direct and indirect measures of PA, assessments to determine environmental events associated with increased PA in children, and interventions to increase PA in typically developing adults and children, as well as those with developmental and intellectual disabilities.

Defining and Measuring Physical Activity

The PAGAC 2018 guidelines highlight the importance of distinguishing between light, moderate, and vigorous PA (LPA, MPA, and VPA, respectively). Examples of activities representative of MPA and VPA are based on absolute intensity (which does not consider the individual's cardiorespiratory fitness), including brisk walking as moderate physical activities (MPA), and running and playing soccer as vigorous physical activities (VPA). The guidelines also describe a subjective scale, based on self-perceived heart rate (HR) and breathing difficulty, that may be used to evaluate the relative intensity of activities, which do take into account an individual's cardiorespiratory fitness when assessing effort. However, some activities listed as MPA based on absolute intensity may be considered VPA depending on the individual's fitness and level of effort. Given that even adults underestimate the effort necessary to engage in MVPA (Canning et al., 2014), more precise and objective measures of PA have been used in the literature.

Screening Measures

It is important to make sure that individuals are healthy enough to engage in PA when they join research or treatment interventions. Researchers can require medical clearance or use validated screening tools. For adults, one common screening measure for typical adult populations is the Physical Activity Readiness Questionnaire (PAR-Q; Hafen & Hoeger, 1994). This questionnaire asks for self-reporting of diagnosed heart trouble, feeling chest pains, fainting and dizziness, high blood pressure, joint problems, and age. There is also a question about "other" reasons they should not engage in PA. Reporting any conditions that indicate a higher risk for adverse outcomes requires that medical clearance be obtained to participate. For added safety, screening patients with the Health Status Questionnaire (HSQ; Radosevich et al., 1994) for cardiovascular risk may also be advisable. For older populations, or sustained high-intensity physical activity, the requirement of medical clearance minimizes risk. Such screening measures are less frequently used with children, although some studies have utilized a modified version of the PAR-Q (e.g., Van Camp et al., 2021)

Pedometers

Mechanical devices, such as pedometers, accelerometers, and heart rate monitors, have been utilized as indirect measures of physical activity (Van Camp & Hayes, 2012). Pedometers are typically worn at the waist to measure steps using a pendulum mechanism. Steps are important dependent variables because walking is the safest and most common form of exercise, available to most individuals without the need for specialized exercise equipment or settings (PAGAC, 2018). Behavior studies have targeted day-long steps (steps per day; e.g., Kuhl et al., 2015; Donlin Washington et al., 2014) or steps taken during individual assessment or intervention sessions (often reported as steps per minute [SPM] and sometimes referred to as cadence; e.g., Hayes & Van Camp, 2015; Miller et al., 2018; Tudor-Locke et al., 2011b). It is recommended that adults take at least 10,000 steps per day (Tudor-Locke et al., 2011b). To achieve the recommended time engaged in MPA or VPA specifically, adults may consider measuring SPM, with 100 SPM indicative of MPA and 130 SPM indicative of VPA (O'Brien et al., 2018). In elementary school-aged children, 60 minutes of MVPA is achieved with 13,000–15,000 and 11,000–12,000 steps per day in boys and girls, respectively (Tudor-Locke et al., 2011a). In adolescents, the threshold is 10,000–11,700 steps per day regardless of gender. Specifically, 60–99 SPM is indicative of slow or medium walking (LPA), 100–119 SPM is indicative of brisk walking (MPA), and over 120 SPM is indicative of fast walking (VPA; Barreira et al., 2012; Migueles et al., 2020). These SPM thresholds may be useful in determining whether interventions are increasing MPA or VPA specifically; however, most pedometers do not have a time-stamped memory feature and thus do not allow for a fine-grained analysis of min-by-min steps.

Accelerometers

A recent increase in readily available and low-cost accelerometers to measure PA, such as the

Fitbit, has led to more refined research (see Coughlin & Stewart, 2016 for a review). Several variations have been used in behavioral research, from the first clip-on versions (e.g., Van Camp & Hayes, 2017) to wrist-based devices (e.g., Evans et al., 2017). The most common dependent variable remains steps, although newer models worn at the wrist also measure HR. A benefit of Fitbit is the memory feature, and accompanying website, from which min-by-min step data may be extracted via API researcher access (https://dev.fitbit.com/). For devices that record steps in short intervals like this, it is possible to measure and target specific patterns of movement. Though total daily step counts are useful targets for behavior, there are many different patterns of walking that could lead to equivalent step counts. For example, one might walk 7000 steps in a day by having one long "bout" of running with sedentary behavior the rest of the day, or by having low-intensity levels of movement dispersed throughout the day. Employing measurement that more specifically characterizes patterns in movement can help with balancing the PA recommendations for MVPA and minimizing sedentary behavior. Donlin Washington and colleagues (2014) describe the use of a bout-analysis to characterize the rate of initiation, within-bout responding, and the duration of pauses between bouts of walking. For each minute of the day, they calculated average interresponse times for each step. Additionally, they examined how many minutes per day included steps, the average duration of temporally adjacent intervals that contained steps, and the duration of temporally adjacent intervals that contained no steps (pauses). With a slightly different approach, Tudor-Locke et al. (2011b) characterized cadence, or SPM, walked throughout the day for 3744 healthy adults. They found that on average, adults only spend about 7 min moving at a pace that would at least be considered moderate physical activity (100+ steps per minute). These two approaches can be used to target specific patterns of movement that could be tailored to individual treatment plans. Some individuals may need to increase minutes of MVPA, which would require engaging in more minutes per day with a cadence of at least 100 steps per minute. Other individuals may need to reduce the duration of sedentary behavior, so treatment could address reducing the number of consecutive minutes with no steps. These approaches could inform the gradual shaping of treatment goals by avoiding unattainable or aversive targets, minimizing treatment disengagement.

Heart Rate Monitors

Although activity intensity may be estimated via SPM, beneficial physiological change cannot be assessed directly via pedometers. Energy expenditure from PA may be estimated by measuring HR (Armstrong & Welsman, 2006), using chest-strap monitors that transmit HR data in beats per minute (BPM) to a watch, computer, or phone (e.g., Polar HR monitors). HR may be affected by transient factors (e.g. an individual's emotional state, state of hydration) and climatic conditions (e.g., temperature and humidity; Armstrong, 1998), as well as genetic factors, such as gender, sex, and race (Sarzynski et al., 2013); however, these influences on HR are of much lower magnitude compared to changes associated with PA (Epstein et al., 2001), and in particular they are less likely to affect HR at moderate or vigorous levels (Armstrong 1998). A benefit of HR is that it is sensitive, capable of identifying small changes in activity (Sirard & Pate, 2001), and can detect changes from sedentary to light PA (Van Camp et al., 2021).

HR may also be used to determine the percentage of a session or a day in which an individual's HR reaches MPA or VPA thresholds. The CDC (2020) suggests that the target HR indicative of MPA and VPA is 65% and 76% of maximum HR based on age-based formulas (e.g., Tanaka et al., 2001). However, studies comparing expected HR to actual HR during exercise tests have found significant discrepancies, especially in children (Nikolaidis, 2014). Behavioral assessments of HR while children are engaged in behaviors typically considered LPA, MPA, and VPA have also found significant individual differences in the HRs (Larson et al., 2011; Van

Camp & Berth, 2018; Van Camp et al., 2021, 2022). This variability may be due to individual fitness levels, which are known to affect HR (Piercy et al., 2018); as such, fixed HR thresholds intended to indicate MPA and VPA may not be appropriate for all individuals. Researchers have recommended that formulas be abandoned in favor of individualized evaluations of exercise effort (Arena et al., 2016).

To date, three behavioral studies have evaluated an individualized HR assessment (IHRA) to identify MPA and VPA HR zones in children (Eckard et al., 2019; Van Camp et al., 2021, 2022). The IHRA consisted of participants engaging in different behaviors representative of four levels of activity: being still (sedentary), walking slowly (light PA), walking briskly (MPA), and jogging (VPA; Van Camp et al., 2021, 2022). HR measures were recorded every second, and each activity continued for 2 min. HR typically stabilized within-session during the last 30 s, and average HRs were consistent across repeated sessions. HR levels were differentiated within participants across activities, with running producing the highest average HRs followed by walking briskly, walking slowly, and sitting. However, absolute HRs were variable across participants, and when compared to standardized criteria, not all activities generated HRs within expected ranges (Van Camp et al., 2021, 2022). These individual differences are consistent with research that measured HR while children engaged in specified activities (Eckard et al., 2019; Larson et al., 2011; Van Camp et al., 2018), and with the CDC guidelines that indicate relative and absolute intensity may differ, as only the former accounts for fitness level. Genetic factors (e.g., sex, race, and maturation) also may have contributed to the individual differences, providing justification for conducting IHRAs rather than using standard criteria. These results suggest that even when engaged in behaviorally similar activities there exist individual differences in the physiological effects of those activities (i.e., HR), which may be due to differential exertion levels and physical fitness. Thus, when using HR as a measure of MPA or VPA, it may be prudent to use individual HR assessments.

Direct Observation

Direct observations of PA can produce quantitative and qualitative data. Although some studies focus on large muscle movement (e.g., Fogel et al., 2010; Shayne et al., 2012), most use the Observational System for Recording Activity in Children Preschool (OSRAC-P, Brown et al., 2006), which is based on the Children's Activity Rating Scales (CARS; Puhl et al., 1990). The OSRAC is used to code the topography of PA, as well as detailed indoor and outdoor social and nonsocial contextual information; however, the activity levels are used most often. Both OSRAC and CARS utilize a five-level system to code the intensity of PA: level 1, stationary-no-movement (e.g., standing, sitting); level 2, stationary with limb or trunk movement (e.g., holding a moderately heavy object, hanging off of bars); level 3, slow-easy movement (e.g., slow and easy cycling, walking); level 4, moderate movement (e.g., walking uphill, climbing on monkey bars); and level 5, fast movements (e.g., running, translocation across monkey bars with hands while hanging). The original OSRAC studies utilized momentary time sampling for recording behaviors at each of the five levels, but recent research has codes every second from videotapes and has combined levels 4 and 5 as the primary measure of MVPA (e.g., Larson et al., 2013; Zerger et al., 2016).

Reliability and Validity

An important consideration with both observational and mechanical measures of PA is assessments of reliability and validity. Studies utilizing the OSRAC measured reliability by having two observers simultaneously but independently observe the same session, and comparing their data (e.g., Larson et al., 2013). Some report that reliability is better when data are collected only on the presence or absence of MPVA (levels 4 and 5 combined; Hustyi et al., 2011); however, this precludes one from evaluating changes from sedentary to LPA, and it does not allow one to separate MPA from VPA.

The validity of the OSRAC activity levels has been assessed by evaluating whether HR covaries with activities at each of the five levels. In one study, children walked on a treadmill at various speeds and inclines (Puhl et al., 1990), and in two others, children engaged in example activities listed on the OSRAC (Larson et al., 2011; Van Camp & Berth, 2018). In the original CARS study (Puhl et al., 1990), observation codes (levels 1 through 5) were calibrated by having 25 preschool children engage in activities (controlled walking indoors on a treadmill at various speeds and inclines) while HR was measured. On average, the children's HRs did reach the expected ranges for each of the five activity levels: level 1, below 100 BPM; level 2, 100–119 BPM; level 3, 120–139 BPM; level 4, 140–160 BPM; and level 5 > 160 BPM. However, treadmill activities were more structured than those typically evaluated by the OSRAC (e.g., playing outdoors). When assessed under naturalistic conditions (i.e., while children are playing outside on a playground), activities listed in the OSRAC may not result in expected HR ranges, and individual differences are common (Larson et al., 2011; Van Camp & Berth, 2018). Both studies instructed typically developing children to engage in activities across the five levels while measuring HR and steps. Larson et al. evaluated one bipedal activity per levels 2 through 5 (e.g., walking, jogging; 2011), and Van Camp and Berth (2018) included similar bipedal activities, plus additional activities (e.g., swinging on monkey bars, biking). HR systematically increased across each intensity; however, there were individual differences in HRs associated with each activity, and in some cases, the HRs measured did not match the expected HRs for those activities. For example, level 4 activities led to HRs within levels 3, 4, and 5 ranges across participants, suggesting that despite engaging in similar behaviors, HRs reflected light, moderate, and vigorous levels depending on the individual (Van Camp & Berth, 2018). Though certain behaviors may topographically meet the definition of MVPA, HRs may not meet MVPA levels unless sustained for 30 or 60 seconds. Studies evaluating HRs during activities such as walking briskly and jogging may not reach MVPA levels until 60 s (Eckard et al., 2019; Van Camp et al., 2021, 2022).

The reliability of PA measures recorded via pedometers and accelerometers has been assessed primarily by evaluating interobserver agreement on the number of steps displayed on the device (e.g., Nieto & Wiskow, 2020; Zerger et al., 2017). Devices may be selected based on validity assessments in previous research (e.g., pedometers used in Larson et al., 2011), or be verified by a step test, in which a researcher takes a certain number of steps to verify that the devices register the correct number of steps (e.g., a 50-step test in Kuhl et al., 2015). However, few studies do assess reliability during the course of the study (inter-device reliability). This may be assessed by having an individual wear two devices simultaneously while engaged in PA (e.g., Hayes & Van Camp, 2015; Van Camp & Berth, 2018; Van Camp & Hayes, 2017). Depending on the specific activity, pedometers and accelerometers are not reliable (Van Camp & Berth, 2018). Validity has also been assessed by comparing steps to HR (e.g., Larson et al., 2011; Van Camp & Berth, 2018). Although in general steps and HR covary, discrepancies exist when no steps occur. For example, when children play on monkey bars, HRs increase but neither pedometers nor accelerometers reliably register steps.

When individuals use fixed equipment or bikes (i.e., activities other than those involving walking, jogging, running, or jumping), it is important to determine whether the devices measure steps in the situations specific to that study, even if the devices have been shown reliable and valid in other research. In addition, new Fitbits worn at the wrist can detect HR; however, it is not clear if they are as reliable and valid as chest-based measures of HR. An assessment of inter-device reliability may not assure the validity of the devices, but it may at least identify instances when low reliability deems the devices invalid. Finally, few studies have utilized multiple measures of PA during interventions (for a notable exception, see Hustyi et al. (2011), who measured both SPM and observed OSRAC levels). Given the limitations of certain measures as noted above, future research is needed to verify if PA measured in assessments and interventions are similar regardless of the measure used.

Assessment of Physical Activity in Children

Behavioral assessment of PA is aimed at identifying variables in the environment that maintain PA at differential rates. The behavior-analytic literature appears to categorize the variables relevant to PA into two contexts—environmental and social. Environmental variables include stimuli that are part of the physical environment (e.g., Brown et al., 2009; Hustyi et al., 2012; Van Camp & Hayes, 2017), whereas social variables are those mediated by another person, such as peer or adult attention (e.g., Gonzales et al., 2020; Larson et al., 2013; Larson et al., 2014a, b; Zerger et al., 2016). Behavioral assessment is critical for developing effective behavioral interventions for increasing PA. Two commonly reported methods of PA assessment, descriptive assessment, and functional/reinforcer analysis have been evaluated with children.

Descriptive Assessments

Descriptive assessments are correlational in nature, yet they are the most commonly reported method of assessment for PA. Brown et al. (2009) developed the OSRAC-P for coding five levels of PA, ranging from sedentary to vigorous movements, in various indoor and outdoor contexts under natural conditions. In general, they identified outdoor toys and open spaces to be associated with higher levels of MVPA. Subsequent studies also identified outdoor physical contexts associated with increased levels of PA. For example, Hustyi et al. (2012) used the OSRAC for coding children's PA in three different outdoor contexts and a control condition. Specifically, they observed and recorded children's PA during 5 min sessions of outdoor play, fixed equipment, open space, and control. Fixed equipment was associated with the highest levels of MVPA (≈ 20% MVPA) compared to the other three conditions (e.g., ≈6% in open space). Becerra et al. (2020) used similar procedures to evaluate PA in three children with ASD, with the exception of an added condition to evaluate MVPA in an indoor context with toys. All children engaged in the highest levels of MVPA in the indoor toys context (≈ 70% as coded by OSRAC levels 4 and 5). The empty field condition was associated with the lowest levels of MVPA for two children (≈22.5%), whereas the outdoor toys condition was associated with the lowest levels of MVPA for the third child (42%). Van Camp and Hayes (2017) used Fitbits to evaluate children's PA during recess while engaging in one of three patterns including free play only, structured activity (soccer or tag) followed by free play, or free play followed by a structured activity. Each PA session started with 5 min of laps during which children could walk or jog around the playground. The initial period of laps was associated with the highest levels of MVPA (as measured by a 100 SPM criterion), and similarly, lower levels of MVPA were associated with structured and free-play activities; however, the structured soccer activity was most consistently correlated with more SPM than the other activities. Similarly, Eckard et al. (2019) found differences in HR across biking, exergame boxing, elliptical, and basketball activities.

Social contexts have also been identified as relevant to PA using descriptive assessments. For example, in a systematic replication of Hustyi et al. (2012), Larson et al. (2014a) also found that fixed equipment produced differentially high levels of MVPA (≈35%), particularly when one or more peers were present (≈40%). In a more recent study, Gonzales et al. (2020) evaluated peer presence as a contextual variable during functional analyses of MVPA in preschool children. The presence of peers and/or peer interaction was not contingent on engagement in MVPA; peers were free to engage with the children during any condition in which a peer was present. The results of this study generally indicated that having a peer present produced relatively higher levels of MVPA than in their absence, especially during the interactive play condition (≈54% with and 28% without peers, respectively). To note, however, lower levels of MVPA were observed during conditions in which no adult was present, even in the presence of peers. Thus, peer presence may not be sufficient alone for promoting higher levels of PA. Nonetheless, the research tends to suggest that social variables, such as peer presence, may improve PA under natural conditions. Taken together, these findings suggest that peer presence is an important variable, but that individual differences may be observed for the physical contexts that promote MVPA across children. Thus far, descriptive assessments have been conducted with young children in school or day-care settings; thus, additional research is needed to assess variables associated with PA in older children. Overall, descriptive assessments are useful for quickly developing hypotheses about environmental variables that can be arranged to promote PA; however, because they are purely correlational, the primary limitation of this method is the lack of experimental control over PA.

Functional/Reinforcer Assessments

Recent studies have evaluated methods to identify reinforcers for PA, utilizing functional analysis methods (e.g., Larson et al., 2013, 2014b; Zerger et al., 2016). For example, following a naturalistic (no reinforcement) baseline, Larson et al. (2013) exposed children to interactive play, attention, escape (academic demands), alone, and control conditions in a multielement design. In the test conditions, putative reinforcers were delivered contingent on initiation of MVPA, described to children as "running, skipping, and jumping," and continued so long as the children's engagement in MVPA was maintained (as coded by OSRAC levels 4 and 5); that is, if children engaged in at least 1 s of MVPA, researchers then delivered the putative reinforcer and continued to do so every 10 s as long as the child continued to engage in MVPA. In the control condition, children were prompted to sit with the researchers, noncontingent attention was delivered every 30 s, and no programmed consequences occurred for MVPA. In the alone condition, children were prompted to play as usual and no attention (contingent or noncontingent) was provided. All conditions were conducted in an outdoor context. Differentially high levels of MVPA were observed in the attention (≈31%) and interactive play conditions (≈36%) compared to the alone condition (≈5%). Larson et al. (2014b) replicated and extended this study and observed the highest rates of MVPA in the interactive play condition, with differentially elevated rates also observed in the attention condition for two children. Zerger et al. (2016) also found that attention and interactive play produced the highest rates of MVPA. Taken together, these studies suggest that PA can be increased with social positive reinforcement contingencies, particularly adult attention. However, these findings are based on short sessions (5 min) with preschool children, and it is unclear if the levels of MVPA observed were sufficient to produce health benefits.

Functional analyses yield empirical demonstrations of functional relations between context (i.e., environmental and social) and PA. The few studies conducting functional analyses of PA used the Iwata et al. (1994) arrangement, including test conditions (e.g., attention; see also Jessel, Chap. 26, in this book). However, in the case of PA, these procedures might be more aptly described as reinforcer assessments when there is no known history of social reinforcement (Lambert & Houchins-Juárez, 2020), which is likely to be the case for PA among sedentary individuals. Unlike with problem behavior, it is likely that some level of PA maintained by automatic reinforcement may occur (albeit at low levels in some individuals). Identifying other reinforcers that may increase PA beyond levels maintained by automatic reinforcement could prove beneficial. Broader reinforcer assessments may also introduce other antecedent and consequent arrangements, as well as focus on relevant baseline and control conditions. For example, no-reinforcement baselines should be similar to alone or no interaction conditions. Control conditions should provide noncontingent access to the putative reinforcers while not inadvertently suppressing PA by setting up sedentary activities not present in the test conditions.

Most PA research using either descriptive assessment or functional/reinforcer analysis tends to rely on the use of the OSRAC (a notable exception includes Van Camp & Hayes, 2017). Although primarily conducted with child populations, these methods show promise in informing interventions (e.g., Larson et al., 2014b). These methods may also be amenable to other dependent variables, such as HR or steps, and additional populations. For example, Peña (2018) conducted functional analyses with individuals diagnosed with autism spectrum disorder and found that MVPA varied within and across children, and across experimental conditions. In addition, Pincus et al. (2019) replicated the methods of Hustyi et al. (2012) with three adolescents with disabilities including conditions for gross motor toys, exergaming (fixed activity), open space, and control. They found that exergaming produced the highest levels of MVPA for all participants and was most preferred by two participants. Taken together, these findings suggest that different variables might be relevant for maintaining PA across different populations.

Interventions with Children

Children spend a large proportion of their day in school, making recess and physical education classes important opportunities to engage in PA. However, many children do not engage in sufficient MVPA during school-based physical education (PE) classes (Hollis et al., 2017), and although there has been a rise in interventions to increase MVPA during recess in the last decade (Parrish et al., 2020), many involve multiple components and infrequent evaluation of individual effects. Research conducted by behavior analysts has targeted general PA, as well as MVPA, during both individualized and group-based interventions, during PE, recess, afterschool programs, and day-long evaluations.

Exergaming

One area of research has evaluated the effects of exergaming, which uses video game technology that requires exercise-related movements, during school PE and recess (Fogel et al., 2010). Four 5th-grade children, who were considered inactive by the PE teacher, were exposed to two conditions. In the regular PE condition, the teacher led the class by providing instructions and opportunities for the children to perform a skill. In the exergaming condition, children alternated between 10 different games (such as Dance Dance Revolution). Physical activity, defined as moving large muscle groups, was higher during exergaming, and notably, exergaming provided much more opportunity to engage in PA as less time was spent on listening to instructions and waiting to take a turn. A similar evaluation was conducted with four 3rd-grade boys who were active and not overweight, and who had already been exposed to similar games (Shayne et al., 2012). Definitions of PA and the two conditions were the same, and the results were similar in that more opportunities to engage in PA, and more PA, were observed during exergaming. The assessment of PA also identified the types of exergames that engender the most PA. The extent to which the PA observed was light, moderate, or vigorous was not assessed in these two studies, however. Although not conducted during PE, one study has evaluated HR during exergaming (Eckard et al., 2019) in three children during an afterschool program. The children engaged in a boxing game that varied across two difficulty levels, while wearing a chest-based HR monitor. All demonstrated increases in HR compared to being still, and heart rates were consistently at or above their individualized moderate heart rate zones, averaging 135–155 BPM. As a whole, behavioral studies on exergaming have demonstrated an increase in PA compared to typical PE classes, and compared to sitting still, although it would be important to evaluate the effects of specific games. In addition, even higher levels of PA may be observed during exergaming if reinforcement for engaging in PA was available.

Self-Management and Contingent Rewards.

The effects of contingent rewards have been evaluated in studies focusing on self-management-based approaches to increasing PA. Hustyi and colleagues (2011) measured PA in two 4-year-old children whose weight classified them as obese. Observers coded activity levels using the OSRAC-preschool version, using momentary time sampling (5-second observation and 25-second recording) and all five activity levels. Data on steps were also collected via pedometers. Data were collected during 20 min unstructured outdoor recess sessions, which included access to outdoor playground equipment. The pedometers were masked, and no programmed consequences were delivered at baseline. During the intervention, the children were given a step goal and were prompted to check the pedometers halfway through and at the end of recess. If they made their goals, they earned a prize from a box, which included items identified by the teacher (such as stickers and buttons). Modest increases in steps and OSRAC-measured PA were observed for only one child. It was not clear if the children attended the pedometer, and given no preference assessment was conducted, it is possible the rewards were not reinforcing. A similar study evaluated self-management and reinforcement during school recess in a group of six 3rd-grade children (Hayes & Van Camp, 2015). Physical activity was measured by steps recorded on Fitbits, which were masked during baseline. During the intervention, the Fitbits were unmasked, daily step goals were given to everyone on a slip of paper, and they were given a tangible for meeting the goal immediately at the end of recess. Tangibles were selected based on multiple stimuli without replacement preference assessment and consisted of small toys valued at $3 or less. Overall, the children took 47% more steps during the intervention, including four who took over 100 SPM, indicative of engaging in MVPA. On average, the percentage of recess time engaged in MVPA was 4% and 13% in the baseline phases, and 25% during the intervention. In this study, the children were engaged in recess simultaneously, but consequences were delivered to individuals. The use of Fitbits allowed for easy data collection, making it possible to assess all 6 children at once; however, consequences were delivered only at the end of the 20 min session, and not for engaging in MVPA behavior at the moment.

One way to deliver tangible reinforcement contingent on real-time instances of MVPA is to provide tokens. The effects of token reinforcement were evaluated in one study, during which the PA of four preschool children was assessed via the OSRAC-preschool version using a 1-second partial interval recording (Zerger et al., 2017). OSRAC levels 4 and 5 were combined as a measure of MVPA, and 5 min sessions were conducted with individual children on the school playground, which contained fixed equipment, open areas, and outdoor toys. During baseline, the experimenter remained out of sight, and there were no programmed consequences for engaging in MVPA. In the contingent token phase, children were told if they engaged in MVPA (running, skipping, and jumping), they would receive a token. The experimenter placed a token for each instance of MVPA (and every 10 s if MVPA continued to occur in any given bout) on a token board in sight of the participant, so as to not disrupt ongoing PA. At the end of the session, the children exchanged their tokens for prizes, which increased in presumed value based on the number of tokens required. Prizes were selected by parents and children from a checklist of small tangibles. In the noncontingent token phase, tokens were delivered on a yoked schedule based on previous contingent token sessions such that they received the same number of tokens, and at the same time, in both conditions. The results showed systematic increases in MVPA for two of four children during the contingent token condition, compared to baseline and noncontingent token conditions. Bout durations, defined as consecutive 1-sec intervals with MVPA, were slightly longer in the contingent token condition, but only by one or two seconds. Although tangibles were selected with the children's input, no formal preference assessments were conducted, which may have contributed to the lack of effectiveness for half of the participants. As with the earlier reviewed studies, the interventions were implemented by researchers, not teachers. The use of direct observation may limit a teacher's ability to conduct such evaluations, as typically children would be engaged in PE or recess as a group; however, the use of pedometers or Fitbits may allow for more group-based evaluations that require little additional time to collect data.

Group Contingencies

The effects of group contingencies on PA during PE and recess include modified versions of the Good Behavior Game (Barrish et al., 1969; see also Joslyn, Chap. 47, in this book), which typically involves an interdependent group contingency wherein children are divided into two or more teams, the behavior expected and rewards to be earned are clearly explained, and either the winning team, or any team that meets the stated goal, earns the reward. Jung et al. (2005) evaluated a group contingency during PE, during which children on teams could earn and lose points contingent on correct and incorrect classroom behavior, such as being punctual and engaging in the activity as instructed (e.g., playing ball or engaging in the gymnastics lesson). Each team could earn the reward (computer access during lunch time) contingent on earning sufficient points. Although not directly the focus of the intervention, motor activity increased during the intervention.

More formal evaluations of group contingencies have focused on objective measures of PA during the "Step it UP" game (Galbraith & Normand, 2017; Nieto & Wiskow, 2020; Normand & Burji, 2020). In the first study, PA was defined as steps taken measured via pedometers for 20 students from a third-grade class during outdoor recess, at which time children had access to open spaces and fixed equipment for 12–15 min (Galbraith & Normand, 2017). During baseline, children wore the pedometers but there were no programmed consequences for PA. During the intervention (the Step it UP game), members of the winning team (the one that on average achieved the most steps) won a "step it up champ" badge exchangeable for a lottery ticket in a school-wide lottery (which provided access to small tangibles such as stickers and crayons). The rules of the game were explained prior to each intervention session, and again during reminders every 3 min, and group members were identified by wearing colored belts. On average, both teams took more steps during the game compared to baseline, although the increases were modest (78 steps/min in baseline compared to 89 steps/min during the game). Fourteen of 20 individual participants showed an increase in steps during the game, and the game was rated as acceptable and effective by the teachers. Normand and Burji (2020) replicated and extended this study by evaluating the "Step It UP" game during an unstructured PE class in a group of 18 third-graders. Again, steps were measured via pedometers which were unmasked throughout the study, and children were divided into two groups identified by colored belts (in this case, based on baseline step data to ensure an equal distribution of high and low step-takers). During the game, the winning team earned the "step it up" badge, which, in this case, was not exchangeable for lottery tickets or tangibles. Again, only a modest (10 steps/min) increase was observed during the game, with 14 of 18 participants taking more steps during the 30–40 min PE class. Teachers agreed the game was effective, feasible, and they were willing to implement the game themselves. In addition, the majority of the children voted to play the game when given the choice. Finally, one study compared the effects of the "Step It UP" game with and without contingent adult interaction on the PA (steps measured via masked pedometers) in a group of 23 third-grade students during recess (Nieto & Wiskow, 2020). During the no-game condition, children engaged in typical recess activities for approximately 17 min on a playground with fixed equipment without programmed consequences or interaction from the researchers. Children were then divided into two teams (based on baseline step counts). During the game-only condition, the team with the highest step count received a small tangible prize (which had been selected by the teacher) within 10 min of the end of recess.

During the game plus interaction condition, researchers interacted with the children contingent on MVPA (defined as running, jump roping, etc.), by providing praise and engaging in similar activities as the children. Because there were up to 23 children on the playground simultaneously, this was accomplished by the researcher scanning the playground on a fixed time 30 s schedule and joining in the same activity as at least one child who was engaged in MVPA. After several intervention sessions, the researchers noted that children often stood still while waiting for their turn during various games; thus, they added pre-session reminders that while waiting they could still engage in PA by doing jumping jacks, jogging in place, etc. On average, the game plus contingent attention condition (after reminders were added) resulted in the highest number of steps (90–92 steps/min) compared to the game alone (85 steps/min) and the no game condition (80–85 steps/min). On an individual basis, 19 children showed the highest number of steps in the game plus attention condition, although only 7 averaged the 100 steps or more per minute indicative of MVPA. Children reported preferring the game plus attention condition; however, steps were no higher than baseline in a follow-up game plus attention session. The addition of reminders suggests that it may be important to instruct children on how they can increase PA (see also Eckard et al., 2019). In these Step It UP studies, teacher-selected tangibles, tokens, or badges were used, which may not have served as reinforcers for all children. Given the inconsistent effects on individuals, more research may be needed to identify effective reinforcers. In addition, only modest increases in steps have been observed, suggesting additional research is needed to increase PA to meet the CDC guidelines. Finally, more research is needed to evaluate teacher-lead interventions during the school-based intervention, as researchers conducted these interventions.

One study evaluated an interdependent group contingency-based intervention as part of class-wide function-related intervention teams (CW-FIT), similar to the Good Behavior Game. Twenty-two 2nd-grade children participated, and the teacher led the intervention while researchers served as the observers (Hirsch et al., 2016). The dependent variable was small group engagement, which included appropriately engaging in sports activity and waiting appropriately. The teacher separated the children into four teams, and in the CW-FIT condition, they explained rules, scanned the room every 2 min and delivered specific praise and points contingent on appropriate behavior, and rewarded teams that meant point goal by providing nontangible rewards selected based on a student preference survey, such as dance parties and peer interactions. This condition was compared to standard PE, which did not include programmed praise or points. On average, higher appropriate engagement was observed during CW-FIT, and teachers reported being somewhat satisfied with the intervention, and children reported being very satisfied. This preliminary study did not include all components of standard CW-FIT, and did not target PA per-say (i.e., waiting appropriately was included in the measure of appropriate behavior); however, as a teacher-lead intervention, this approach shows promise, especially as a package intervention that addresses several other classroom needs. Healy et al. (2017) provide a step-by-step guide that details each component of CW-FIT, but additional evaluations and component analyses are needed to ascertain the potential for improving PA during the school day.

Another school-based group intervention includes public posting, in addition to self-monitoring. Zerger et al. (2017) evaluated a class-wide intervention with 16 children, aged 9–12 years, during unstructured recess on the school playground. Steps were measured via pedometers, which were masked during baseline. Children were separated into pairs, based on baseline steps. During the intervention, children were encouraged to look at their step counts and those of their teammates and self-recorded steps at the end of recess. The researchers then showed the entire class a bar graph of the top 3 teams. No tangible or activity rewards were provided, just the public review. On average, increases in steps were observed during the intervention phases (99 and 94 SPM), which were compared to the baseline (67 and 59 SPM) in a reversal design. Eight (of 16) individuals' data demonstrated a consistent effect of intervention, and 12 took a sufficient number of steps to meet MVPA criteria (100 SPM) during the intervention. A follow-up study conducted a component analysis of a similar intervention with a group of 17 children, aged 5–8 years, during unstructured school recess (Miller et al., 2018). Children were separated into pairs and wore masked pedometers in baseline. In the first experiment, three conditions were compared. In the public posting-only condition, feedback was provided as public posting of the highest scoring teams and pedometers remained masked. In the public posting plus self-monitoring condition, pedometers were unmasked, and children self-recorded their step counts. Although the step data were variable, on average more steps were taken during the public posting-only condition (74.6 SPM) compared to the baseline (72.6 SPM), and a modest increase was observed when self-monitoring was added (86.3 SPM). The increase in steps during the combined intervention was replicated in a reversal design; however, although most individuals showed an increase during the intervention with the combined intervention, only four met the MVPA 100 SPM threshold. Experiment two was a replication of experiment 1 with added reinforcement. One condition included feedback with self-monitoring and goal setting, and the other condition was the same plus a reward. Raffle tickets, exchangeable for leisure items from a prize box, were delivered to each individual student meeting their step goal. Results showed increases in SPM with the added reinforcer, and 11 participants met the 100 SPM MVPA threshold during the final intervention phase that included reinforcement. In this study, feedback (in the form of public posting) alone did not increase steps, slight increase with self-monitoring were observed, and the highest increase was observed when reinforcement was added.

Researchers have also evaluated day-long PA with interventions conducted in school. Kuhl et al. (2015) measured steps via pedometers in thirty 3rd-grade children from two classrooms. Two interdependent group contingencies were evaluated (based on both individual and cumulative class goals). Teachers selected and presented five activities as possible rewards, and extra recess time was selected by the majority of children. Because the dependent variable was the total number of steps taken in a day, data on steps were recorded each following morning at the start of school, 4 days a week. During baseline, the pedometers were masked, the researchers recorded the steps, and no self-monitoring occurred. In the classroom cumulative total condition, the pedometers were unmasked allowing for self-monitoring, the criteria for reinforcement were based on the cumulative steps taken by the entire class over 4 days, and feedback was provided to the group via public posting of the total step count for each day. In the individual goals condition, pedometers were unmasked, individuals received praise for meeting their step goal daily, and the class earned extra recess if 80% of the participants met their daily goal each of the 4 days. During the feedback schedule thinning, goals and feedback went from daily, to every 2 days, to every 4 days. Recess was earned every week in both conditions, and generally, boys took more steps in all conditions compared to girls. Although baseline data were variable for the majority of individuals, making clear intervention effects difficult to ascertain, both interventions increased steps, with the highest number of steps seen in the individual goal condition (an increase of 4800–5000 steps per day). The results of this study highlight the importance of individual feedback, which was not available during the less effective group feedback condition. In addition, some decrease in effectiveness was observed as feedback was faded.

Another study evaluated the effects of incentives (study money exchangeable for gift cards at the end of the study) on day-long steps, which were also administered at school (Evans et al., 2017). Forty-two 6th-grade children from three classrooms wore Fitbits (wrist-based models) all day, and steps were recorded by researchers. In this study, a group design was used, wherein each class was assigned to one of three conditions. In the Fitbit plus goal and incentive condition, students were taught to self-monitor their steps, and both individual rewards ($1 per day in study money) and group rewards (bouncy house party for the class) were available contingent on meeting step goals based on engaging in the 60 min of MVPA per day. In addition, students competed against the teacher, with the losing team having to engage in an activity challenge selected by the winner (10 pushups for example). In the Fitbit-only condition, students were taught to self-monitor, but no goals or incentives were provided. In the control condition, students did not wear Fitbits, but this condition was included as weight at the beginning and end of the study was a secondary dependent variable. The results showed no group differences (notably no increase) in MVPA or steps from baseline to follow-up in the two Fitbit conditions, nor was there an effect on weight. The authors concluded that although the participants wore the Fitbits the majority of the day (adherence was 73–80%), they may require specific instructions on how to increase PA (e.g., Eckard et al., 2019).

Summary

All of the studies evaluating behavioral interventions for PA in children have been conducted at school (either during recess, PE, or day-long but reviewed at school). The results have been mixed, with some evidence that exergaming, contingent tangibles, and public posting have been effective for some participants. However, often increases are modest and do not frequently contribute significantly to the goal of engaging in 60 min of MVPA per day (although that limitation may be related to relatively short sessions). A common limitation reported by authors is that teacher- or parent-selected reinforcers (including those available in a "prize box") may not be reinforcing to all individuals; thus, it is important to conduct preference assessments with individuals if possible. It is also important that even if interventions are based on group contingencies, the effects on individuals still can be evaluated. The use of mechanical devices such as pedometers and Fitbits may aid in providing individual data without requiring additional personnel to conduct observations in such group evaluations. We may not expect these interventions to be effective for all individuals but focusing on individual data may allow one to determine the necessary and sufficient components of interventions on an individual basis. Indeed, many interventions involve several components, yet few component analyses have been conducted. Another potential area of research is the effects of choice, although a preliminary study suggests the choice of physical activities does not increase MVPA (Boga & Normand, 2017).

Interventions with Adults

Interventions with adults are often very different from interventions used with children. For one, adults are not typically in environments where they are required to spend time engaging in PA. Though workplaces sometimes have gyms or wellness programs that encourage PA, they are not typically compulsory (with some exceptions, e.g., in the military, law enforcement, firefighters, and professional athletes). Self-selection for participating in a PA treatment study may lead to individuals who are actively interested in becoming more physically active. Alternatively, individuals may contact PA treatments because of a medical diagnosis (e.g., cardiovascular disease, diabetes). Adults often engage in different topographies of physical activity. However, like child interventions, increasing the duration and intensity of physical activity is often the goal of the intervention. Functional analyses and assessments utilizing direct observation are rarely conducted in behavioral studies of adult PA; however, several studies have evaluated individuals' preferences for types of PA via self-report.

Physical activity norms vary according to some demographic variables like age, gender, geographic location, and socioeconomic status (CDC, 2019a). For example, the WHO (2020c) notes that cultural practices and low-income levels may limit the accessibility of PA to women internationally. Physical activity levels tend to decline with age, but the degree of change interacts with other demographic variables as well. Preference for the type of AP often varies according to these demographic variables as well. Kurti et al. (2015) surveyed rural adults in Florida and found that age, race, education status, and gender all affected self-reported barriers to engaging in PA, preferences for types of PA, and preferences for types of interventions to increase PA. For example, both males and females were likely to endorse walking or biking, but women were more likely than men to prefer dancing or aerobic exercise, whereas men were more likely than women to identify running and basketball as preferred activities. Childcare and monetary factors were more important to younger individuals compared to older individuals. Cadmus-Bertram et al. (2019) surveyed women in Wisconsin and found that inactive women reported having less use of community locations for PA (e.g., walking trails, gyms, and parks). Most women preferred a group-based intervention for PA and preferred walking or yoga as an activity. Several studies indicate that men prefer competitive PA more than women (e.g., Molanorouzi et al., 2015; van Uffelen et al. 2017) It is advisable to consider recent local demographic and cultural norms in PA engagement on the CDC, WHO, or other health organization websites. The Neighborhood Physical Activity Questionnaire (NPAQ, Giles-Corti et al., 2006) and the Neighborhood Environment Walkability Scale (NEWS, Saelens & Sallis, 2002) can be used to characterize the accessibility of physical activity opportunities geographically as well.

General Strategies

Adult PA programs may utilize several behavioral strategies, including goal setting, self-monitoring, feedback, competition, social cooperation, and consequence-based incentives. Though MVPA can certainly be reached in adults through several types of activities, the majority of behavioral research in adults has focused on taking steps (walking or running). This focus is likely due to the ease of both engaging in the activity and obtaining objective measurements of activity engagement using accelerometers (e.g., Fitbit, Actigraph). It is likely that approaches outlined to increase steps could generalize to other types of PA.

Tudor-Locke (2002), in a report to the President's Council on Physical Fitness and Sports, endorsed the use of pedometry to combat overweight and obesity problems, citing that lack of PA was a major contributor to the newly emerging epidemic. This paper is also the origin of the ubiquitous walking goal of 10,000 steps per day for healthy adults, though also endorsed tailored goal-setting and behaviorally oriented interventions to address problems with motivation to become physically active, stating "It is foolish to surmise that if we distributed enough pedometers to each household in the nation our work as physical activity promoters would be done (p. 4)". With rises in both obesity and pedometer and accelerometer use over the coming years, it is apparent that she was correct. Pedometers and accelerometers are tools for addressing PA rather than technology to treat motivational problems. Simply counting steps is not enough for all participants to meet MVPA recommendations (e.g., Normand, 2008; Van Wormer, 2004). Effective PA interventions for adults tend to use several strategies to maximize efficacy, including self-monitoring (e.g., Donaldson & Normand, 2009; Normand, 2008; Van Wormer, 2004) goal-setting, feedback, and prompts (e.g., Andrade et al., 2014; Donaldson & Normand, 2009; Donlin Washington et al., 2014, 2016; Green et al., 2016; Irons et al., 2013; Kurti & Dallery, 2013; Normand, 2008; Stedman-Falls & Dallery, 2020; Van Wormer, 2004) and consequence-based incentives (e.g., Andrade et al., 2014; Irons et al., 2013; Donlin Washington et al., 2014, 2016; Kurti & Dallery, 2013; Stedman-Falls & Dallery, 2020).

The simplest intervention to increase PA would be to train individuals to set goals, monitor, and graph their own behavior. Van Wormer (2004) monitored walking via a pedometer in three overweight adults during a baseline period. During the monitoring phase, a goal was set to the average of baseline steps per day, and individuals recorded their step counts on an excel sheet daily. All participants increased step counts during this phase, with the two participants with the lowest baseline averages able to more than double their step counts. Subsequent addition of e-counseling with praise and weekly goal setting did not further improve step counts. All three participants failed to maintain PA improvements at a 6-month follow-up. Normand (2008) sought to expand on Van Wormer's finding by creating a package of goal setting, self-monitoring, and feedback for four non-obese adults using an ABAB reversal design. During baseline, individuals wore covered pedometers for 1 week, and the average of those days was set as a goal for subsequent conditions. During the package-intervention phase, participants reported daily steps via email. The researcher responded via email by providing praise or encouragement. During a weekly in-person meeting, graphs, verbal descriptions of progress, and praise or encouragement were provided. Three of the four participants increased PA by at least 2500 steps per day. Both interventions would be considered inexpensive, as they required only the purchase of pedometers and minimal researcher intervention.

With technological advances, behavioral research incorporated new tools to collect data beyond the capability of pedometers: Heart rate monitors and accelerometers. Donaldson and Normand (2008) used a Polar heart rate monitor with 12-day memory to calculate calorie expenditure in five obese or overweight adults. Using a 22-week multiple-baseline across-participants design, they evaluated a package intervention of goal-setting, self-monitoring, and feedback. During baseline, participants wore the Polar monitor, but the output was blocked from view. During the intervention, the polar monitor displayed caloric output. Goals were set to be 10% higher than the average daily caloric expenditure during baseline. Participants reported daily expenditures via email and received feedback based on performance. Additionally, weekly in-person meetings were held to obtain data from the monitor, provide feedback and alter goals for the upcoming week. Two participants requested modifications to the study designs. One subject requested omitting daily feedback because it was "discouraging" when goals were not met. Another participant requested an alteration of goals depending on the daily schedule and availability of time to work out. Additionally, two participants dropped out at the onset of the baseline reversal because the polar monitor output would not be visible. All participants showed an increase in caloric output ranging from 10% to 54% during the intervention phases. However, the dropouts and study accommodations emphasize the need for interventions to be flexible to accommodate individual preferences and abilities.

One way to address setting individualized goals is to use percentile schedules. Galbicka (1994) describes how to implement this operant shaping strategy. The approach emphasizes an incremental change in behavior that adjusts with the most recent output of behavior. First, behavior is measured over time. For example, daily step counts may be measured over a week. Those counts are then rank ordered. One of the previous step counts is then set as the upcoming goal. The difficulty of meeting the goal can be balanced with the likelihood that the participant will meet the goal. If the median step count is set as a goal, it should be easy to meet, as the participant has already exceeded that goal about half of the time over the previous week. With each successive day, the "window" of ranked previous step counts shifts by 1 day as well. This should gradually increase the goals for individuals, always requiring them to exceed the steps taken on about half of the days in the previous week. Targeting a higher-ranked step count may be harder to attain but would likely lead to quicker increases in daily step counts. Galbicka recommends targeting around the 70th percentile over short periods of time to optimize behavioral gains. This would require individuals to perform better than they did on 70% of the previous week's days.

Accelerometers have become the more-frequently utilized technology to capture PA in more recent studies. Valbuena et al. (2015) examined the effectiveness of accessing the Fitbit website to address PA in seven overweight adults. Individuals wore a Fitbit during all waking hours throughout the study. During a baseline, the Fitbit display was covered, and individuals did not have access to the website. In the next phase, individuals could log into the Fitbit website to view step counts, track calories, BMI, weight, set goals, earn badges, and post in forums. In a final condition, access to the website was paired with coaching; the individuals received 80th percentile goals set from the last 10 days, got tailored feedback, and social support via videoconferencing. By the end of the website phase, six of the seven participants increased PA (4.6–199%). With the addition of the coach, gains rose to 44–256%. Participants reported liking the program and finding it easy to use.

Green et al. (2016) specifically targeted the reduction of sedentary behavior in three office workers, using tactics prompts, feedback, and goal setting. During the study, participants wore an Actigraph accelerometer on their legs. During the intervention phase, a watch that could vibrate to deliver tactile prompts was also worn. Sedentary behavior was defined as having fewer than 100 movements per minute. Bouts of sitting were calculated by adding together the consecutive minutes of sedentary behavior. After a baseline phase, participants were given information about minimizing the length of sedentary behavior, which led to small and transient effects on sedentary behavior. During a subsequent phase that included a tactile prompt, feedback, and goal setting, there were reductions in the sedentary bouts that lasted longer than 30 min (ranging from 33% to 44% decrease). Additionally, the average length of the sedentary bouts decreased by 4–12 min. Batchelder and Donlin Washington (2021) conducted a similar study, in which 16 university faculty and staff received interventions using prompts, feedback, goal-setting, and financial incentives. Individuals were randomized to receive goals and prompts, goals and monetary consequences, or goals, prompts, and monetary consequences. Goals were set to walk at least 400 steps within each work hour, for at least 7 out of the 8 h of the workday. In conditions with a prompt, participants received a text message reminding them to walk at least 400 steps at the beginning of each hour. In conditions with monetary consequences, participants earned $0.25 per hour in which 400 steps were taken which could escalate by $0.10 per hour each consecutive day in which goals were met. If goals were not met on consecutive days, the value was reset to $0.25. The most effective condition was prompts-only, with two out of the three participants in that condition meeting goals on three consecutive days. Incentives did not improve outcomes, though the amount of the reinforcer was likely low for the population.

Kurti and Dallery (2013) conducted two studies to increase PA in older, sedentary adults. In both studies, adults ≥50 years old, who reported less than 3 days of PA per week and averaged ≤6000 steps per day were given initial goals equal to the baseline average plus 1000 steps per day. Participants in both studies logged onto the researcher website, MOtiv8, to report step totals, and fill out activity logs, earning $1 per activity log in baseline and $0.50 per log during the intervention. The website displayed graphs of step counts. Subsequent goals used an 80th percentile schedule, requiring participants to exceed the 2nd highest step count over the last 5 days, or an increase of 1000 steps over the previous block's goals, whichever was higher. In study 1, six participants could earn money for meeting goals. If goals were between 2000 and 2999 steps, they could earn $2 a day, and the value incremented by a dollar for every 1000-step increase in range. A $3 bonus was awarded for moving to the next higher block of goals. The intervention lasted for 2 months, or when an individual averaged 10,000 steps for at least two consecutive blocks of days. All six participants increased stepping, from 80% to 256% improvement. As a group, they met 91% of their goals and earned between $56 and $102.50. These gains in PA were clinically significant but came with a cost to researchers; the Fitbits used were more expensive than the pedometers in previous studies (at least $100 each), and participants were earning more than a dollar a day on average. In study 2, the methods were repeated except that no money could be earned for meeting goals, but they could earn $0.50 per day for filling out an activity log. Five of the six participants in this study improved between 8.7% and 186%. They met 63.6% of their goals. Without financial incentives, not as many participants improved, and those who improved had generally smaller gains in PA.

Donlin Washington et al. (2014) studied the effects of an intermittent “prize bowl” intervention on physical activity in 15 healthy adults using an ABA reversal design. Throughout the study, participants could earn prize draws out of a “fishbowl,” which had a 50% probability of earning a prize. During the initial weeklong baseline, participants earned one prize draw per day for wearing a Fitbit and text-messaging their step count at the end of the day. Prizes during this phase were valued up to $5. During a one-week intervention period, participants were texted goals set to ~71st percentile (3rd highest day of the last 7) for the previous week. Prize draws were earned for meeting goals and were valued from $5 to $120 (with the probability of winning inversely proportional to the value of the prize). There was an effect of the intervention, with four subjects showing improvements in step count greater than 4300 steps per day, and another four subjects improving by around 2800 steps per day. The intervention cost about $1.80 per day per person, which was not much financial savings over the Kurti and Dallery (2013) study.

Two more recent studies have sought to further decrease the cost of financial incentive-based interventions by using “deposit contracts” or “commitment contracts” (Donlin Washington et al., 2016; Stedman-Falls & Dallery, 2020). These contracts require that a participant contribute at least part of the money to be used for reinforcing goal attainment. In Donlin Washington et al., 19 underactive adults were randomized to either a deposit-contract condition, in which they deposited $25 with the researcher to be used toward subsequent incentives, or to a non-deposit-contract condition. All participants could earn $1.50 a day for meeting goals during the intervention, and a bonus of $2.65 for meeting 3 consecutive goals, for a total of $50 during the phase. Goals were set to the 70th percentile over a week-long period. Both groups showed equivalent increases in PA, with the deposit group increasing step counts by about 49% and the non-deposit group increasing by about 45%. Similarly, the percentage of goals met were not different (70.9% vs. 77.7%, for deposit and non-deposit), and neither were earnings ($34.56 vs. $40.25 for deposit and non-deposit groups). Requiring participants to deposit half of the money delivered for meeting goals reduced the research cost from $1.81 per day per participant in the non-deposit group to only $0.48 per day per participant when some of what they were earning back was from their own deposit.

Stedman-Falls and Dallery (2020) further streamlined these interventions by examining whether in-person or a mobile-based delivery of a deposit contract treatment was equally effective with a within-subject reversal design. Twelve underactive adults wore Fitbits and uploaded data through the Fitbit app. During baseline, no goals nor consequences were programmed. They were then randomized to start either an in-person or mobile-based deposit-contract intervention. For the in-person phase, individuals visited a lab and deposited $10 in person. For the mobile phase, deposits were made through PayPal. For both conditions, reminders and goals were sent via text or phone message, and goals were set to 2000 steps higher than the initial baseline average and did not change. At the end of intervention conditions, performance graphs and feedback were delivered either in-person or via mobile messaging. Money earned was delivered either in-person or via PayPal refunds. Nine participants completed both types of intervention. The modality (face-to-face or mobile) of the intervention did not obviously affect the gain in PA (83% of goals were met in at least one treatment condition for all subjects). Only two participants failed to meet treatment goals in any conditions. The authors report the net cost of the entire study was $27, greatly reducing the per-day cost for participants. Importantly, participants reported that the mobile treatments were more cost and time effective, and acceptable. They also reported that deposit contracts were effective in changing their behavior.

Another hurdle to the dissemination of behavioral interventions is the maintenance of behavior change. The length of intervention has varied across the studies reviewed. Andrade et al. (2014) examined whether a reinforcement-thinning schedule would lead to longer maintenance of PA gains in 77 adults. After a seven-day baseline period, participants could earn prize draws for meeting a standard goal of 10,000 steps per day. They visited the lab three times a week and could earn money prizes varying from $1 to $100 by drawing from a prize bowl with 50% of the tickets being winners. They could earn additional prize draws by having consecutive days of meeting goals. This phase cost researchers about $7.38 a day per person, quite expensive compared to previous studies. If they successfully met 10,000 step count goals on 14 of the last 21 days, by the end of the phase, they were randomized to either a Monitoring-only phase or a Monitoring with reinforcement thinning condition. The “thinning” of the schedule was met by randomly choosing days to have participants visit the lab for a prize draw, with the probability of a day being chosen reducing throughout the phase. They could earn draws based on the previous 4 days of walking. Therefore, there were fewer opportunities to earn prize draws. Individuals in the monitoring-only condition met about 26% of their walking goals over 3 weeks, whereas the reinforcement-thinning group met 61% of their goals over the same period. The cost of monitoring only averaged about $0.71 a day (earned for attending meetings rather than meeting goals), whereas the monitoring plus reinforcement phase cost about $1.63 a day per subject. Though this study showed that thinning out reinforcement was more effective than simply monitoring behavior, the cost of this intervention was high compared to that of the deposit contract studies.

Studies that refine the scalability and cost of behavioral interventions for PA are important to the dissemination of these effective interventions. Keeping pace with technological advances has allowed for easier delivery of interventions, with more acceptability by participants, and bigger gains in health behavior change. Behavioral interventions will be most effective when they incorporate individualized goal setting, prompting, feedback, and consequence-based incentives.

Interventions with Special Populations

As mentioned earlier in this chapter, children and adults are not engaging in sufficient levels of MVPA during the day at school or otherwise. Further still, individuals with ASD and other disabilities are engaging in even less PA than their typically developing peers (Srinivasan et al., 2014). Few studies outside of behavior analysis have evaluated interventions focused on improving PA or related health measures for individuals with ASDs and/or other disabilities; however, the majority of those that have tended to target cardiovascular and resistance activities, including jogging/running, horseback riding, martial arts, yoga and dance, and swimming, and most studies with children took place in school settings (for reviews, see Bremer et al., 2016; Hallett, 2019; Sorensen & Zarrett, 2014; Srinivasan et al., 2014). A similar dearth of research exists within the behavior-analytic literature as typically developing children and adults have been the focus of most PA interventions (see earlier sections of this chapter for reviews). However, in contrast to the non-behavioral studies, the majority of behavior-analytic studies have included adults with disabilities and have taken place at educational day programs or in residential facilities (a notable exception is Becerra et al., 2020). As well, these studies have targeted a variety of activities, including walking, jogging/running, hopping (and other child-typical activities), high-intensity interval training (HIIT), and resistance training.

Visual Schedules

One recent area of research involving children with ASD has evaluated the use of photographic activity schedules for increasing MVPA (Becerra et al., 2020). Participants included three 4-year-olds diagnosed with ASD. Researchers used most-to-least prompting to teach children nine steps for completing the photographic activity schedule, and they earned a flavored sports drink upon completion of the schedule. The photographic stimuli representing each activity were randomized between each session and included pictures of activities that were expected to be age-appropriate, such as running, hopping, and crawling. All children demonstrated improvements in the percentage of MVPA compared to baseline (over 50% as coded by OSRAC levels 4 and 5), and MVPA was maintained at consistently high levels during generalization and maintenance (albeit at slightly lower levels). Notably, MVPA increased in an environment without additional stimuli to help promote PA, such as toys, peers, or fixed equipment. Further, activity schedules may serve as a common stimulus to promote the generalization of MVPA to other environments with or without additional activity-promoting stimuli (Becerra et al., 2020); however, it may be important to evaluate the maintenance of PA when the presence of activity schedules are faded out, as schedules may not always be feasible or appropriate to use.

Researchers have also evaluated visual schedules as part of a multicomponent intervention package for increasing PA among individuals with ASD using technology. Bassette et al. (2018) evaluated a multicomponent treatment package that involved the use of a mobile fitness application, the Exercise Buddy, which included video models, visual schedules, and feedback. Four participants between the ages of 18 and 21 watched video models in the Exercise Buddy application of other individuals with ASD performing one of four exercises, including squats, hip extensions, dumbbell lateral raises, and dumbbell push-up rows. Following the video model, researchers instructed the young adults to begin exercising by providing the prompt "show me how you do [*n*] reps of [targeted exercise]". Access to preferred activities and/or monetary reinforcement was delivered contingent on completing a predetermined number of reps. The number of reps for each exercise was initially set at two and increased by another two reps upon mastery. Least-to-most prompting was used if the young adults did not independently complete a step of any given exercise. Following mastery in phase 1, the same procedures were used to teach the same exercises at a local YMCA in phase 2. In the final phase, each young adult selected their most preferred community setting (other than the YMCA) to complete the exercises. Phase 3 also consisted of teaching young adults to develop a visual schedule within the Exercise Buddy application in which targeted exercises were chained together. Auditory feedback was provided to the young adults while they were using the app, which consisted of brief statements of praise such as "keep it up." The young adults were able to choose the order of the workouts in the visual schedule and the same teaching procedures as in the first two phases were used. Improvements in the number of exercise steps completed independently were observed for all young adults and across all phases, and all indicated that they enjoyed using the app and were able to use it successfully. Although it is difficult to ascertain the effect of each behavioral component in the intervention, the results of this study indicate the utility of technology for teaching PA among individuals with ASD. Additionally, the amenability of the Exercise Buddy application to developing visual workout schedules was an effective means for producing longer bouts of PA, which are likely to have greater health benefits than single exercises. Additional evaluations with dependent measures directly related to PA are necessary, as well as component analyses to help determine the necessary and sufficient conditions for promoting PA among individuals with ASD.

Self-Monitoring and Contingent Rewards

Other multicomponent intervention packages have been evaluated using self-monitoring (Valbuena et al., 2019) and self-monitoring with goal setting (LaLonde et al., 2014). LaLonde et al. (2014) evaluated walking behavior among four adults with ASD using goal setting with self-monitoring and reinforcement. Daily steps were recorded during the adults' time at an educational day program that focused on vocational and independent living skills. Adults wore pedometers to track their daily steps and a new goal was set each day. Each adult's initial goal was determined by adding 10% to the average number of steps in the baseline. Goals then increased by 10% each time the previous goal was met for two consecutive days. Each morning, adults wrote their daily goals on a datasheet kept in the classroom. Thirty minutes prior to the time at which the classroom was released for the day, adults were prompted to check their pedometers to see if their goal had been met. If the adults met their goal, they wrote "yes" on their datasheet and were able to choose a prize from the prize box. If they did not meet their goal, they wrote "no" on their datasheet and were told they had the remaining 30 min of free time in class to do so, but they did not receive a prize. Although variable both within and across adults, walking behavior increased for all adults such that they were regularly meeting their daily goals and were walking more than 10,000 steps per day by the end of the intervention. In addition, all adults indicated that they liked wearing the device and teachers found the intervention highly acceptable. Thus, the goal-setting intervention was both effective and socially valid. It is possible that the activities included as part of the educational program helped facilitate such high levels of walking behavior and similar levels may not be observed in other settings, such as workplace environments for adults or in school settings for young children. However, including other incentives, such as monetary reinforcement, may be effective at promoting increased PA in adults with disabilities.

Valbuena et al. (2019) evaluated walking behavior among five adult men with intellectual disability (ID) using self-monitoring and monetary reinforcement. Adults attended an educational day program that focused on vocational and independent living skills, and the first hour of the day was spent outdoors during free time. Daily steps were recorded using pedometers that were worn on the hip and could be monitored by the adults during the intervention phase. At the end of each day, researchers recorded the total number of steps displayed on the pedometer and the adults were given $0.25 for every 1000 steps they had walked. The intervention was compared to the baseline, in which the adults could not see the steps displayed on the pedometer, in an ABAB reversal design. Average steps per min increased for all adults during intervention phases and were maintained during staff implementation. In addition, both adults and staff rated the intervention as effective and acceptable; however, lower ratings were observed when adults were asked the question "I will continue walking more if I do not receive money for it." This finding might suggest that monetary reinforcement was a critical component of the intervention, although further evaluations using monetary reinforcement without self-monitoring are warranted. Nonetheless, the authors concluded that the intervention was successful and suggested that monetary reinforcement might be beneficial for adults with disabilities because of its effectiveness as a generalized reinforcer. Further, money can be used to engage in important life skills while purchasing essential goods and services (Valbuena et al., 2019).

The above-described studies have focused on increasing walking behavior or resistance training. Although these studies have indicated improved outcomes, such low-intensity exercises may not produce beneficial increases in PA. Another study evaluated the effects of using a lottery reinforcement system to teach HIIT to three adults with developmental disabilities (DD; May & Treadwell, 2020). Specifically, this intervention targeted HR using a changing criterion design. These adults were residents in an independent supported-living facility that included a fitness center. Each adult's target HR was identified by calculating 75%–80% of HRMax. Prior to HIIT sessions, behavioral skills training (BST) was used to teach the adults how to raise their HR by running in intervals on a treadmill. Back-up reinforcers for the lottery were identified by a self-report preference assessment. During HIIT sessions, adults were on the treadmill for three 10 min blocks (i.e., 30 min), each divided into distinct intervals. Each 10 min block started with a 6 min self-paced interval followed by a 2 min (or less) warm-up interval, and a 2 min high-intensity interval began once the adult's target HR was met. Tokens were provided after each 10 min block if the adult maintained their target HR during the entire 2 min high-intensity interval. Each token could then be exchanged for a lottery slip at the end of the session to be entered into a drawing for each adult. Back-up reinforcers for the lottery drawing included edible items or one-on-one time with the researchers, except 50% of the drawings were labeled as "No Reward". Results indicated that all adults increased their HR to meet criterion changes more than 80% of the time and average HRs increased overall by 35–52%. These findings suggest that the lottery system was effective in increasing HR to beneficial levels, even when no reward was earned for half of the drawings. Tokens were used as conditioned reinforcers during the HIIT sessions and adults had a history of exposure to a token economy that was previously implemented to increase PA, though not high-intensity activity. It is therefore possible that token delivery during HIIT sessions influenced running behavior on the treadmill, which was delivered throughout each 30 min session contingent on real-time HR.

Providing tokens was discussed earlier in this chapter as one method to deliver tangible reinforcement contingent on real-time engagement in MVPA for typically developing children. The effects of token reinforcement have also been evaluated among adults with DD. Krentz et al. (2016) evaluated the effects of tokens on PA at a day training facility with five adult men with ID. Researchers delivered tokens contingent on each lap completed by the adults while walking during 1-h sessions. Tokens were exchanged for low- or high-preferred items that were identified based on a Multiple Stimulus Without Replacement preference assessment, and the exchange ratio was based on individual performance. An increase in laps was observed for all five adults during the intervention. Token economies have also been evaluated across extended observation periods. Nastasi et al. (2020) delivered tokens to four adults with DD contingent on walking behavior over a period of several days. Specifically, each adult had a daily goal for steps and a token was delivered contingent on meeting their goal from the previous day (as recorded by Fitbit devices worn on the wrist). Tokens were accumulated on a poster board and could be exchanged on Fridays for a prize (two tokens per prize). In addition, out of every 5 days during the token economy program, step goals were increased if the adults met their goal on at least 3 of the days. Three of the four adults demonstrated increases in steps relative to baseline, but only one adult increased their daily steps to meet the recommended 10,000 daily step goal. The authors concluded that token delivery across several days was effective at improving walking behavior among sedentary individuals with DD, though additional modifications may be necessary to increase walking to beneficial levels (Nastasi et al., 2020). Nonetheless, delivering tokens over an extended period during the intervention may be a more economic and feasible approach to improving PA.

Physical Activity as an Intervention

Finally, PA interventions have also been evaluated to reduce problem behaviors and/or improve skill acquisition among individuals with disabilities. In an early study evaluating the effects of PA on problem behaviors, Larson and Miltenberger (1992) found that neither leisure games nor structured walk-jog sessions reduced behavior to consistently low levels. Conversely, Neely et al. (2015) found increases in academic engagement and decreases in stereotypy when children with ASD were allowed to jump on a trampoline before instructional sessions. Notably, this intervention was most effective when children could jump until they showed indicators of satiation, suggesting that jumping on the trampoline may have been an abolishing operation for stereotypy. Other non-behavioral studies have found reductions in stereotypy, aggression, self-injury, and improvement in social and daily-living skills when using, for example, goal-setting, instructions, modeling, praise, rewards, and picture schedules (for reviews, see Bremer et al., 2016; Hallett, 2019; Sorensen & Zarrett, 2014; Srinivasan et al., 2014).

Conclusions and Future Directions

In the last two decades, research in applied behavior analysis has made great strides in identifying reliable, valid, and meaningful measures of PA, assessing antecedents and consequences associated with increasing PA in general, increasing MVPA, and decreasing sedentary behavior. Direct observations (e.g., using the complete OSRAC) provide important qualitative information about PA and the environment in which PA is most likely to occur, during time-limited sessions. In addition, sophisticated yet affordable devices allow for automatic data collection of steps or heart rate, which may be used to provide an estimate of PA. However, given emerging technology, studies should continue to assess the reliability and validity of the indirect and direct measures of PA, including comparative studies across a wider range of populations and activities.

Intervention studies have often focused on the delivery of positive reinforcers contingent on engaging in MVPA at the moment, meeting individual session goals, or day-long goals. Individual differences are common and not all individuals display increases in PA; however, the methods and procedures used in applied behavior analysis are well suited to discovering the constellation of antecedents and consequences best suited to increase PA in any given individual. Specifically, it is important to establish the level of PA during no-interaction baselines when individuals can freely engage in PA. Direct observation of PA should be systematic and include all levels of PA, as increases in light over sedentary is also beneficial. That said, specifically increasing the duration of time engaged in MVPA is also important. For day-long assessment of PA, the use of devices such as accelerometers and heart rate monitors with memory features may allow for bout analyses, such that the individual's specific pattern of PA can be understood and treated if necessary. In addition, more refined reinforcer assessments should be developed to inform interventions for both children and adults.

Behavioral research in PA has often been informed by the methods and procedures first utilized to address skill deficits, as well as decrease problematic behaviors, in special populations. Yet, the health consequences of engaging in low levels of PA are ubiquitous, calling for effective interventions for all individuals who are not already meeting PA guidelines. Several lines of research have already identified approaches that increase PA, although not necessarily yet to the levels recommended by the CDC. In addition, a particular challenge for behavioral research is to address individual differences we know may affect PA, while designing group- or community-based interventions to reach more people. Finally, to date relatively less behavioral research has been conducted on bone-strengthening, muscle-strengthening, and flexibility and balance-related exercise. Indeed, despite the advancements of behavioral research in the area of PA, there remains a great deal to learn for the ultimate benefit of the world's population.

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24 Treatment Integrity

Candice L. Colón and Robert Wallander

The behavior analyst who develops a work ethic, inclusive of a desire for robust treatment integrity and validated training practices can provide an empowering and enriching experience for those they serve and supervise. Striving for accurate, consistent, and uniform treatment implementation allows a practitioner to lay the groundwork for continual support of client progress. Maintaining optimal treatment implementation requires clinical decision-making and translation into actionable steps via evidence-based supervision and training methods. Whether the treatment setting is a school, clinic, community, home-based or residential group home, upholding the integrity of applied behavior analytic practice is a necessary quality indicator and a required skill for practitioners who seek to join and/or lead a team of applied behavior analysis (ABA) professionals. Fortunately, research from the last 40+ years can assist with the preparation, monitoring, and maintenance of adequate treatment implementation. This chapter aims to provide an in-depth look at this research and provide actionable steps for practitioners. This chapter will first provide an overview of the treatment integrity literature and its relationship to client outcomes. A discussion regarding the clinical implications of the existing literature and it's relationship with strategies necessary to provide training and supervision then follows.

ABA research has a proven track record of investigating procedures that improve socially significant behavior. Once effective procedures have been identified, having awareness of the practical constraints associated with these procedures is necessary to determine the generality of their effects and parameters associated with maximal and minimal treatment effectiveness (Baer et al., 1968, 1987). An approach common in ABA for identifying these effects and parameters entails an investigation of treatment integrity. Treatment integrity has been defined as the extent to which an independent variable (IV) is implemented as intended (Gresham, 1989; Gresham et al., 1993). Practitioners often choose evidence-based procedures that were proven effective in controlled settings with near-perfect integrity; however, the generality of such treatment effects in the natural setting under conditions of less-than-optimal treatment integrity is of particular concern in the clinical setting. Those implementing ABA treatment often have multiple responsibilities (e.g., data collection, conducting lessons, and facilitating peer interactions) and competing contingencies (e.g., avoidance of target behavior or collateral behavior; Allen & Warzak, 2000; Miller et al., 2010; Sloman et al., 2005; Stocco &

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_24

Thompson, 2015) that may interfere or conflict with treatment implementation. Moreover, treatments requiring a high response effort such as multiple component treatments (Yeaton & Seachrest, 1981), treatments requiring material resources (Woodward, 1993), and treatments requiring a lot of time to implement (Noell & Gresham, 1993; Noell et al., 1997) may also put a treatment at risk for intervention integrity failures.

The investigation of treatment integrity includes the observation and measurement of the accuracy and/or consistency of implementation (Gresham et al., 2000; McIntyre et al., 2007; Peterson et al., 1982). Consistency refers to the extent to which the treatment is implemented according to a set schedule (Homer & Peterson, 1980; Peterson et al., 1982). Under these circumstances, failing to implement a treatment on a fixed ratio (FR) 1 schedule and instead providing it less frequently would be a consistency error of omission. On the other hand, providing the treatment on a denser schedule than prescribed or for a behavior that it is not prescribed would be a consistency error of commission. Accuracy refers to the extent to which the treatment's definition matches the implementation of the treatment in practice, inclusive of all components (Gresham et al., 2000; Peterson et al., 1982). Therefore, if a therapist adds a treatment component, it is considered an accuracy error of commission whereas failing to implement a treatment component is referred to as an accuracy error of omission. If a therapist adds a non-prescribed component, it is considered an error of commission, whereas failing to implement a treatment component is referred to as an accuracy error of omission. In addition, accuracy errors may occur in isolation (an error on one component) or in combination (more than one error at a time).

The above-mentioned considerations of consistency and accuracy focus on the performance of each individual person implementing a specific treatment. However, it is important to note that on a more global level there are also varying degrees of treatment implementation across people and/or settings. For example, if all staff members employed at a day program follow a plan with strong homogeneity but their performance differs greatly from staff members working in the client's residential setting this would be termed a lack of uniformity. In one setting, consistency and accuracy may be high, but divergence may occur in comparison to another setting. Similarly, in a single setting, multiple caregivers who carry out a treatment in a dissimilar manner create a lack of uniform treatment delivery. The term uniform is characterized as being the same as or consonant with another or others (Merriam-Webster, n.d.). This definition provides two equally important qualities for consideration in relation to treatment integrity: (1) calling attention to "sameness" or at least degrees of similarity, and (2) the word "consonant" as used here refers to an agreement with others, extending the notion of working in a manner that is mutually beneficial and cohesive. If treatment implementation is not uniform, a phenomenon known as behavioral contrast may arise. Behavioral contrast is described as a change in responding under one set of stimulus conditions as a result of a change in the reinforcement conditions associated with another set of stimulus conditions (Mazur, 2006; Reynolds, 1961). Therefore, this reinforcement change in one condition directly affects responding in other conditions due to more or less reinforcement being available (Hernstein, 1970). Along the same lines, researchers should examine the extent to which the implementation of the same treatment at varying levels (poor uniformity) may evoke challenging behavior that can be termed iatrogenic. In the fields of medicine and psychology, iatrogenic events are adverse conditions that are caused by any number of medical oversights or errors. A few examples of iatrogenic events include if a patient were to develop an infection because a medical professional did not wash his or her hands after touching a previous patient, a surgery in which the wrong kidney is removed, or the wrong hip is replaced or psychological therapy that results in a worsened mental health condition. Hospitals are particularly concerned with preventing iatrogenic events and therefore identify trends and areas to work on for system-wide improvement. ABA practitioners and their organizations should focus on treatment integrity in a similar manner and realize that iatrogenic effects may occur if careful measurement and subsequent performance diagnostics are not pursued to mitigate divergence between persons or settings to prevent unwelcome circumstances that are inadvertently caused by a lack of uniform treatment delivery.

In summary, treatment integrity can be analyzed across three broad areas of concern: (a) consistency encompasses whether the treatment was conducted when it is supposed to be conducted (regardless of accuracy); (b) when the treatment is implemented, accuracy refers to whether or not all treatment components were implemented as trained, and lastly; (c) uniformity describes the cohesive implementation across people and settings (see Table 24.1 for an overview of the three types of errors). Therefore, a procedure may be implemented by an individual in a consistent but inaccurate manner and vice versa. Likewise, an intervention may be uniform across persons and/or settings, but may be low in accuracy and/or consistency across those individuals or it may in fact be uniformly high in consistency and/or accuracy, the latter of which is the ultimate goal for treatment implementation.

Lapses in treatment integrity may have desirable or undesirable effects on treatment outcomes (Gresham et al., 2000) and may lead to the addition of procedures that are not intended to be used. For example, if the therapist engages in an error of commission such as adding a reprimand following a challenging behavior during differential reinforcement of alternative behavior (DRA) plus extinction (EXT) procedure, then the original treatment may be altered if the reprimand functions as a punisher and strengthens the intervention, albeit in a manner that was not prescribed. Another less desirable outcome can occur if the addition of the reprimand functioned as a reinforcer and the challenging behavior increased as a result of this lapse in treatment integrity. Treatment components may also be omitted from a treatment plan. Errors of omission may also affect the outcome of treatment if an essential treatment component is not implemented or the treatment is not implemented at all. Even when inaccurate treatment implementation is acknowledged and beneficial effects of treatment are demonstrated, it may be unclear what the outcome would have been if the designed treatment procedure had been followed. Ultimately, without knowledge of the specific variables affecting IV parameters, no definitive conclusion regarding the functional relation between the intended IV and the dependent variable (DV) can be drawn (Alkhateeb, 1988; Gresham et al., 1993). Therefore, when faced with a treatment that is not producing optimal results, investigating treatment integrity (along

Table 24.1 Overview of treatment integrity errors

Type	Consistency		Accuracy		Uniformity	
Description	A treatment is implemented per the schedule prescribed		All components of a treatment are implemented as prescribed and no additional/unprescribed components are included		A treatment is delivered consistently and accurately across settings and people	
Error types	Commission	Omission	Commission	Omission	Across settings	Across people
Error examples	Delivering treatment on an FR1 schedule when a plan calls for an FR5 schedule	Delivering treatment on an FR5 schedule when a plan calls for an FR1 schedule	Providing an edible and a token for correct responses when a plan indicates that only a token should be provided	Delivering a pretzel contingent on manding for one but not providing verbal praise although the plan indicates both should be provided	All staff members at a day program follow a plan as trained, but caregivers in the residential setting do not	In a school setting, 3 of the 5 teachers in a classroom are implementing a plan with accuracy and consistency

with interobserver agreement) should be the first step in clinical decision-making prior to considering treatment modifications (see Fig. 24.1). Having reliable and objective information about why an intervention may be ineffective and how to address it with a targeted and informed solution can be the difference between obtaining socially significant changes or producing ineffective client progress and staff member dissatisfaction.

Fryling et al. (2012) completed a brief review that focused on treatment integrity and intervention effectiveness. That review led the authors to conclude further empirical evaluation could benefit from including descriptive research depicting treatment integrity in natural settings. In that review, they found it uncommon for descriptive assessments to highlight the occurrence of treatment integrity errors in both the home and classroom setting (Arkoosh et al., 2007; Northup et al., 1994; Taylor & Miller, 1997; Wood et al., 2007). For instance, following a yearlong descriptive study, Arkoosh et al. found that a parent-delivered treatment for the reduction of challenging behavior was delivered inconsistently (range, 0–75%). Likewise, Northup et al. (1994) found that treatment consistency was highly variable when delivered in the classroom setting (range, 0–100%). Moreover, their direct observations indicated that procedures for appropriate responses (DRA) were implemented more frequently (*M* = 76–80%) than procedures implemented contingent on self-injurious behaviors (physical guidance, response blocking; *M* = 27–72%). Likewise, with regard to the accuracy, several descriptive studies have shown low levels of integrity (DiGennaro et al., 2013; Gross et al., 2014). This is concerning given that levels of accuracy may not only influence the treatment effects related to the target behavior but may also have collateral effects on other behavior. For instance, a study conducted by Dib and Sturmey (2007), demonstrated that improvements in accuracy during discrete-trial teaching led to a collateral decrease in stereotypy for three children diagnosed with autism spectrum disorder (ASD).

A few other descriptive studies have also drawn correlational comparisons between treatment integrity and treatment outcome (Carr et al., 1996; Gerhardt et al., 2003; Northup et al., 1994; Wood et al., 2007) For instance, Wood et al. examined interval by interval treatment integrity data in the classroom setting to determine whether poor treatment implementation of a DRA with EXT procedure was correlated with a difference in intervention results. When the classroom teacher implemented the intervention with integrity, the participant was on task 91% of the time in comparison to 9% of the time when the treatment was implemented with poor integrity. In addition, the participants' on-task behavior decreased to pre-treatment levels when treatment

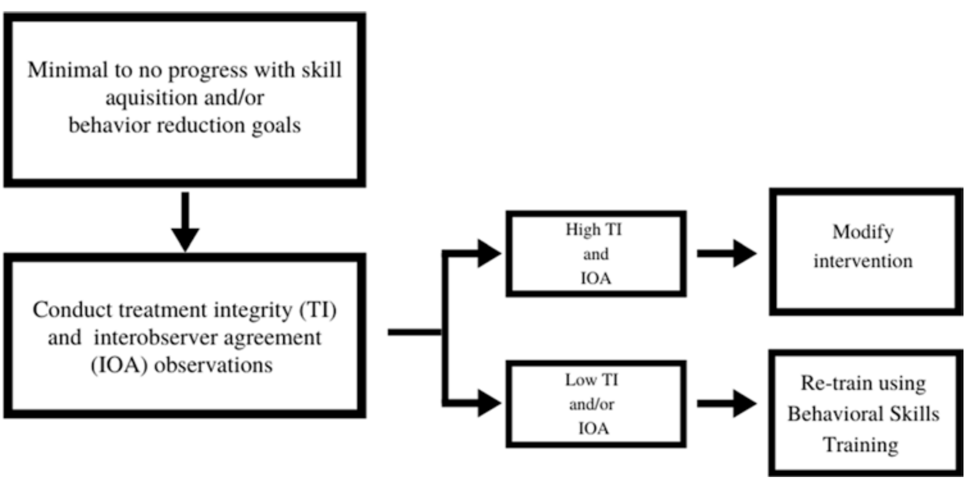

Fig. 24.1 Treatment integrity clinical decision-making model

consistency fell below 80%. Due to the prevalence of such treatment integrity errors, analyses in a controlled setting have been conducted to analyze the impact on treatment outcomes.

Although the behavior analytic literature has used experimental methods to investigate the relationship between treatment integrity and treatment outcome, very few studies have been conducted for this exact purpose. Reviews conducted by Fiske (2008), Fryling et al. (2012), McIntyre et al. (2007), and Progar et al. (2001) touched upon the emerging literature, briefly discussed studies that analyzed treatment integrity effects on treatment outcome, and found that treatment outcomes were sometimes successful under degraded levels of treatment integrity (e.g., Northup et al., 1994; Vollmer et al., 1999). In the present chapter, additional considerations including the conditions under which treatment integrity affects treatment outcomes for different types of behavioral interventions will be reviewed and the clinical recommendations based on these findings will be shared.

Consistency

The strength of treatment must be considered when interpreting how treatment consistency affects treatment outcomes. Related to this is *contingency* strength, or the varying probabilities of responses and consequences in the context of environmental events (Vollmer et al., 2001) can be conceptualized along a continuum from very strong (FR1) to neutral and negative contingencies (Hammond, 1980). While similar, overall *treatment* strength requires knowledge of the probability that the responses are being reliably followed by programmed consequences outlined in a treatment procedure. Many practical questions regarding treatment effects following exposure to degraded levels of integrity can be answered by manipulating the schedule of treatment implementation (McIntyre et al., 2007; Peterson et al., 1982). For instance, intermittent schedules reflect a pattern that can be representative of naturally occurring lapses in treatment integrity. Empirical questions regarding treatment outcomes under degraded levels of integrity can be answered by manipulating the consistency of treatment implementation (McIntyre et al., 2007; Peterson et al., 1982). Parametric analyses have been used to investigate such phenomenon. Parametric analyses manipulate a specific range of values of an independent variable for the purpose of establishing the extent to which each value influences responding (Ahrens et al., 2011; Kliebert et al., 2011; Lerman & Iwata, 1996; Smith et al., 1999; St. Peter Pipkin et al., 2010; Vollmer et al., 1999). As a result, parametric analyses are useful to derive treatment outcome effects produced across a range of treatment integrity values.

Interventions for Challenging Behavior

Differential Reinforcement Procedures Several studies have investigated treatment consistency in relation to differential reinforcement procedures with and without EXT. For instance, Vollmer et al. (1999) exposed three participants to several levels of combined commission (providing a reinforcer for challenging behavior) and omission (failure to provide a reinforcer following the alternative behavior) consistency errors during a DRA with EXT procedure. Specifically, Vollmer et al. tested various schedules of reinforcement in differing orders, across a continuum from baseline (0% reinforcement for appropriate behavior and 100% reinforcement of inappropriate behavior) to a continuous DRA with EXT procedure (100% reinforcement of appropriate behavior plus 0% reinforcement inappropriate behavior). Baseline followed by the continuous implementation of DRA with EXT (100%) were always the first two conditions of participant exposure. When the schedule of reinforcement was equal (50% reinforcement for inappropriate behavior and 50% reinforcement for appropriate behavior) the participant's responding was allocated to appropriate behavior, indicating that recent history with 100% implementation may minimize the effects of treatment integrity failures.

In a subsequent study, St. Peter Pipkin et al. (2010) asserted that sequence effects may have played a role in the Vollmer et al. findings. Thus, St. Peter Pipkin and colleagues conducted a translational study consisting of a series of DRA with EXT experiments to test this hypothesis. Among these experiments were a parametric analysis (80%, 60%, 40%, and 20%) conducted with one participant and an analysis of sequence effects comparing exposure to baseline versus 100% treatment implementation directly before treatment integrity failure conditions with another participant. The parametric analysis results indicated that unfavorable treatment outcomes were obtained when levels of consistency were 40% or lower. In addition, when 50% integrity was evaluated during the sequence effect analysis a favorable treatment outcome was obtained only when the 100% condition directly preceded it. Leon et al. (2014) investigated the consistency of a DRA without EXT procedure following no treatment (baseline) versus full treatment implementation (100%) and similar to St. Peter Pipkin et al. (2010), Leon et al. also found that a slightly more favorable outcome was obtained when the 100% condition directly preceded a 60% consistency condition rather than the baseline condition.

Prompting Procedures Wilder et al. (2006) evaluated the effect of three levels of accuracy (20%, 50%, and 0%) of a three-step prompting procedure via a multielement design with a baseline phase non-compliance with two typically developing preschool children. The dependent measure was compliance to an initial directive to complete known motor tasks (e.g., “Give me X” and “Put X away”). The prompting procedure steps were as follows: (1) call the child’s name, (2) model the correct response, and (3) physically guide the child through the correct response. Correct responses after the second or third prompt were not scored as compliance. Each demand was associated with a different level of treatment integrity for each participant and varied across participants. Response effort was kept equal across demands by keeping the distance a participant had to travel (to comply with the directive) the same for all demands. For both participants, during 50% consistency, compliance was above baseline levels but well below the 100% condition. In a related study, Stephenson and Hanley (2010) also manipulated the integrity of a non-compliance intervention with two typically developing preschoolers. They found that a similar prompting procedure was effective at increasing compliance for two participants when implemented at degraded levels of integrity. However, it is important to note the procedural variations between the studies. Their intervention consisted of a three-part antecedent procedure (the teacher crouched within 0.3 m of the child, touched the child’s shoulder, and delivered 5 s of vocal attention before delivering the directive) and a three-step prompting procedure (initial directive, model, and physical guidance). Compliance was also measured as engagement in motor responses; however, each response was not associated with a different treatment condition as they were in the Wilder et al. study. Instead, all participants were first exposed to 100% treatment consistency followed by the procedure being systematically degraded based on a set criterion. Under these conditions, the procedure was effective when delivered as little as 20% of the time. Therefore, recent reinforcement history may have again been a determining factor in the stability of treatment outcome. It is also possible that gradually degrading treatment consistency may have contributed to the success of treatment at lower levels of integrity.

Punishment Procedures Few studies have directly assessed the effects of degraded levels of treatment integrity on punishment-based procedures. Nonetheless, a study conducted by Clark et al. (1973) first found that an FR1 schedule of time out (TO) was effective in treating several challenging behaviors for one participant with special needs. They then tested the following variable ratio (VR) schedules: 33% (VR3), 25% (VR4), and 12% (VR8) and found that low rates of challenging behavior were maintained under VR3 and VR4 schedules. Furthermore, Northrup et al. (1997) investigated the consistency of a

DRA plus EXT procedure paired with TO. During the intervention, the schedule of DRA plus EXT and TO was systematically manipulated from 100% (FR1), to 50% (VR2) to 25% (VR4). Therefore, all participants in this study had a recent history with 100% integrity levels prior to exposure to degraded treatment integrity levels. For two participants, treatment strength for both DRA and TO was simultaneously manipulated in this manner. For both participants, the DRA plus TO procedure was effectively implemented at 50% consistency. In a more recent study, St. Peter et al. (2016) investigated the effects of both omission and commission consistency errors and found that 50% also produced adequate treatment effects for a DRA with response cost procedure in the context of a translational human operant arrangement.

A few studies have evaluated the extent to which treatment integrity impacts the treatment outcome of response interruption and redirection (RIRD). For example, Ahrens et al. (2011) implemented a parametric analysis using the values 50%, 25%, and 10%. Their results indicated that RIRD was effective during the 50% condition but treatment effects were not maintained at the lower values of implementation. In a more recent study, Colón and Ahearn (2019) also investigated RIRD treatment integrity via a descriptive assessment followed by parametric analysis of RIRD consistency for the treatment of the automatically maintained vocal stereotypy of three participants in a classroom setting of a private school. The types of treatment integrity errors that occur in the natural setting were determined via descriptive assessment. The results of the descriptive assessment indicated that consistency of implementation was the most common error. However, when the procedure was implemented, it was implemented with a high degree of accuracy. Therefore, a parametric analysis was conducted in a controlled setting to determine the impact of consistency errors on RIRD treatment outcomes. Following an ABAB (baseline, 100%; baseline, 100%) treatment analysis, a withdrawal design was used to analyze 75%, 50%, and 25% consistency in alternation with baseline during the parametric analysis. In addition, 25% consistency interspersed with booster sessions at 100% were also evaluated. The results indicated that RIRD was generally effective at 50% consistency or higher. In addition, treatment effects similar to those observed in the 50% condition were also obtained when 25% consistency was interspersed with 100% booster sessions. In a follow-up study, Gauthier et al. (2020) compared the treatment effects of RIRD at two levels of integrity (100% and 33%). In this study, however, degraded treatment integrity conditions were not preceded by exposure to full integrity. Four children diagnosed with an autism spectrum disorder between the ages of 8 and 16 participated. The effects of treatment integrity on vocal stereotypy were assessed using an ABAB-variant design in which B consisted of an alternating treatments comparison of different levels of integrity. Results varied across participants, and although both conditions decreased stereotypy, 100% integrity produced lower levels of stereotypy quicker than 33%. For two participants, following a second exposure to both 33% and 100% in an alternating fashion, suppression of vocal stereotypy was maintained during the 33% condition in the absence of the 100% condition. However, given minimal differentiation between the 33% and 100% alternating conditions for these two participants, it is possible that a lack of discrimination may have produced cumulative exposure to a mean schedule of 66% consistency. This phenomenon may be more closely examined in future studies by associating each condition with salient putative discriminative stimuli. For instance, each condition could be implemented by different experimenters to simulate how caregivers may implement the procedure at different integrity levels in the natural environment.

Moreover, RIRD is an excellent example of an intervention that has been proven to be an effective treatment (for automatically maintained behavior) but can potentially prove to be time-consuming; particularly if participants engage in high levels of the target behavior (Colón & Ahearn, 2019; Duffy-Cassella et al., 2011; Love et al., 2012). However, based on these results, it may be possible to implement RIRD less often while still producing significant treatment effects. In addition, even though the implementation of RIRD with full treatment integrity (100%) resulted in a faster and greater reduction of vocal stereotypy, more time was spent implementing RIRD during this condition, leading to longer session durations. This increase may potentially lead to treatment integrity errors in the natural environment. Environmental constraints such as a classroom setup, as well as teacher-to-client ratios, may prevent the implementation of RIRD following all instances of the target behavior. Future research should determine if treatments that are more time-consuming result in more integrity errors. If two procedures are equally effective, it could be useful to assess which one is the less resource-intensive treatment option. Given that Colón and Ahearn (2019) found that RIRD was effective when implemented with at least 50% consistency following recent exposure to 100%, if the current procedure was in fact functioning at 66% consistency (average between 100% and 33% condition), this would have provided the participants with recent exposure to RIRD above 50% consistency prior to experiencing the 33% alone. Therefore, future studies could examine treatment consistency below 50% from the outset of treatment (following baseline) via a reversal design, to determine if treatment effects are adequate under such conditions.

In addition, the RIRD procedure was ineffective during the 33% condition for one participant. Moreover, for one participant, when 100% consistency was interspersed with diminished consistency, over time both conditions suppressed stereotypy. However, when conducted alone, the 33% condition did not effectively suppress stereotypy. This finding also extended those of Colón and Ahearn (2019), by demonstrating that, interspersing 100% integrity booster sessions can increase the efficacy of the procedure under impaired integrity conditions. Therefore, booster sessions may be beneficial in sustaining treatment effects in the clinical setting. Additional research in this area is necessary to gather more information on the maintenance of treatment effects over time. Nonetheless, these results generally replicated previous research, showing that lower levels of integrity can be effective in suppressing stereotypy.

Summary

The existing literature pertaining to consistency has yet to establish a clear difference between omission errors or a combination of omission and commission errors as it relates to their impact on the level of consistency necessary to produce a beneficial treatment outcome. Instead, the existing literature indicates that if treatment failure follows exposure to full treatment implementation the impact on treatment outcome may be less substantial. Further research is required to determine whether treatment effects would be stronger if treatment failure conditions are directly preceded by 100% integrity conditions rather than BL conditions (St. Peter Pipkin et al., 2010; Vollmer et al., 1999). It also remains unknown how recent or how long the exposure to 100% treatment integrity must be to afford a successful treatment outcome during treatment integrity failures. Another relevant question for future research is whether or not a longer history of reinforcement for one behavior over another affects response allocation in the face of less-than-optimal treatment integrity (Vollmer et al., 1999).

Accuracy

Analyzing the accuracy of a procedure and its effects on treatment outcomes can be investigated via comparative analyses and component analyses. Comparative analyses are used to determine the impact of inaccuracies on previously validated procedures via evaluations of programmed accuracy errors versus conditions of 100% accuracy. Whereas, component analyses can systematically determine the necessity and/or relative impact of treatment steps (Carroll et al., 2013; Cook et al., 2015; Ward-Horner & Sturmey, 2010).

Interventions for Challenging Behavior

Differential Reinforcement Procedures A few treatment integrity studies have explicitly investigated accuracy as it pertains to interventions for challenging behavior. Of these studies, the vast majority examined differential reinforcement procedures paired with other procedures. For example, several studies have investigated FCT procedures and found that EXT was a necessary component to achieve significant treatment effects (e.g., Shirley et al., 1997; Volkert et al., 2009; Worsdell et al., 2000). For instance, Worsdell et al. investigated the effects of the inconsistent application of EXT during the acquisition of functional communication training (FCT). Without any previous exposure to EXT for the challenging behavior, EXT was manipulated by thinning the schedule of reinforcement for the challenging behavior while reinforcement for the functional communication response was delivered on a continuous schedule. When the schedules of reinforcement were equal for both the challenging behavior and the alternative behavior, the procedure was ineffective for four out of five participants. For the participant who acquired the alternative response during continuous reinforcement for both responses, the authors indicated that it was possible that the participant's challenging behavior (SIB) may have also produced aversive consequences (e.g., pain) influencing response allocation towards the alternative behavior. For all other participants, the procedure was not effective until at least half of the target responses were followed by EXT (i.e., FR2, FR10, and FR20). Furthermore, for the two participants for which the treatment was not effective until the FR20 schedule was implemented, it was rare that they engaged in 20 responses per session, therefore these sessions may have functioned as 100% EXT conditions. In addition, the authors did not provide exposure to EXT in order to minimize recent history effects; therefore, it is unclear whether these results would have been different following recent exposure to EXT at 100% treatment integrity. Furthermore, Pritchard et al. (2014) conducted a review of behavioral momentum theory (BMT) including how the theory relates to recent history and treatment integrity. BMT research has shown that behavior is more persistent when faced with disruptors (e.g., EXT) in contexts associated with higher rates or density of reinforcement (e.g., Grimes & Shull, 2001; MacDonald et al., 2013; Nevin et al., 1990). Moreover, in line with this theory, basic and translational research has shown that recent exposure to alternative reinforcement may actually increase resistance to EXT (Ahearn et al., 2003; Mace et al., 2010; Nevin et al., 1990). This is problematically paired with the reality that a caregiver may occasionally fail to provide reinforcement for functional communication responses causing the challenging behavior to reemerge (Durand & Carr, 1991). This phenomenon has been referred to as a resurgence. A study conducted by Volkert et al. highlighted the occurrence of EXT-induced resurgence following a successful implementation of an FCT + EXT procedure. In this study, a resurgence occurred with four out of five participants when reinforcement was either provided on a thin schedule (FR12) or no longer provided at all for the functional communication response.

Punishment Procedures Northrup et al. (1997) investigated the accuracy of DRA plus EXT paired with TO with two participants. Both participants had a recent history with 100% integrity levels prior to exposure to degraded levels. DRA was held constant at 100%, and TO was effectively reduced to 50% (VR2) for one participant and 25% (VR4) for the other participant. For this participant, 25% TO was also effective in the absence of DRA (EXT for appropriate behavior). Although the results for the third participant may be idiosyncratic, it is also possible that the use of a VR schedule may have contributed to a lack of discrimination between conditions, leading to similar results across the 50% and 25% conditions. Saini et al. (2015) also found that a low level of accuracy produced significant treatment effects when they reduced the response requirement component of the RIRD procedure from three demands (100%) to one demand (33%) without diminishing treatment effects on stereotypic behavior for the four children diagnosed with ASD who participated in their study. Following baseline, Saini et al. introduced a multielement design inclusive of baseline alternating with 100% and 33% accuracy conditions, followed by the reintroduction of baseline and finally 33% alone. The 33% condition which consisted of one demand instead of three demands produced similar results to that of the 100% condition and was maintained over time when the 33% condition was implemented alone.

Given the few existing analyses of treatment accuracy targeting the treatment of challenging behavior, future research inclusive of descriptive studies and experimental studies is encouraged to determine the relative impact and parameters of treatment steps/components.

Academic Skill Acquisition Procedures

In recent years, there is emerging research regarding treatment integrity effects on academic teaching procedures. In specific, multiple studies have explored the impact of one or more components of academic skill acquisition procedures. For example, Carroll et al. (2013) conducted a descriptive assessment to determine relevant treatment integrity errors that occur during discrete-trial (DT) instruction in the classroom setting. They then manipulated the treatment integrity of the three most commonly observed errors (failure to deliver a tangible following correct responses, failure to deliver a controlling prompt, and failure to present the correct instruction once) combined and in isolation. Future research should investigate the other components of DT instruction that were also observed to be low in the classroom setting (e.g., establishing attending behavior prior to each trial). When combined errors were tested in comparison to 100% accuracy they found that 100% accuracy led to a greater likelihood of acquisition. Only one of the six participants acquired the skill under low accuracy conditions, the rest of the participants required exposure to 100% accuracy to acquire the skill. Furthermore, the targets exposed to the three combined errors 67% of the time (33% accuracy) required more instruction sessions than those targets taught using all components. When the three errors were tested in isolation with three participants from the previous study, two of the three participants acquired the skills under all conditions. However, one participant required exposure to 100% accuracy for the targets previously presented with 33% accuracy to acquire all target skills. Moreover, two participants who did not acquire the target stimuli when the errors were combined in the previous study did acquire the skills when the errors were tested in isolation. This finding indicates that combined errors may have a greater impact on skill acquisition than singular errors. Furthermore, correct responding was lowest when the controlling prompt was omitted or a different instruction was given for two participants. For the other participant, the lowest levels of correct responding occurred when a tangible was not provided contingent on correct responding. Although this study presents an elegant evaluation of treatment integrity errors encountered during DT teaching, it requires replication and further extension. Moreover, the authors point out that conducting a within-subject replication with additional target sets may be beneficial as it is possible that assigning different stimuli to different test conditions affected the outcome.

Pence and St. Peter (2015) conducted two experiments that tested the accuracy of consequences for correct responding during a mand training procedure. In experiment 1, they evaluated the effects of delivering an incorrect item across three participants, and in experiment 2, they evaluated the delivery of an item independent of a mand response across three participants. Four levels of accuracy (0%, 40%, 70%, and 100%) were tested in each study. Overall, the results indicated that mands were acquired when accuracy was high (70% and 100%), and the acquisition was less efficient during the 70% condition. However, the manner in which preferred stimuli were assigned to each treatment integrity condition presents a potential confound. For example, the highest preference item was assigned to the lowest integrity condition and the lowest preferred item was assigned to the high integrity condition. Consequently, one participant acquired a mand under conditions of 0% accuracy (when an incorrect item was delivered) presumably due to the potency of the reinforcer which was in sight during all sessions. The extent to which the assignment of preferred items to each condition and possible fluctuations in preference may have affected the results as a whole is uncertain and requires further investigation.

Holcombe et al. (1994) investigated the impact of accuracy as it relates to constant time delay prompt delivery. Via a comparative analysis, efficiency and effectiveness were measured with six preschool children with developmental disabilities during a DT procedure. Specifically, they used an adapted alternating treatments design to apply two different treatment accuracy conditions to independent sets of target stimuli. They compared 100% accuracy with low accuracy prompt delivery. During the low accuracy condition, the controlling prompt was not delivered during an average of 44% (range, 35–52%) of opportunities across all participants (66% accuracy). One participant did not acquire the target skills under either condition. Of the remaining five participants, all five acquired the skill with 100% accuracy. During the low accuracy condition, four of the remaining five acquired the skill. However, following exposure to 100% accuracy, this participant demonstrated mastery of the stimuli previously associated with low accuracy. In addition, when the 100% accuracy condition was in effect, four of the five participants required less time to acquire the skill relative to lower accuracy conditions.

Grow et al. (2009) also found that altering the accuracy of a prompting procedure produced less efficient learning in comparison to the recommended and validated prompting strategy when teaching a five-step response chain (pattern design) was conducted with four children diagnosed with ASD. Specifically, they compared the use of a least to most prompt hierarchy, verbal, model, and physical with a 5 s delay, (100% prompting accuracy) to a condition that entailed repeating the verbal prompt three times, not providing the opportunity to respond after the model prompt and omitting the physical prompt (0% prompting accuracy). In the 100% condition, if the participant completed a step following a model prompt, they received praise only. Under both conditions, if the participant completed the entire response chain without experimenter prompts, they received access to a toy for 30 s. Although all participants acquired the skill, three of the four participants required additional trials to acquire the skill, resulting in approximately 3–9 min of additional teaching time. Although this is not a considerable amount of time in isolation, the possible cumulative effects overtime and across several skill domains are unknown. It is important to note that this study altered all elements of their prompting procedure, therefore further research may be necessary to determine whether one or more modifications to the prompting are responsible for these findings. Although this study was framed in reference to treatment integrity, given that the study compared 0% accuracy with 100% accuracy this study may instead be considered a general test of the efficacy of this procedure's utility, rather than a treatment integrity analysis of prompting accuracy. Therefore, the merit in this study as it relates to treatment accuracy relates to the possible impact on the efficiency of a procedure when the prompting procedure is not run accurately but consequence procedures remain intact.

In a similar study, Groskreutz et al. (2011) examined three levels of accuracy (100%, 50%, and 10%) of physical prompting for a three-step appropriate play sequence with two participants. Three toys were selected for each participant dependent on high levels of inappropriate toy play and low levels of appropriate toy play. As with previous studies, each toy was assigned to a specific accuracy level. For one participant, appropriate toy manipulation increased under both 50% and 100% accuracy. However, for the other participant, toy manipulation was only acquired during the 100% accuracy condition. Furthermore, this participant did not acquire the other target skills even after 100% was introduced following failures in the 50% and 10% conditions. Therefore, these findings may be due to recent history effects comparable to past treatment integrity consistency studies (Ahrens et al., 2011; Lerman & Iwata, 1996; Northrup et al., 1997; St. Peter Pipkin et al., 2010; Stephenson & Hanley, 2010; Vollmer et al., 1999). Therefore, due to a lack of exposure to 100% accuracy prior to degraded levels of treatment integrity, treatment effects were not salvageable. Nevertheless, due to the fact that toys were selected based upon levels of engagement in inappropriate play rather than a lack of engagement it is possible that a concurrent operant arrangement was also a factor.

The error correction component of DT instruction was evaluated by Worsdell et al. (2005). They found that more sight words were acquired with 100% accuracy versus 33% accuracy; however, both levels of accuracy were adequate for all six of their participants to acquire more sight words than previously demonstrated during baseline. Further analysis of the error correction procedure to test other values would be beneficial to determine if a certain level of accuracy (above 33%) produces a similar rate of acquisition to 100% accuracy. Furthermore, during this study, all other components were held constant, including positive reinforcement for correct responses. Therefore, it is unclear how such inaccuracies of consequences for incorrect responding would impact acquisition if inaccuracies of the consequences for correct responding occurred simultaneously. Future studies could determine the parameters of inaccuracies for both consequence components similar to the combined investigation carried out by Carroll et al. (2013) but perhaps with titration of each schedule via a parametric analysis.

The majority of skill acquisition studies have investigated treatment integrity errors of omission. Conversely, DiGennaro Reed et al. (2011b) investigated errors of commission during a receptive identification program for nonsense shapes taught via discrete-trial instruction to three participants. Following the baseline condition in which no programmed consequences were delivered contingent on performance, three different integrity levels were tested (0%, 50%, and 100%). Each level was associated with a different nonsense shape. Commission errors entailed providing tokens and social praise following an incorrect response and before implementing the error correction procedure. Their findings demonstrated that acquisition only occurred in the absence of commission errors (100% integrity) for all participants. In an extension of this study, Jenkins et al. (2015) tested commission errors in the same manner as the previous study however they did not implement the error correction procedure following reinforcement. They also added putative discriminative stimuli by printing the match-to-sample stimuli (modified Japanese alphabet characters) on different colored paper associated with each treatment integrity level (0%, 50%, and 100%). Furthermore, they introduced 100% treatment integrity following exposure to degraded integrity with three of the four participants. The results for these three participants replicated the findings of the DiGennaro Reed, Reed, Baez, and Maguire study. The other participant did not meet the mastery criterion in any condition indicating that the proposed discriminative stimuli may not have assisted with discrimination between conditions for this participant. When 100% integrity was introduced, two of the three participants showed a delay in acquisition, but the adverse effects of degraded treatment integrity were reversible for all three participants. It is important to note that the ecological validity of these two studies is uncertain given that such errors do not seem likely to occur at such high rates in the natural setting. Descriptive assessments may be beneficial in identifying whether this type of error is common and indicate components to analyze in future studies.

Summary

In summary, accuracy studies that solely entailed commission errors (DiGennaro Reed et al., 2011b; Jenkins et al., 2015; Pence & St. Peter, 2015) all required a fairly high level of accuracy to be effective (70–100%). These three studies also all manipulated consequence errors; therefore, it is difficult to determine whether errors of commission, consequence errors, or a combination of commission consequence errors may be responsible for this outcome. Therefore, further research should be conducted to determine the conditions presumably warranting this high level of accuracy. In contrast, the studies that solely investigated omission errors included four studies that manipulated antecedent errors (Groskreutz et al., 2011; Grow et al., 2009; Holcombe et al., 1994; Saini et al., 2015) and three studies that manipulated consequence manipulations (Northup et al., 1997; Worsdell et al., 2000, 2005). In comparison to the commission studies, these studies generally required a lower level of accuracy (33–66%), indicating that perhaps errors of omission are less detrimental than errors of commission. Yet, as previously mentioned additional studies would be necessary regarding errors of commission to further support this conclusion.

When studying accuracy specific to discriminative stimuli presentation, Carroll et al. (2013) found inaccuracies to lead to lower rates of correct responses but did not prevent the eventual acquisition of the target skill. Of the three studies that investigated the impact of prompting procedure inaccuracies, the majority of the participants acquired target skills under conditions with as low as 50% accuracy. However, two of these studies also found that inaccurate prompting compromised the efficiency of the teaching procedure (Grow et al., 2009; Holcombe et al., 1994). Efficiency may also be affected when the consequence delivered for a correct responding is inaccurate (Pence & St. Peter, 2015). Given that few studies have investigated the accuracy of antecedent implementation, further research is warranted. As for, the accuracy of consequences delivered for incorrect responses (error correction) the existing literature indicates that although acquisition may occur following inaccurate error correction procedures, more skills may be acquired when accuracy remains intact (Worsdell et al., 2005). The existing literature also demonstrates that providing reinforcement for incorrect responses is detrimental to skill acquisition (DiGennaro et al., 2011a; Jenkins et al., 2015). However, Jenkins et al. (2015) demonstrated that skill acquisition is eventually possible following exposure to inaccuracies related to the consequence delivered for incorrect responding when 100% accuracy is subsequently implemented. Similar results were found regarding combined inaccuracies in the Carroll et al. (2013) study. Unfortunately, Groskreutz et al. (2011) found that one participant who failed to acquire skills at 50% and 10% prompting accuracy also did not meet the mastery criterion when 100% accuracy was ultimately implemented.

Discussion

Contemporary treatment integrity research (1973–2019) consists of only 20 experimental analyses that examined treatment integrity with enough rigor to determine an impact on treatment outcome. To provide insight into the available evidence on intervention integrity for adoption into practice or for informing future research, there are twice as many studies regarding treatment accuracy than those concerned with treatment consistency. Echoing the findings of Fryling et al. (2012), there remains a void in the reinforcement-based literature with respect to non-contingent reinforcement and differential reinforcement of other behavior, therefore, future research should investigate treatment integrity as it relates to both of these procedures.

With respect to punishment-based procedures, there is a considerable gap in the literature. It is important that we make every effort to study the parameters of any and all procedures we may use in clinical practice. Thus, further knowledge regarding punishment parameters (i.e., intermittent punishment without extinction, availability of alternative reinforcement, magnitude of relevant stimuli, and recent history) is imperative to ensure that practitioners are fully equipped with the technology to provide behavioral treatment in an effective and efficient manner. In like fashion, many of the consistency studies focused on variations of DRA procedures (with and without extinction or time out) with minimal examination of other procedures. For instance, one study investigated timeout alone, one investigated response cost, one investigated RIRD and two manipulated prompting procedures. Likewise, the accuracy literature lacked variety as well with the majority of accuracy studies investigating skill acquisition procedures rather than treatments for challenging behavior. More specifically, these studies predominantly investigated DT instruction components with little or no emphasis on various other skill acquisition procedures (e.g., task analyses, natural environment teaching, and video modeling) indicating an area for future research. Given the lack of repeated studies across various treatment procedures represented in the literature, further analyses are necessary to determine if there is a certain level of accuracy and/or consistency necessary to produce beneficial treatment outcomes for specific types of treatments.

However, when comparing antecedent versus consequence procedures the literature does appear to indicate a likely difference between the levels of integrity that are effective. With regard to consistency studies, in the studies that investigated antecedent manipulations (Stephenson & Hanley, 2010; Wilder et al., 2006) the integrity level under which they were effective was 20–50%, whereas the studies that examined consequence manipulations (Leon et al., 2014; Northup et al., 1997; St. Peter Pipkin et al., 2010; Vollmer et al., 1999; St. Peter et al., 2016; Colón & Ahearn, 2019) were generally effective for most participants within a slightly higher range of 50–100% with the exception of the Clark et al. (1973) study which reported treatment effects with consistency as low as 25% consistency. With regard to accuracy, a similar pattern was evident. Studies that investigated antecedent manipulations (Groskreutz et al., 2011; Grow et al., 2009; Holcombe et al., 1994; Saini et al., 2015) were effective under relatively low levels of accuracy 0–66%, in comparison to the studies that examined consequence manipulations (DiGennaro Reed et al., 2011b; Holcombe et al., 1994; Jenkins et al., 2015; Pence & St. Peter, 2015; Worsdell et al., 2000, 2005) which were generally effective for most participants at a slightly higher range of 50–100%, with the exception of the Northup et al. (1997) study which reported treatment effects with consistency as low as 25% accuracy. Notably, this study was also the only accuracy study in which the participants were first exposed to a recent history of 100% accuracy which poses the question of whether or not this was the determining factor for the low level of accuracy necessary to obtain a favorable treatment outcome. The lack of studies examining the accuracy and recent history indicates a need for further investigation in this area. Ward-Horner and Sturmey (2010) described two types of component analyses. The add-in method involves systematically introducing components (e.g., Hanley et al., 2000) while the dropout method entails the systematic removal of components (e.g., Cooper et al., 1995). Future research could use dropout analyses to establish clear findings regarding the accuracy parameters of specific treatments. Once this literature base has been established, a comparison to add-in analyses could assist in determining the impact of recent history and sequence effects. Common multi-step treatments should be investigated in this manner to determine the weight of each component or step. This also assists with paring down treatments for the sake of efficiency as well as determining the parameters of certain treatment components for treatment success.

Several parametric analyses of treatment consistency have simulated systematic schedule thinning by implementing variations of treatment integrity on a continuum (Northup et al., 1997; Stephenson & Hanley, 2010; Vollmer et al., 1999) and obtaining behavioral stability before titrating up or down the schedule. Schedule thinning requires a systematic approach to gradually decreasing the amount of time or number of instances that an individual has access to a consequence until a desired schedule is reached. Although these data are useful in providing an overall scope of the necessary level of treatment integrity, it is unlikely that treatment implementation in the natural environment occurs with such a systematic pattern of delivery. A range of environmental factors (e.g., other children to attend to, time constraints, and avoidance of collateral behavior) may produce variability in treatment delivery. Therefore, future research investigating a random schedule of treatment consistency may be more relevant to testing the effects of naturally occurring treatment implementation on treatment outcomes.

It is also important to note that considerations related to treatment outcomes not only include the consistency and accuracy of implementation but also the immediacy and magnitude. Substantial research has yet to be conducted to determine how immediacy and magnitude are associated with treatment integrity and how they may interact with consistency and accuracy errors. One study that investigated immediacy as it relates to treatment integrity was conducted by Kliebert et al. (2011). Via a parametric analysis, the authors manipulated delays (3 s, 15 s, and 30 s) to implementation of a response interruption procedure with two participants who engaged in automatically maintained skin picking and hair twirling. They found that delayed response interruption was effective for one of the two participants. The participant with whom delayed response interruption was effective was first exposed to immediate response interruption. In contrast, the second participant (for whom delayed response interruption was ineffective) was first exposed to all three delay conditions prior to the immediate response interruption condition. Other studies have found that delays as little as 3 s can generally weaken treatment strength and in turn can decrease treatment impact (Leon et al., 2016), particularly if the delay is unsignaled and not introduced via systematic fading (Fisher et al., 2000; Hanley et al., 2001; Kelley et al., 2011; Lattal, 1984). Due to these mixed results and a lack of replication for each experimental sequence further investigation is warranted. Similar to the lack of applied studies that specifically analyze treatment integrity parameters of delayed implementation, current studies have not analyzed magnitude parameters from a treatment integrity perspective. However, past research concerning reinforcer magnitude indicates that differences in magnitude effect response rate. For instance, during time-based reinforcement a larger reinforcer magnitude results in a lower response rate (Carr et al., 1998; Roscoe et al., 2003) whereas a larger magnitude when faced with delays to reinforcement may produce a higher likelihood of acquisition (Doughty et al., 2012). Given the various changes that different magnitudes can produce, future research should manipulate the magnitude of consequence stimuli to determine whether magnitude can make a treatment more or less susceptible to undesirable treatment outcomes during lapses in treatment consistency across different types of procedures (Leon et al., 2014).

In 2012, Fryling et al. asserted that it is possible that treatment integrity failures are less detrimental if preceded by a history of high integrity. Despite significant gaps in the treatment integrity literature, the current review indicates that across procedures, recent history appears to be a pivotal factor affecting treatment outcomes following exposure to treatment consistency errors (e.g., Clark et al., 1973; Stephenson & Hanley, 2010; St. Peter Pipkin et al., 2010; Vollmer et al., 1999). Therefore, this finding reiterates and extends the literature base supporting the role of recent history and its impact on treatment consistency. Furthermore, consistency and accuracy delivered at 50% or higher were reliably effective across several studies (e.g., Leon et al., 2014; St. Peter Pipkin et al., 2010; Vollmer et al., 1999; Wilder et al., 2006). In other studies, a successful treatment outcome was possible when consistency and accuracy were delivered even less than 50% of the time (e.g., Carroll et al., 2013; Clark et al., 1973; Stephenson & Hanley, 2010). In terms of efficiency, Pence and St. Peter (2015) indicated that learning may take longer following accuracy errors. However, the existing studies did not investigate the efficiency of a procedure following consistency errors. Moreover, amongst the variety of unresolved questions, it is unclear how a combination of consistency and accuracy errors may affect treatment outcomes. To resolve such questions, a connection between treatment integrity and empirically supported behavioral principles and parameters (e.g., immediacy, magnitude, schedule, concurrent operant) must be made to provide a scope for future research and subsequent improvements in clinical practice. In an effort to make such information more consumable and easier to locate, as a field, we can make an effort to reliably include treatment integrity considerations in the discussion section of any research article that covers content relevant to the above-mentioned questions, even if it is not the primary purpose of the research.

Clinical Implications and Recommendations

Based on existing literature some general clinical considerations can be gleaned. For instance, the parametric analysis research indicates that one of the most critical times to ensure exposure to 100% treatment integrity is when the treatment is first introduced. This finding highlights the necessity of evidence-based training practices and increased clinical oversight at the outset of a new intervention. Behavioral skills training (BST) is an evidence-based methodology that comprises an explicitly stated order of steps that, when followed in its entirety, fosters a high degree of competence. BST can (a) *teach new* skills or (b) *improve skills* already in a person's repertoire. When staff members are trained using this model and provided with appropriate and ongoing feedback, treatment integrity can be expected to increase. Even experienced staff members can benefit from client-specific training and supervision to refine their skills. Parsons et al. (2012) emphasized this distinction by stating: "Though knowledge enhancement is clearly an important function of certain training endeavors, the goal of this protocol is improved performance. The distinction between training performance versus verbal skills is important because of the different outcomes expected..." (p. 2). When working to eliminate treatment integrity barriers, employing BST can have far-reaching benefits, therefore BST is highlighted in this chapter to show how it is suitable to address practical treatment integrity issues. For a thorough description of BST's essential components, please refer to Parsons et al. (2012). A summary of the standard steps encompassed in the BST model and their relationship to treatment integrity is presented in Table 24.2 and outlined in the following section.

The Relationship Between Treatment Integrity and BST A chief goal of training is to assure staff members and/or caregivers that the proposed intervention will improve the client's quality of life. Without an adequate reference tool, the implementation may suffer from mistakes related

Table 24.2 Behavioral skills training (BST) steps and their relation to treatment integrity

BST Step	Description	Relation to treatment integrity
1	*Communicate a description of the* intervention steps and *provide a rationale*	Provides a question and answer forum and strives for buy-in from trainees
2	Provide a *written summary* of the intervention	Provides a clear, concise, and objective reference tool that promotes consistency, accuracy, and uniformity
3	*Model performance* of the intervention	Provides the instructor the show the trainee the skills and offers the opportunity to emphasize all subtleties that are difficult to communicate in written form alone
4	rainees *practice* implementing the intervention (in vivo or via role-playing)	Provides objective confirmation that trainees deliver an intervention consistently, accurately (and uniformly acorss trainees).
5	*Observe trainee performance* and *provide affirmative and supportive feedback*	Provides instructor opportunities to shape accuracy and demonstrate how ongoing observations and feedback will be delivered
6	*Repeat steps 4 and 5* until the trainee demonstrates mastery of implementation	Provides necessary opportunities to improve performance and increase the likelihood of 100% treatment integrity at the outset of treatment
M	*Post-training* treatment integrity observations inclusive of data collection with BST components embedded as needed	Provides opportunities to promote optimal treatment integrity, boost degraded integrity, and maintain desired treatment outcomes

to poor recall or unclear expectations which in turn may also encourage improvisation in the form of further errors of omission and/or commission.

For that reason, the first step in BST includes communicating a description of and rationale for the intervention. By starting out with a description and rationale, the behavior analyst can gauge audience reaction, answer questions, recognize treatment aspects that may require modification, and create a firm foundation to deliver written instructions and subsequent training steps. This step allows the behavior analyst the opportunity to describe *why* the course of action has been chosen and what impact it is expected to have for the client. After delivering a description and rationale for the intervention procedures, BST directs a practitioner to provide written instructions outlining what trainee behaviors comprise the intervention you are training (e.g., break the intervention down into easy-to-follow steps similar to a task analysis) and how to implement the intervention across relevant scenarios. A written version offers a standard reference tool for use by multiple staff members and/or caregivers, which is consistent with the technological dimension of ABA (Baer et al., 1968). To accomplish uniformity across staff members and caregivers it is recommended that the intervention be operationally defined in a clear, concise, and objective manner (Gresham et al., 1993).

The next three BST components (modeling, practice, feedback delivery) have been linked to the most significant improvements in staff performance (e.g., Gardner, 1972; Hogan et al., 2015). Modeling via role-playing, video model, or in vivo provides the instructor the opportunity to show the treatment in action and emphasize any subtleties that may be difficult to communicate in written form alone. Building knowledge about particular skills is valuable as an initial means of learning; however, it is ineffective for the continued maintenance of client-specific treatment implementation (Parsons et al., 2012). Thus, the next BST step advances the process into the observable and requires that trainees practice the target skill in its entirety. To complete this key step, trainers typically create role-play scenarios that replicate circumstances in which the intervention is to be employed. It is important to model various situations that may occur when working with a client (e.g., "This is what you do if... But if this happens, do this..." "In this setting you may need to do this..."). For instance, when training a skill acquisition program, the role play should include the practice of both the error correction procedure and the reinforcement procedure. Failure to include multiple practice opportunities is likely to degrade treatment integrity being that an explanation alone may not adequately illustrate motor movements, pauses, and non-vocal expressions (i.e., demeanor and body language). Therefore, trainees are asked to practice the skill and receive feedback. Carrying out modeling and practice with feedback furnishes the practitioner with the opportunity to share how post-training treatment integrity observations will occur. By using this model, a practitioner is able to share performance evaluation criteria via verbal and written instruction modeling and practice with feedback so that trainees are then familiar with the post-training feedback style and the breadth of expectations.

The last formal step of conventional BST involves trainees continuing to practice all necessary skills until competency is demonstrated (ideally more than once). Although conducting initial training to competency is valuable it is likely ineffective for the continued maintenance of client-specific treatment implementation. Thus, this final step in the BST model has been termed the "last formal step" because in actuality the periodic replication of the BST model should become a part of one's ongoing clinical practice. This maintenance phase is integral to foster ongoing accuracy, consistency, and uniformity; therefore, practitioners should set aside ample time to conduct regular treatment integrity observations for each individual staff member or caregiver as part of a supportive client supervision structure. Moreover, as errors are observed, retraining per the BST model should be employed. As previously mentioned, the use of the BST model during treatment integrity observations is beneficial as it offers a framework that staff members and/or caregivers are familiar with given their previous experience during initial training. Moreover, treatment integrity observations should entail data collection based on the written steps of the procedure. This practice is in line with the Behavior Analyst Certification Board® (BACB®) Ethics Code for Behavior Analysts (2020). Specifically, code 3.11 Documenting Professional Activity states that "Throughout the service relationship, behavior analysts create and maintain detailed and high-quality documentation of their professional activities to facilitate provision of services by them or by other professionals, to ensure accountability, and to meet applicable requirements (e.g., laws, regulations, funder and organization policies). Documentation must be created and maintained in a manner that allows for timely communication and transition of services, should the need arise." *In addition,* Therefore, initial training, treatment integrity monitoring, and retraining should all be documented by a practitioner. Figure 24.2 offers an example of recommended treatment integrity documentation components. These components can be used to create a data sheet that coincides with a behavior intervention plan or a skill acquisition program. Figure 24.2 utilizes the procedural steps of a hypothetical program to illustrate the following components of a treatment integrity data collection form: (1) a section to tally all observed opportunities to implement the treatment, (2) a section to tally observed implementation of the treatment per the schedule trained (consistency), (3) a section to tally the number of opportunities to implement each component of the treatment, (4) a section to check off each step of the intervention that was observed to be completed as trained (accuracy), (5) sections to note errors of commission (This section is important as a reminder to that practitioner do not overlook such errors and are helpful to reference in terms of interference with clinical outcomes.), (6) a section to calculate the percentage of consistency and percentage of accuracy, and (7) a section to document all support provided during and after each observation inclusive of training details, affirmative feedback (e.g., "That was such a great way to set-up a teaching opportunity. It really captured your cleints interest") and supportive feedback (e.g., "Dont' forget to have preferred items readily available so that you can provide the reinforcer as immediately as possible. Do you need any help with ideas for arranging your set-up before running the next program?").

The frequency and duration of treatment integrity observations will depend on the level of support required to oversee a particular case. Nevertheless, a practitioner should set a minimum expectation regarding the regularity (e.g., at least monthly) of treatment integrity observations and increase support as needed based on data gathered via progress monitoring and treatment integrity observations. In addition, having objective and clear data collection allows a practitioner to provide impartial feedback to foster a supportive training process.

During initial training, practitioners should be transparent by sharing how training practices will be ongoing and outline how treatment integrity observations will be included in these practices while being sure to highlight the benefits for staff professional development, generalization of client skills with caregivers, and overall client progress alike. Treatment integrity monitoring assists with the challenge of providing feedback by structuring performance expectations and thereby offering objectivity to the feedback provided. A practitioner should provide affirmative feedback often so that supportive feedback does not stand out as the only feedback given. Formal treatment integrity allows for a structured account for affirmative feedback opportunities, but feedback should also be provided outside of these observations. Also, the BACB® Ethics code for behavior analysts *4.08 Performance Monitoring and Feedback states that "Behavior analysts engage in and document ongoing, evidence-based data collection and performance monitoring (e.g., observations, structured evaluations) of supervisees or trainees. They provide timely informal and formal praise and feedback designed to improve performance and document formal feedback delivered."* (Behavior Analyst Certification Board, 2020). When feedback is provided done

Treatment Implementation (Consistency)

Staff member or Caregiver action	Number of opportunities to implement	Number of times implemented
Procedure is implemented when it is prescribed to be conducted (whether or not all components are included or implemented correctly)		
TOTALS		
Errors of commission (e.g., was the procedure implemented when it was *not* prescribed to be conducted?)		

Treatment Components (Accuracy)

Staff member or Caregiver action	Number of opportunities to implement	Number of times implemented
1. Set up activity and omit one item necessary to complete the activity.		
2. Provide instruction to engage in the activity.		
3. If child does not request missing item within 2 seconds provide the next prompt in least to most prompt hierarchy.		
4. If child accurately requests the missing item (with *or* without prompting), immediately (within 2 seconds) provide the missing item.		
5. If child accurately requests the missing item (with *or* without prompting), immediately (within 2 seconds) deliver praise (e.g. "Nice job asking for that!").		
6. If child accurately and independently requests the missing item (*without* prompting), immediately provide the missing item (within 2 seconds) AND a small preferred edible.		
7. If child engages in an incorrect response, error correction is conducted.		
TOTALS		
Errors of Commission Were any additional components added to the procedure that are not prescribed?		

Data Collection Summary	
Treatment Consistency (Number of times implemented/Total number of opportunities to implement x 100%)	
Treatment Accuracy (Number of components implemented/Total number of implementation steps x 100%)	
Feedback & Training Summary	
Affirmative Feedback notes:	
Supportive Feedback notes:	
Additional training *Check all that apply to confirm retraining occurred during the observation session.* ___Plan review/explanation __Modeling __Role-play practice with feedback __In-vivo practice with feedback ___Check if additional training is necessary after the observation session. Additional training suggested: Additional Notes:	

Fig. 24.2 Example of treatment integrity data collection components

per current clinical and ethical standards, it fosters an environment of support, education, respect, and compassion. In turn, staff members and caregivers are more likely to welcome the treatment integrity observation process as a means to sharpen their skill set and readily accept suggestions for continuous improvement. Practitioners should strive to promote an environment that emphasizes supportive feedback as a learning opportunity and not a punitive event. An enriching relationship is best established when a practitioner is transparent about training and treatment integrity practices and lets the staff member or caregiver know when treatment integrity observations will take place, what they will entail and the purpose of such practices prior to their first observation, ideally at the outset of the professional relationship. There should be complete transparency regarding the process as well as the outcome. In fact, as part of the feedback process staff members and caregivers should be provided with both a discussion of feedback as well as written feedback on their performance via the BST training model and a copy of their treatment integrity documentation (e.g., completed treatment integrity data collection form and/or graphs of their performance). In addition, open lines of communication between a practitioner and those implementing treatment are crucial to client success. All staff members and caregivers should be encouraged to ask for clarification or feedback. For instance, they should be encouraged to ask questions if a program or plan is difficult to run or hard to understand. This type of ongoing communication will allow optimal responsiveness on the part of the clinician to achieve client progress and foster staff member and caregiver confidence and proficiency.

Several studies have referred to the abovementioned maintenance phase as BST booster training inclusive of role-play has proven effective in re-establishing high treatment integrity across various settings (e.g., Miller et al., 2014). In addition, Hogan et al. (2015) extended this research by forgoing role-play and instead conducting in vivo BST booster training with actual clients in a classroom setting to improve staff member implementation of a behavioral intervention plan. Because treatment integrity research has shown that interspersing booster sessions (consisting of 100% treatment integrity) with a client offers a promising method to salvage previous treatment effects (e.g., Colón & Ahearn, 2019; Gauthier et al., 2020), if the opportunity to ensure initially high integrity has been missed, or treatment integrity erodes over time the in vivo use of the BST model will create an instance of client exposure to 100% integrity while also bolstering staff and caregiver performance. Thus, the dual benefits of BST integrated into treatment integrity observations is seemingly the best course of action to maintain high levels of treatment integrity and improve client outcomes. However, if ample practice opportunities are not available during in vivo training, the addition of separate training sessions inclusive of role-playing can also be used in combination with in vivo BST booster sessions. Nonetheless, given that a lack of training and supervision can contribute to a considerable percentage of staff resignations (Kazemi et al., 2015), the use of BST and treatment integrity observations alongside frequent progress monitoring should be part of a practitioner's comprehensive plan to support clients, caregivers and staff members, regardless of the combination of application.

Treatment Integrity Monitoring From treatment selection to ongoing treatment monitoring and modification, gaining further knowledge of various procedures may allow practitioners to engage in more efficient and effective practices. For instance, aside from procedures that require 100% treatment integrity due to safety concerns, practitioners often choose an arbitrary retraining criterion such as 80% consistency and accuracy. However, the type of procedure, component, or error may determine the level of integrity necessary to produce significant treatment effects. Treatment integrity research offers a means to determine what level of integrity is necessary for optimal treatment effects and may assist in determining a more precise criterion for retraining based on the treatment or error being observed.

This information allows practitioners to allocate their time and resources accordingly. Specifically, treatment integrity analyses may identify the level of risk associated with specific treatment integrity failures, the boundaries of a procedure for clinical application and the ideal context to conduct a particular treatment (i.e., Vollmer et al., 1999). It is beneficial to know which treatment procedures can be used intermittently versus those that require closer monitoring, again allowing practitioners to determine the time and resources necessary to implement and monitor a given treatment procedure. In the medical field, doctors, nurses, and therapists focus on precautions to avoid medical errors, which would be considered an iatrogenic event. These mistakes are never intended, of course, but they are no less harmful to the patient. At the same time, some recommended treatments are known to produce potentially adverse effects, and therefore the healthcare team would weigh the pros and cons of these treatments and be aware of the risks. Our practice is no different and should be executed in a similar manner, therefore once a procedure or a component of a procedure is determined to be at high risk for treatment integrity failures or susceptible to poor treatment outcomes at certain levels of treatment integrity, strategies can be developed for practitioners to most efficiently avoid the detrimental effects of such treatment integrity failures. Overall, further analyses are necessary to solidify the level of accuracy and consistency necessary to produce beneficial treatment outcomes across various types of treatments (e.g., punishment procedures). However, the existing literature indicates that consequence errors should be of particular interest for practitioners to monitor as higher levels of accuracy and consistency were necessary to obtain a favorable treatment outcome for consequence manipulations in comparison to antecedent manipulations. Nonetheless, while the treatment integrity literature is developed further, it is integral for practitioners to monitor treatment integrity and treatment effects simultaneously to ensure that the level of ongoing treatment integrity is producing significant change and determine whether treatment modifications are necessary (De Fazio et al., 2011).

Conclusion

Because the practice of ABA is so closely tied to a foundation of supporting research, studies that result in predictable outcomes are easily translated into best practice standards (Ayllon & Michael, 1959). However, practitioners must be aware that in comparison to a research context, control over many programmed and/or extraneous variables cannot be equally replicated when addressing socially valid problems in the natural setting (Peterson et al., 1982). Therefore, it is key for a practitioner to adopt the perspective that their work will encounter obstacles and that they can draw upon well-researched and validated strategies to continuously improve consistency, accuracy, and uniformity. The present chapter illustrated one such empirically-validated strategy in the form of BST. While BST can be highly effective in shoring up problems with treatment integrity, it is strongly recommended that research using BST to combat low treatment integrity continue to be refined and shared.

Many are attracted to research and practice from a behavior analytic perspective due to its emphasis on parsimony, both in philosophy, explanation, and individualized treatment design. However, efforts to create a well-designed intervention in a community-based or school setting may reveal inevitable treatment integrity challenges. Overcoming barriers and proceeding to limit the unwelcome influence on treatment variables personifies a practitioner's commitment to an important recommendation made by B.F. Skinner (1972), "A failure is not always a mistake, it may simply be the best one can do under the circumstances. The real mistake is to stop trying."

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Social Validation

25

John J. Wheeler and Stacy L. Carter

Historical Development of Social Validation

Origins of Social Validation

Social validation (Kazdin, 1977; Wolf, 1978) emerged in the field of applied behavior analysis out of concern for determining whether behavioral treatments were of social relevance (Houten, 1979). Van Houten noted that there were two methods of social validation that emerged, that is, in the mid-1970s that were used in the selection of target behaviors and to determine whether a treatment was successful. These two methods were social comparison and subjective evaluation. Social comparison is a method that uses exemplars such as non-disabled, same-aged peers to establish a "behavioral norm" used for comparison when designing treatment programs and in evaluating the performance of students or consumers on their acquisition and performance of these target behaviors. With subjective evaluation, individuals such as teachers and clinicians provide feedback on the appropriateness of target behaviors selected for treatment and in turn evaluate and rate the behavior of the student or consumer before and after the treatment to provide a measure of feedback on their performance of the behavior. It could be interpreted by some that in the early formation years of social validation, the process was driven more by the viewpoints and direction of the interventionists and or researchers than from the perspective of the consumers for whom the treatments were intended.

It was during this time that Wolf's (1978) three-component definition of social validity emerged and made an impact on how treatment and research were viewed. Wolf believed that behavior analysts should ask consumers about their level of satisfaction with their treatment and the services they received which was a departure from previous practices. Wolf's definition of social validity included the following components (a) the social significance of the goals of treatment, (b) the social appropriateness of treatment procedures, and (c) the social importance of the effects of treatment. The inclusion of all three components was termed total construct social validity and stressed by Wolf that anything less than these components would be termed partial construct.

Kazdin (1980) was a proponent of this viewpoint and asserted that it was important to determine whether treatments were socially

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_25

acceptable. Kazdin also believed that a treatment should be acceptable to the individual receiving it and that treatments should not infringe upon the rights of the persons receiving the treatment, and finally it was important in determining key variables associated with treatment acceptability. Evaluating treatment acceptability as advocated by Kazdin (1980) would not only assist in refining the design and delivery of treatments but also in promoting treatment compliance on the part of the recipient. A person is more apt to engage and adhere to a treatment that they find acceptable. Adherence to treatment on the part of the stakeholder is critical to the success of any treatment program be it in the domains of education, behavior, or health care.

Schwartz and Baer (1991) further advanced this thinking and noted that the purpose of social validity assessment was to garner information that would contribute to the survival of a treatment program. They stressed that for a treatment to survive it must of course be effective and must address behaviors that are important to the consumer, that is, the individual receiving the treatment. The value to the consumer must take priority in the planning, delivery, and evaluation of a treatment program. Feedback from the consumer is vital to the success of any treatment program as it can assist us in identifying aspects of a treatment that are liked or disliked by consumers that could lead to increased engagement on the part of the consumer to fully participate and adhere to the treatment. Given the benefit of consumer feedback to the treatment process, it points to the value of total construct in the assessment of social validity. Finney (1991) reinforced this view and believed that it should be reflected in an ongoing interaction between researcher and consumer and that both grow in their understanding and refinement of the treatment resulting from this exchange. Unfortunately following the early establishment of social validity and its importance to the design, delivery, and evaluation of treatments there has been a decreasing trend over time in the development and reporting of social validity measures in the literature (Carter & Wheeler, 2019b).

Social Validity and Positive Behavior Interventions and Supports (PBIS)

With the advent of the PBIS movement, the field witnessed a deepening commitment to person-centered planning in the design, implementation, and evaluation of interventions and supports for persons with disabilities. PBIS placed great emphasis on the development of programs that were committed to the quality of life of the consumer such as expanded access to the community and opportunities for peer interactions (Dunlap & Fox, 1996). The PBIS model in many ways extended the values of the normalization principle in that it placed emphasis on the dignity and worth of the individual as its focus and the building of individualized supports through person-centered planning to foster success in daily life and environments of the individual. Basically, PBIS has been summarized as (a) a person-centered approach that is directed toward the needs and preferences of the consumer; (b) PBIS recognizes the individuality of the consumer in the delivery of support; and (c) PBIS seeks to produce meaningful outcomes that enhance the quality of life of consumers (Anderson & Freeman, 2000). These values were reflected in the original criteria that Horner and colleagues (1990) who proposed that behavioral treatments must address three criteria that included (a) the intrusiveness of treatment upon the individual targeted for treatment, (b) the social acceptability of the treatment, and (c) the degree to which a competent professional supervises and monitors the treatment. Later Carr et al. (2002) expanded on these foundations and identified nine critical features of PBIS which included (a) a focus on lifestyle change and quality of life, (b) an emphasis on lifespan supports, (c) ecological validity, (d) stakeholder participation, (d) social validity, (e) systems change and multicomponent intervention, (f) an emphasis on prevention, (g) flexibility with respect to scientific practices, and (h) multiple theoretical perspectives.

Clearly, PBIS places an emphasis on the individual and the importance of person-centered supports with social validity being one of the anchors in the development and evaluation of these individualized supports. Despite these values, the question that bears asking is how is social validity reflected in the empirical literature and to what extent has it been applied as Wolf (1978) intended, from a total construct approach.

Reviews and Empirical Findings

There have been several recent reviews of social validity in the literature ranging across the years 2010–2019 that have examined social validity within single-case studies across persons with disabilities. Unfortunately, the trend observed from all of these reviews has been a scarcity of reporting of social validity measures in general, and even more infrequent has been the use of total construct social validity in experimental studies.

Brosnan and Healy (2011) conducted a review of $n = 18$ studies in the area of developmental disabilities and only one study reported on the use of an informal measure of treatment satisfaction whereas none of the studies reviewed used any formal measures of social validity. In a subsequent review, Spear et al. (2013) reviewed single-case studies conducted with students deemed at-risk for emotional and behavioral disorders (E/BD) and though social validity was mentioned in studies, the use and reporting of social validity measures were low.

Ledford et al. (2016) reviewed single-case studies with young children with autism from 1993–2013 and reported only 44% of the studies reviewed actually included the measurement of social validity. This trend of reviews reporting low percentages of social validity continued. Callahan et al. (2017) conducted an extensive review of $n = 828$ articles of which only 26.7% or $n = 221$ studies reported on measures of social validity. In another study, Snodgrass et al. (2018) conducted a systematic and in-depth review of single-case studies across six journals dating from 2005–2016. In total, they reviewed $n = 429$ studies from the years 2005–2016 and only 27% of studies reported social validity of which only 7% of the studies reviewed utilized total construct social validity as defined by Wolf's (1978) three-part definition. Carter and Wheeler (2019b) conducted a comprehensive review similar to that of Snodgrass et al. (2018) but targeted their review to single-case design studies from one journal, *Education and Training in Autism and Developmental Disabilities* (*ETADD*) spanning from 1997–2018. They conducted an initial electronic and hand search that revealed a total of $n = 858$ articles of which 85% of the articles or $n = 298$ were single-case design studies. Carter and Wheeler (2019b) had three objectives for their review, the first being to identify the percentage of studies that utilized total construct social validity, second, to determine how total construct was measured in terms of instrumentation and finally to present a reliable instrument for measuring the types of social validity in the literature.

The results from the Carter and Wheeler (2019b) review indicated that of the 298 single-case design studies reviewed, $n = 138$ or 46% of the studies reported social validity. Of this number, $n = 128$ or 93% of studies used partial construct social validity and $n = 10$ or 7% of the studies used total construct. The review also determined that single-case designs in the journal *ETADD* reported social validity more frequently, that is, 46%, and also total construct social validity was reported more frequently, that is, 7% greater than other journals as referenced from previous reviews.

When one considers the data from these reviews it is apparent that there is a need for the increased reporting of social validity within single-case research studies and also a need to examine journal review practices relative to social validity as a fundamental component in single-case studies. Studies submitted for review should not be judged solely based on the efficacy of their data related to behavior change with no consideration given to inputs or feedback from the consumers with regard to their acceptability and satisfaction with such treatments. Carter and Wheeler (2019b) stressed the importance of total construct social validity as defined by Wolf (1978) as the "gold standard" of practice when designing, implementing, and evaluating interventions. This practice reinforces the person-centered philosophy advocated within the PBIS model and reinforces the points made earlier by Wolf (1978) and others. Finally, Carter and Wheeler (2019b) posed the question if the absence of social validity data was a function of editing practices across various journals with respect to page limits of manuscripts and whether or not social validity should be an element within a single-case research study that is required for publication? Is the absence of these data a matter of having not collected them or a failure to report them? The inclusion of a standard requiring that social validity is reported within a study prior to a review would reinforce this evidence-based practice within the literature and subsequently enhance our understanding of the acceptability of specific treatments from the perspective of consumers that could potentially better inform research and practice.

Methods of Evaluating Social Validity

There are several methods for measuring social validity, which could broadly be categorized as informal and formal methods (Carter & Wheeler, 2019a). Informal methods include such options as researcher-developed scales, interviews, open-ended questions, and personal narratives. Formal methods include questionnaires and rating scales that have undergone some level of validation in terms of their reliability and validity. It is recommended that both informal and formalized measures are necessary to present an accurate depiction of the social validity of interventions to control for researchers who could possibly develop a bias and use only those methods that provide favorable social validity ratings. It is frequently the case that informal methods are most often used in the development of treatment goals, treatment acceptability, and treatment satisfaction. The benefits associated with informal methods of evaluation are that they are specific to the individual consumer, the setting, and the situation. Given this, they are the most useful in terms of the development of a treatment program for an individual and in determining the level of satisfaction on the part of the consumer with the treatment and the treatment outcomes for the individual and their quality of life.

Informal Measures

Though the informal method of social validity has a great deal of functional utility when in applied contexts, on an individual level there are challenges when assessing social validity. Snodgrass et al. (2018) highlighted the challenges of evaluating social validity in applied settings given the vast variety of factors that must be considered. One of these challenges is that informal measures lack validity and reliability. Another obvious challenge is the variability found among consumers with disabilities including presenting characteristics, individual strengths, and support needs especially among persons with severe disabilities. The use of formal measures seems more applicable when working with groups of stakeholders as in the case of school districts that are looking at implementing interventions or policies that will affect a greater number of stakeholders such as teachers, students, and families.

One area of formal measurement within social validity is treatment acceptability (Kazdin, 1980) which is defined as the subjective judgment of persons concerning the acceptability of treatments. These individuals can be consumers, family members, and/or nonprofessionals. The importance of treatment acceptability reinforces the views of Wolf (1978) who spoke of the social importance of treatment in terms of the social significance of treatment for the individual, the social acceptability of the treatment in the view of society, and finally that the treatment should have clinical significance (Carter & Wheeler, 2019a, b). The research on treatment acceptability is a new area of study within the fields of education and psychology and even less in the area of health sciences, but certainly an area worth further investigation in the future. Unfortunately, the trend within social validity research, in general, is that it is typically not the topic of interest, but rather a secondary topic within treatment studies aimed at behavior change (Kennedy, 2002).

There are several methods for evaluating social validity under the categories of informal and formal measures. Informal measures are most popular and are developed for a specific treatment and as stated do not include any formal validation of the instrument. Formal instrumentation however is used within some research studies. Both methods pose challenges in terms of monitoring the frequency and efficacy of their use within the research given they are a methodological component of a study and are secondary to the major focus of the study. Table 25.1 provides some examples of methods used to assess social validity.

With respect to the use of interviews in assessing social validity as Carter and Wheeler (2019a, b) have indicated this method allows for the gathering of a great deal of information in a brief amount of time, though as the authors warn it can result in information that is not necessarily related to the evaluation of a treatment. There have been references made in the literature as to the use of interview formats such as the semi-structured interview, a method that utilizes a question and answer format pertaining to specific areas of social validity. One early illustration of this method was a study conducted by Gresham and Lopez (1996) that consisted of 21-initial questions with the addition of follow-up questions. These questions reflected the three areas of social validity, the first set of questions 1–9, were directed toward the significance of treatment goals, the second set of questions 10–15 assessed treatment acceptability, and the remaining set of questions, items 16–21 addressed the social importance of effects. The format created by Gresham and Lopez (1996) provides a very systematic and cohesive structure for the semi-structured interview when assessing social validity.

Table 25.1 Examples of methods used to assess social validity

Interviews (formal or informal)
Inventories
Questionnaires
Surveys
Rating scales
Formal instruments
Social comparison using performance criteria, for example, normative such as peers
Behavioral observation

Behavioral observation is a useful method for determining the social validity of treatment including peer comparison and acceptability (Carter & Wheeler, 2019a, b; Schwartz & Baer, 1991). Though peer comparison has not been cited as frequently in the literature in recent years a study conducted by Ennis et al. (2013) offered suggestions to researchers when using peer comparison for evaluating social validity within the context of learners with challenging behaviors. They provided examples of using multiple baseline and withdrawal designs to monitor challenging behaviors and also the behaviors of comparison peers on the same graph to allow for peer comparison. Ennis et al. (2013) emphasized that peer comparison is the most objective form of social validity and these recommendations for data collection allow for ease in both data collection and allowing for peer comparison.

Formal Measures

There are a variety of formal measures designed to measure social validity, of which we will identify and discuss a representative sample. For a more exhaustive analysis of formal measures, the reader is encouraged to consult Carter and Wheeler (2019a).

Of the emerging number of formal measures aimed at assessing treatment acceptability the *Treatment Evaluation Inventory* (TEI) developed by Kazdin (1980) along with the *Intervention Rating Profile* (IRP) designed by Witt and Elliot (1985) are the most widely used. Kazdin (1980) developed the TEI to assess treatment acceptability for treatments developed for children with behavior disorders. The intent of the TEI was to evaluate treatment acceptability independent of the effectiveness of the treatment. The TEI consists of a 15-item in the form of questions using a seven-point Likert scale regarding specific treatment procedures. Scores are tallied and totaled by summing the responses from all the items with the higher summed total scores indicating greater levels of treatment acceptability. A principal component analysis of the TEI resulted in item loadings from 0.61 to 0.95 on a unitary factor accounting for 51.4% of the variance (Carter & Wheeler, 2019a, b).

The *Intervention Rating Profile* (IRP) (Witt & Elliott, 1985) was created in an effort to increase treatment acceptability research in educational treatments and to increase awareness among practitioners of treatments deemed acceptable by teachers. The IRP consists of 20 items that are rated on a six-point Likert scale. Scores are summed and totaled with higher scores indicating greater levels of acceptability. The internal consistency of this instrument was reported to be 0.89 (Carter & Wheeler, 2019a, b). The IRP was modified in an effort to shorten the instrument and improve internal consistency and became known as the *IRP-15* (Martens, Witt, Elliot, & Darveaux, 1985). The IRP-15 includes a 15-item, six-point Likert scale with higher summed scores indicating greater levels of acceptability (Carter & Wheeler, 2019a, b).

The *Treatment Acceptability Rating Form* (TARF; Reimers & Wacker, 1988) is a measure designed to assess treatment acceptability as perceived by parents within a clinical setting. The TARF consists of 15 items and utilizes a seven-point Likert scale with the internal consistency of this instrument ranging from 0.80 to 0.91. The *Treatment Acceptability Rating Form-Revised* (TARF-R; Reimers et al., 1991) is an expanded version of the TARF designed to measure the acceptability of treatments within clinical settings. The internal consistency of this instrument was reported as 0.92. The TARF-R consists of 20 items of which 17 items address treatment acceptability, two questions are dedicated to addressing problem severity and one question addresses understanding the intervention. The scoring involves arriving at total scores by summing all items with higher summed scores indicating greater levels of acceptability (Carter & Wheeler, 2019a, b).

In spite of the increased number of formal instruments available to assess treatment acceptability there does not appear to be an increasing trend in the use of these tools by researchers. One possible reason for their lack of use is their inability to detect small changes in behavior (Elliot et al., 1993; Carter & Wheeler, 2019a, b). Carter and Wheeler (2019a, b) provided some potential strategies for increasing the usage of acceptability measures that included making these instruments more readily available to researchers and clinicians as often the instrument is only referenced in an article but obtaining the actual instrument can sometimes prove quite difficult. Increasing a fluent knowledge and understanding of these instruments within graduate training programs will assist in improving their use and understanding among researchers and practitioners and hopefully result in their visibility within programs serving persons with disabilities. Finally, there needs to be a resurgence in both personnel preparation programs within colleges and universities and also within program delivery as to the importance of social validity and the value of these data in serving consumers.

A Summary of Research on Social Validity

The research that has been conducted on social validity has focused on three areas, namely (a) treatment acceptability or social appropriateness of treatment, (b) significance of treatment goals, and (c) the effects of treatment. Of these three dimensions, the area of treatment acceptability has been the most widely researched (Carter & Wheeler, 2019a, b).

Treatment Acceptability

The area of treatment acceptability was initiated by Kazdin (1980) who in the formative stages of developing the Treatment Evaluation Inventory (TEI) evaluated the acceptability of four treatments for deviant child behavior described to 88 undergraduate college student raters. The four treatments ranged from least-intrusive-to-most intrusive and consisted of (a) reinforcement of incompatible behavior, (b) time-out, (c) drug therapy, and (d) electric shock. The procedures involved the presentation of one of two different case descriptions, that is, details on the behavioral challenges, the person seeking treatment, characteristics and diagnostic label, the setting, and four differential treatments for a child with significant behavioral challenges. After listening to these cases, the participants completed the TEI and selected items from the Semantic Differential (Osgood et al., 1957). This process was repeated until all cases were completed. Statistically significant differences were found across all treatments with the order of acceptability as rated by participants as reinforcement of incompatible behavior, time-out, drug therapy, and electric shock.

Kazdin (1980) completed a subsequent replication study aimed at studying the potential impact of the severity of the presenting problems contained in the case study descriptions. The second study differed in terms of the specifics of the case studies as one child was reported to have moderate behavioral challenges and the other one severe behavioral challenges such as self-injury, property damage and severe disruptive behaviors associated with intellectual disabilities and based within an institutional setting. The procedure was the same as the first study. Each of the $n = 94$ participants was presented with one of the four case descriptions. The findings from this study indicated that reinforcement was rated significantly more acceptable than the other treatments and notably electric shock was rated significantly less acceptable than the other treatments. No differences were noted between the remaining two treatment options, that is, time-out and drug therapy. The studies conducted by Kazdin (1980) serve as a template for studying treatment acceptability and as a model for research investigations in this area.

Treatment acceptability has been widely reviewed in the literature on a variety of topics. These reviews have resulted in information designed to guide practice in the area of treatment acceptable. One such review by Reimers et al. (1987) resulted in the identification of five factors believed to influence treatment acceptability that included (a) severity, (b) treatment approach, (c) time required to implement a treatment, (d) the side effects associated with a treatment, and (e) the cost of a treatment. Several additional reviews on treatment acceptability have been conducted and have included reviews on the acceptability of behavioral interventions and support for school-aged children (Elliott, 1988); early childhood education (Miltenberger, 1990); measurement trends in social validity (Kennedy, 1992); schoolwide positive behavior supports (Rasnake, 1993); school-wide delivery services (Eckert & Hintze, 2000) among others.

Significance of Treatment Goals

Though most of the research on social validity has centered on treatment acceptability and the social significance of treatment effects, it is most important to consider the development of treatment goals as a major component of the three-component process that qualifies as total construct social validity (Wolf, 1978). When selecting socially significant treatment goals several considerations must be taken into account.

Critical to this period of consideration in the development of treatment goals is what Carter and Wheeler (2019a, b) have referred to as pre-treatment assessment. This phase of the process allows for careful consideration of the variables that must be considered in the formation of socially significant goals. Important in this individualized process are the inputs from the consumer, their family, any data pertinent to the discussion, and the resources in terms of support that are available for the individual. Most development of treatment goals relies on informal interviews, but Carter and Wheeler (2019a, b) devised a list of the questions to be considered in the development of socially significant treatment goals from an extensive review of the literature on the development of treatment goals. From this review, a number of specific questions were developed to aid in the process and in the enhancement of the social significance of treatment goals. These questions were arranged into five categories (1) preferences and values of the consumer; (2) normalization; (3) choice; (4) habilitative potential; and (5) awareness of coercion.

Preferences and Values of the Consumer

The personal preferences/values of the consumer must be a primary consideration. Goals are individualized based on the input received from the consumer and their family in many cases. It is important to determine the values of the consumer and family as a foundation for goal development (Carr, 1996). In previous years, many persons with disabilities were denied these inputs, and personal choice was not something readily available to them as individuals and is something of the utmost importance especially as it pertains to behavior change. This is often a challenge as many professionals see their role as of greater importance and their input as more valued when in reality it must be a partnership between professionals/consumers and family members when applicable. This is perhaps, even more, a concern when professionals are working with individuals from diverse cultures where the cultural norms and values may be something unknown to the professional. During this pre-assessment phase, it is important that professionals utilize both formal and informal means to gather the relevant information needed to consider the personal preferences and values of the consumer.

One example of this from the field of special education is the use of the McGill Action Planning System (MAPS) (Forest & Lusthaus, 1989; Vandercook et al., 1989). It represents a team-based approach with the student, their family including siblings and grandparents, members of their educational team including teachers, instructional assistants and therapists, and significant others including same-aged peers and is a process by which goals and supports are identified through a series of questions led by a facilitator. The group is asked about (a) the student's history, (b) the student's dreams and goals and that of their family, (c) the concerns the student or parents have, (d) the individual student's gifts and strengths, and (e) the individual student's needs? After gathering this information, these inputs are discussed and then prioritized with the team forming a plan of action to aid in providing a student-centered plan with the support needed for the student to realize their goals.

Some examples of relevant questions to ask when developing goals are, do the goals align with the personal preferences and values of the consumer? Is the consumer comfortable with the goals and potential outcomes associated with the goals? Do the treatment goals involve other individuals valued by the consumer? (Carter & Wheeler, 2019a, b).

Normalization

Another important aspect of developing socially significant goals is to distinguish to what degree the proposed goals promote increased opportunities for normalization for the consumer. Questions to consider in his area are the treatment goals focused on age-appropriate activities and behaviors. Do the treatment goals reflect activities engaged in by typical same-aged peers and do treatment goals provide support for existing skills needed for normalization (Carter & Wheeler, 2019a, b).

Choice

The opportunities for personal choice in life are important to everyone and one consideration when developing socially significant goals is to consider whether are there opportunities for choice as a component of the goals. Freedom of choice is an essential component to one's quality of life and treatment goals should reflect that. Carter and Wheeler (2019a, b) state that the choice of treatment goals may be a factor in influencing the significance of the treatment goal. Directly related to this are the questions of will the treatment goals generate high-quality reinforcement and do the treatment goals allow for immediate reinforcement. So as the choice is an essential component to the development of treatment goals, access to reinforcement associated with the goal should be considered also.

Habilitative Potential

“Habilitative potential” is a term that Hawkins (1991) operationalized behaviors that maximize increased opportunities for reinforcement and minimize opportunities for punishment. Carter and Wheeler (2019a, b) summarized this area with the following relevant questions to be considered. Are treatment goals aimed at the development of new and emerging skills such as social skills, leisure skills, and educational skills? Do treatment goals increase access to new environments? Are treatment goals focused on acquisition and fluency or more long-term gains such as maintenance and generalization?

Awareness of Coercion

Coercion should never be a part of any form of treatment, but obviously, it is likely to be something that still occurs too often. For consumers who do not have the requisite self-determination skills and for those who are limited in terms of their abilities to communicate, self-advocate, and who are passive, they may experience a greater likelihood of coercion pertaining to treatment goals than others.

In summary, some strategies for increasing the social significance of treatment goals are to consider conducting semi-structured interviews with the consumer and their family gathering their input on their specific goals, their values, and the things that they enjoy. Next, seek information from multiple sources to provide clarity in the development and selection of treatment goals. Take into account all relevant aspects of the individual’s life in terms of what it generally consists of, the people who comprise it, the environments that surround it, and also the opportunities and areas where support is needed. Once goals are established, then rank-order them in order of importance and develop desired outcomes associated with them.

Treatment Effects

The social significance of treatment effects is the final criterion identified by Wolf (1978). Treatment effects are an area that behavioral research has typically addressed within research studies. Treatment effects are consistent with outcomes and those effects or outcomes realized speak to the merits of a treatment. An important aspect of treatment effects that often is overlooked is the benefits of a treatment to the consumer. Simply put, the impact that the treatment has on the life of the individual for whom it is intended. Carter and Wheeler (2019a, b) point out that treatments may produce significant clinical benefits and demonstrate a functional relationship between an intervention and the dependent measure, but if the treatment fails to have valuable consequences (benefits) for the consumer it fails to address the most important consideration.

If a treatment program is aimed at changing behavior and the outcome of the treatment produces no measurable impact on the individual’s quality of life can it be judged effective? Kazdin (1994) identified three types of data collection that are essential for evaluating social validity in terms of treatment effects and these are (a) peer comparison data, (b) subject evaluation data, and (c) social impact measure data. Peer comparison data involves data from typical same-aged peers who are the normative group that serve as the comparison group thus providing a model of desired behavior.

Subject evaluation consists of having the consumer collect data with support if needed on how important some of their individual behaviors are to them and then using this information to develop treatment goals. After a treatment has been implemented, these same behaviors can be re-evaluated by the consumer to determine if the same behaviors are still considered a high priority or if they are considered less detrimental to the consumer because of the treatment (Carter & Wheeler, 2019a, b). Social impact data are those data contained in formal reports such as school office referrals and or informal reports such as teacher, or parent narratives. Each of these sources of data can be used to enhance the development of treatment goals by providing a written record of occurrences of certain events.

Future Research Considerations

Though research in the area of social validity has progressed over time since its inception there are areas where future research could expand the field's understanding of the application of this important construct. These areas will be briefly discussed with recommendations provided for future consideration.

Research on Social Validity and Ethics

When one considers the importance of ethics within a profession and the code of ethical practices that guide professionals in the delivery of services the relationship between these values and the use of social validity in the delivery of these practices to individuals would appear to be very strong. Hayes and Tarbox (2007) defined ethical conduct in behavior analysis as (a) comparing and contrasting the options that are available and (b) after considering these options, then making a decision as to the course of action to take to address the situation. In the future, it would benefit the field to further explore this relationship between social validity and ethical practices, especially in areas such as treatment acceptability. The value of the individual, a respect for their rights and freedoms, and a responsibility to uphold these in the design, delivery, and evaluation of treatment are embedded within the ethics and values that serve to govern practice and also as the foundation for social validity. Professional organizations have ethical standards that govern professional conduct in the areas of PBIS and ABA.

Wheeler and Richey (2019) summarized the ethical practices across professional bodies including the National Education Association (NEA), the Council for Exceptional Children (CEC), the standards of practice for the Association for Positive Behavior Support (APBS), and the Behavior Analysis Certification Board that resulted in nine organizing themes. In summary these organizing themes derived from the code of ethics from each of these organizations affirmed (1) the worth and dignity of the individual; (2) the behavior of children and youth serves a function or a need for the individual; (3) systematic and thoughtful management of learning environments will serve to help in preventing and mitigating challenging behavior; (4) families, children and youth should be central to all aspects of PBIS including active participation in the planning, implementation an evaluation of interventions; (5) the uniqueness of children and youth as reflected by their family's diversity (race, culture, ethnicity, and religious practices) should be taken into consideration when addressing their behavior support needs; (6) natural environments and inclusive settings are desirable for children and youth with challenging behavior, but school personnel must do so in a responsible manner by providing supports to all involved including the student(s) and teachers and a continuum of placement alternatives should also be available when needed; (7) naturally and logically occurring consequences are preferable to contrived consequences for promoting self-discipline independence and self-determination; (8) behavior supports should be positive and should not include punitive practices; and (9) actions on the part of professionals aimed at addressing challenging behaviors should be aimed at the development of meaningful replacement behaviors that are positively related to the quality of life for the individual.

Schalock and Luckasson (2005) synthesized the ethical principles governing many professional organizations into five principles that included (1) competence, (2) professional and scientific responsibility, (3) respect for people's rights and dignity, (4) concern for the welfare of others, and (5) contributions to society.

Carter and Wheeler (2019a, b) took these same five points as described by Schalock and Luckasson (2005) and proposed a framework for conducting research in the area of social validity along these same principles. More specifically Carter and Wheeler (2019a, b) proposed that in the area of competence professionals should become fluent in their understanding and application of the conceptualizations and methods used in the area of social validity. Within the principle of professional and scientific responsibility, they recommended that professionals be directly focused on improving and promoting the methods used in the evaluation of social validity. In the area of respect for the dignity and rights of the individual, it was recommended that research be conducted on the input of consumers on the development of goals, procedures, and the effects of treatment. The need for research on standardizing a process for conducting social validity assessments was recommended as a method for reflecting the welfare of others through new research in this area. Finally, concerning the last principle of contribution to society and others, Carter and Wheeler (2019a, b) note that research on social validity assessment and its relationship to ethical conduct be a topic at the forefront of future research on contributing to the betterment of society and others in the area of ethics.

Research on Social Validity and Cultural Diversity

The role of social validity when working with persons from diverse cultures is an area in need of further research to better inform our practices. This is an area that has long been overlooked. Unfortunately, professionals with limited knowledge and background respective to persons from diverse cultures have had their professional efficacy diminished because of a lack of cultural competence. The term cultural competence defined by Rew et al. (2003) included four components. These included (1) cultural awareness, (2) cultural sensitivity, (3) cultural knowledge, and (4) cultural skills. Basically, cultural competency includes one's ability to meaningfully interact with persons from diverse cultures in a manner that invokes one's awareness of the culture, sensitivity, respect for the culture, and a working knowledge of the culture to allow for a working relationship. More research is needed on the applications of social validity within educational, community, and healthcare programs serving persons from diverse cultures. Some research on embedding culturally sensitive and responsive practices in the delivery of healthcare has emerged that has included the field of nursing (Campinha-Bacote, 2002; Shen, 2015).

Some specific areas to examine would be the development of social validity measures sensitive to the cultural norms of persons from diverse cultures. Also critical to this is the assessment of cultural preferences and norms. One example from the healthcare literature was a review of culturally competent healthcare practices conducted by Anderson et al. (2003). They referenced a framework that could be used to evaluate the effectiveness of programs designed to enhance the cultural competence of healthcare providers. This framework utilized the following interventions with a focus on developing cultural competence among the staff. These included (a) programs aimed at the recruitment and retention of staff members who reflected the cultural diversity of the community, (b) the use of interpreters and bilingual staff to accommodate the communication needs of the patients, (c) cultural competency training and professional development for staff, and (d) the use of linguistically diverse and culturally specific health education materials for patients. So, more research is needed to improve our delivery practices to persons from culturally diverse populations and social validity assessment can be a tool to assist in these efforts.

Fong et al. (2016) provided practical considerations for behavior analysts working with persons from diverse cultures. These recommendations though targeted for behavior analysts do have broader applicability to professionals from other disciplines including education and allied health. Minimizing the technical language within the discipline could serve to confuse consumers. Unfortunately, the cultural context of the consumers including that of family members, is sensitive to the native language of the consumer and their family, and utilizing available resources to better inform one's cultural competence can help maximize person-centered service delivery (Fong et al., 2016). These recommendations serve as general guidelines for enhancing the delivery of services and support to consumers from diverse cultural backgrounds. The need for targeted research on enhancing these relationships and the development of culturally sensitive social validity measures is warranted.

Research on Social Validity and Healthcare

Finally, healthcare represents an area where social validity is most needed to improve the accessibility of healthcare interventions (WHO, 2016). This has become more evident given the Covid-19 pandemic and its global impact that reinforced the need for efficient and patient-centered healthcare delivery systems. Social validity measures in the area of treatment acceptability could enhance healthcare delivery in areas such as patient compliance and adherence to treatment. There is a need for research on this as examples are minimal in the literature. However, the field of nursing has to some degree addressed the topic. These have included studies on treatment acceptability and patient preferences (Sidani et al., 2009) treatment acceptability in the geriatric patient population (Fox et al., 2018).

More research is needed on the acceptability of healthcare interventions and social validity is recommended as a means by which to increase our understanding of the acceptability of specific interventions from the perspectives of patients and to increase the probability of their use (WHO, 2016). Such treatment acceptability data could enhance the efficacy of patient care practices and in turn could lead to more optimal patient outcomes as a result of improved treatment adherence.

Summary and Conclusions

In summary, this chapter has attempted to provide a brief over on the construct of social validity (Kazdin, 1977; & Wolf, 1978). We have discussed the value of social validation as an efficacious method for ensuring that behavioral treatments, goals, methods, and outcomes reflect the values and goals of the individual and are satisfactory to the individuals served and their families. This chapter examined the historical development of social validity, the application, and implementation of these methods across behaviors and populations, the need for reporting social validity in empirical studies, and the need for expanded research on social validity with regard to professional ethics and practices, the need for culturally sensitive social validity measures and finally the applications of social validity in healthcare and the acceptability of treatments.

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Part IV

Functional Assessment

26 Experimental Functional Analysis

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The experimental functional analysis (EFA) technology maintains a strict adherence to establishing a believable demonstration of the influence of environmental events over problem behavior. The EFA distinguishes itself from other functional assessment methods (i.e., indirect assessments, descriptive assessments) in that its core procedures involve the direct observation of measurable, operant behavior and systematic manipulation of environmental events in a single-subject experimental design (Hanley et al., 2003). When the EFA methodology is stripped of any defining features of specific formats, the requirements are simplified to a test–control comparison of contingent putative reinforcement presented in the test condition and noncontingent delivery of those same reinforcers in the control condition. In other words, the most conservative demonstration of functional control over problem behavior involves a simple change in the contingency while maintaining all other constants across the test and control conditions.

It is important to point out that EFA is not simply an empirical demonstration of control over problem behavior. Considering that the target behavior will always be one of social importance, the purpose of conducting an EFA is to inform effective, function-based treatment. Therefore, an EFA always incorporates a level of clinical and experimental relevance, with an underlying focus on clinical implications. That is, an EFA is only as good as the treatment it informs. This connection between EFA and treatment is defined as treatment utility.

Treatment utility broadly refers to the importance of a set of procedures for improving the socially relevant outcomes of a client. When applied to the EFA, it means that clinicians should select the method that best informs the design of the most effective and acceptable set of treatment procedures (Hayes et al., 1987; Slaton et al., 2017). In that regard, an EFA can only be validated as having utility by evaluating the subsequent treatment it has informed. Therefore, an EFA is more than just an analytic tool for identifying relations between environmental events and problem behavior. There are a seemingly infinite number of contingencies that can be evaluated if applied researchers were so inclined to identify and catalog them. The usefulness of an EFA is determined by its ability to (a) identify the ecologically relevant contingency in a reasonable amount of time and (b) influence the clinician's decision-making process when developing a subsequent treatment package (Kratochwill & Shapiro, 2000).

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_26

Researchers and clinicians both share the need to understand why behavior is occurring; however, clinicians are bound by a level of restraint to understand only to the point that is useful in helping the clients they serve. The concept of treatment utility seems to be at direct odds with the views shared by many staunch basic scientists who wish to understand behavioral mechanisms down to the intricate details. Applied behavior analysts may, therefore, find themselves caught in a balancing act of scientific inquiry and practical demonstrations of functional control. However, that which separates those who are applied behavior analysts and those who are basic behavior analysts are dimensions of societal relevance (Baer et al., 1968). Therefore, applied researchers need to keep in mind that what clinicians define as effective is dependent on the clinical goals they are looking to achieve. In other words, clinicians use the EFA to determine the best care that can be provided to a patient. Understanding clinical utility will help applied researchers determine the socially relevant boundaries of the EFA and how to establish a level of control that sufficiently contributes to meaningful change in problem behavior.

The purpose of conducting an EFA is, and always has been, to develop effective behavioral interventions for problem behavior based on an operant understanding of environmental variables that are believed to be contributing to problem behavior. Although this purpose has remained immutable over the years, EFA technology has changed considerably since its early founding in behavior analysis.

Historical Influence

Behavior is a direct product of environmental variables, and these environmental variables substantially impact the occurrence of problem behavior. Early behavior analytic researchers were tasked with first demonstrating that problem behavior as obscure as self-injurious behavior (SIB) could be influenced by the same operant principles as lever-pressing or key-pecking in a laboratory. That is, early accounts of problem behavior were often mentalistic or appealed to genetic contributors because operant causes were conceptually difficult to consider without empirical demonstrations. Furthermore, behavior modification approaches in some of the first applications of operant principles to socially relevant situations provided evidence that problem behavior could be reduced using powerful arbitrary punishers (Aexlrod & Apsche, 1983); however, these demonstrations did not implicate that environmental variables including reinforcement necessarily contributed to the original development of the problem behavior. In other words, it was well understood that problem behavior could be modified, mollified, or suppressed using behavioral interventions, but the origins of maintaining variables remained a mystery.

Schaefer (1970) provided one of the first demonstrations of problem behavior being shaped by reinforcement. Using two docile rhesus monkeys, Schaefer began providing various fruits contingent on raising a paw and subsequently reinforced closer approximations until the animals were making contact with their heads. In addition, the experimenter was able to gain discriminative control over head hitting using verbal cues, including statements of concern (e.g., “poor boy”). Schaefer even, possibly unintentionally, foreshadowed the evaluation of common contingencies to be evaluated in future applied work when describing the potential perception of the arrangement to others (p. 113): “To a naïve onlooker it might well have appeared that the experimenter showed extreme ‘compassion’ or ‘attention’ during the S^D periods, while he was ‘indifferent’ during the S^Δ period.” Schaefer may have been alluding to the fact that some caregiver actions that appease an individual’s problem behavior, although empathetic, can come to serve as reinforcers and thereby worsen the behavior, contraindicative to the caregiver’s well-meaning intent. Early basic studies such as Schaefer led to the conceptualization of problem behavior being sensitive to and influenced by an underlying history of reinforcement, a belief now regarded as a well-solidified assumption by current applied behavior analysts.

After discovering that problem behavior, although topographically distinct, could be influenced by environmental events, early applied researchers paved the way for determining exactly what contingencies existed in an individual's context that could possibly lead to such deleterious outcomes. It is one thing to show that problem behavior can act as an operant if you systematically arrange for arbitrary reinforcers to follow their occurrence. This evidence, in and of itself, is limited to informing the clinician that problem behavior is *susceptible* to reinforcement in the broad sense but not necessarily sensitive to naturally occurring contingencies. Teachers and caregivers are not openly attempting to reinforce problem behavior in the school or home environment. Therefore, the experimental question needs to be reverse-engineered to understand contingencies supporting problem behavior that already exists. It is one of our truths that we must accept as behavior analysts that if operant behavior is occurring, there must be a source of reinforcement. To be of more clinical value, applied researchers needed to create an EFA technology that could identify the reinforcement responsible for problem behavior in a socially relevant environment.

The logic of unmasking reinforcers in the natural environment contributing to problem behavior using experimental designs has been of interest as early as the 1960s. In one of the first published demonstrations, Lovaas (1965) was working with a young girl in a psychiatric ward who had been diagnosed with schizophrenia. The patient exhibited severe SIB and, based on his experience with her, Lovaas was well aware that various forms of social approval were the preferred consequence. Through multiple experiments, Lovaas systematically drew conclusions regarding the relation between social approval and SIB, beginning with displays of elevated levels when the positive attention was removed in the context of play (i.e., problem behavior was evoked during extinction) and ending with a demonstration of the contingent delivery of attention following SIB. This case proved to be an important step in the development of the EFA for two reasons. First, environmental events that contribute to problem behavior can include antecedent variables in addition to reinforcers. Lovaas established the value of attention by removing it from observations and saw a corresponding increase in SIB without the manipulation of consequences. Second, attention is a common event that occurs within a child's life and is likely to hold some value with many individuals. Many applied researchers were influenced by Lovaas to further develop standardized approaches to understanding the evocative effects of common antecedents and strengthening effects of select consequences beyond a demonstration with a single individual.

The validation of common environmental events contributing to problem behavior leads to applied researchers establishing categories of possible operant mechanisms that any individual could be experiencing. Carr (1977) put forth his own hypotheses for common variables, of which many are still identifiable to this day. Three categories included (a) positive reinforcement in the form of social consequences, (b) negative reinforcement often in the form of escape from academic demands, and (c) self-stimulation we would now consider automatic reinforcement. Carr repeatedly expressed that neither of these categories were necessarily all-encompassing in that attention was the only form of possible positive reinforcement and escape from academic work the only form of negative reinforcement; however, it put forth the assumption that these were common culprits. This was enough to establish two EFA models based on Carr's general categories of positive, negative, and automatic reinforcement.

The first EFA focused solely on the evocative effects of academic demands and has been termed an antecedent–behavior (AB) model because any consequences are not manipulated. In some early demonstrations, researchers would select easy and difficult academic tasks for the participant to complete and found that more problem behavior tended to occur in the condition with the difficult tasks (Carr & Durand, 1985). The AB model is somewhat incomplete in that it only empirically validates the influence of academic tasks as discriminative stimuli that evoke problem behavior, and the behavior analyst is left to infer the value of removing those tasks as negative reinforcers. This is juxtaposed with the second functional analysis model in which the antecedents and consequences are systematically presented and removed contingent on problem behavior, termed the antecedent–behavior–consequence (ABC) model. The ABC model thereby completes the contingency manipulating both the discriminative stimuli that evoke problem behavior and the reinforcers likely to maintain the problem behavior.

An early ABC model (Iwata et al., 1982/1994) used a similar condition evaluating the influence of academic tasks; however, escape is provided contingent on the occurrence of problem behavior. This escape condition is then alternated with two other test conditions and one omnibus control. The test condition evaluating positive reinforcement includes contingent reprimands following any instances of problem behavior, and the remaining test condition acts as a default to determine if the behavior will continue to occur in the absence of any socially mediated reinforcement (i.e., automatic). All of these conditions are compared to the control that includes a synthesis of establishing operations to reduce the occurrence of problem behavior, whether it is influenced by escape from tasks, access to attention, or self-stimulation. In other words, the participants were provided with continuous access to preferred toys, noncontingent attention, and no demands. Of course, this is not an ideal preparation to compare individual test conditions to a single omnibus control, but adherence to experimental precision gave way to practical considerations (it is more efficient to only include a single omnibus control instead of multiple control conditions per each test condition).

EFA Core Components

The ABC model designed by Iwata et al. (1982/1994) has come to be designated as the standard EFA and is comprised of five core procedural components. These five components are identifiable as being replicated in studies across decades of EFA research and are mutually exclusive in that an EFA model either has a core component of the standard or does not (Jessel et al., 2020a). Therefore, components juxtaposed with the standard EFA can be identified as countercomponents.

The first core component is the inclusion of multiple test conditions compared to a single, omnibus control condition. Behavior analysts may have multiple hypotheses for what could be contributing to problem behavior or may be interested in understanding the effects of different components of a reinforcement contingency. More commonly, multiple test conditions are used to separate general classes of reinforcement to create a broad but superficial interpretation of many different environmental events. A limitation of including multiple test conditions is the possibility of creating an overwhelming environment for the participant that extends exposure to a multitude of different conditions during an assessment period. That is, differences between conditions and the contingencies being evaluated can begin to be muddled, making discrimination difficult. Researchers have attempted to reduce this limitation by including salient discriminative stimuli (Conner et al., 2000) or arranging a specific order of implementation to capitalize on establishing operations (Hammond et al., 2013). A second limitation of using multiple test conditions is the potential confounded comparison of isolated reinforcement in each test condition to the synthesized reinforcement of the control condition. The EFA including multiple test conditions reduces the experimental rigor of the analysis procedures because more variables are being manipulated in the play control than compared to each individual test condition. The countercomponent eliminates these limitations by creating a single test–control comparison. The applied researcher could develop an EFA with a single test condition in one of two ways. First, multiple hypotheses could still be evaluated; however, they are conducted in separate analyses with their own control conditions. Second, hypothesized contingencies could be combined into a single test condition, creating an equal and opposite omnibus test compared to the omnibus control (Jessel et al., 2016).

The second core component of the standard EFA is the use of uniform test conditions across participants. The general contingencies evaluated with one participant are replicated and repeated with each individual during an EFA that uses uniform test conditions. From an economical perspective, using uniform conditions implies using the same set of materials across clients, potentially reducing cost. Furthermore, training staff members on how to conduct the EFA may become simplified because the procedures will hardly differ between clients and the same training can be used to conduct multiple assessments. That being said, any qualitative information specific to the history of reinforcement and experiences of each individual is lost. This is especially pertinent to individuals with problem behavior that is not sensitive to general classes of reinforcement (Schlichenmeyer et al., 2013). Therefore, the countercomponent is to create unique test conditions representing individualized contingencies designed from qualitative information obtained through open-ended interviews with caregivers and direct observations. EFAs with unique test conditions are tailor-made to understand specific contingencies affecting problem behavior, requiring each assessment to include distinctive procedures.

The third core component involves attempting to isolate the effects of positive and negative reinforcement on problem behavior. Doing so emulates the basic laboratory, decoupling events that naturally co-occur in an attempt to understand the main effects. Socially mediated reinforcers in the natural environment tend to co-mingle to establish complex contingent relations, and isolated reinforcement is rarely recognized for contributing to human communicative behavior (Skinner, 1957). Like the single atom in an object, what we see and interact with is the combination of molecules sorted and configured in a very specific manner. The behavior analyst conducting the EFA can use isolated test conditions to quash empirical curiosities of the individual properties of reinforcement or include the countercomponent of synthesized contingencies aimed to represent the daily experiences that contribute to the problem behavior in the client's natural environment. Thus, the level of synthesis in a test condition is more of a continuum in that a behavior analyst can combine every potential reinforcer or attempt to reduce the contingency to its basic elements. From a practical standpoint, the contingency should be synthesized to the point that best informs effective therapeutic strategies (Slaton & Hanley, 2018).

The fourth core component of the standard EFA is the inclusion of a play control condition whereby the clients are provided with additional tangible items unrelated to the test conditions and presented with qualitatively different attention in the form of natural interactions in the context of engagement with the preferred items or general praise. The play control creates an enriched environment that suppresses problem behavior with a collection of potential reinforcers and preferred items. The countercomponent matches reinforcement in the control to that of the test condition to reduce exposure to multiple confounds. For example, if problem behavior is assumed to be sensitive to attention, much like the test condition, the control should incorporate only attention to reduce the influence of other potential contingencies. The matched control ensures that the elimination of the contingency is the only difference between the two conditions (Thompson & Iwata, 2005). Rather than suppressing problem behavior using an enriched environment, the matched control eliminates problem behavior using the same reinforcement identified in the test condition that maintains it.

The standard EFA may have created a commitment to using a set of specific core components; however, variations in EFA formats exist and have been developed for expressed practical purposes (Iwata & Dozier, 2008; Metras & Jessel, 2021). The historical influence of the standard EFA should not be overlooked for its impact on the movement in applied behavior analysis toward relying on experimental demonstrations of control over problem behavior. In addition, it is safe to say that many, if not all, EFA formats developed in the past three decades have some ancestral connection to the standard model, be it sharing some of the core components or being influenced by the original ingenuity. That being said, the EFA technology continues to evolve as the research shifts in the direction of evaluating socially relevant procedures for improved adoption of the EFA among clinicians and acceptability among constituents.

Variations in EFA Formats

The standardization of EFA laboratory procedures allowed researchers to clearly communicate their findings with one another, and the amount of research published on functional analyses of problem behaviors rapidly grew (Beavers et al., 2013; Hanley et al., 2003). As the efficacy of this standard EFA format increased, so too did the demand for function-based treatments of problem behaviors. As an assessment model, the standard EFA developed by Iwata et al. (1982/1994) was sufficiently general to be used across a variety of behavior topographies. The inclusion of categories of reinforcement commonly reported to maintain problem behavior (e.g., access to attention or tangibles, escape from instructions) ensured that the widest variety of clients possible would have had an opportunity for their behavior to come under the control of these contingencies. Testing for a behavior's broad sensitivity to each purported general consequence for problem behavior attempted to ensure that no possible reinforcement effect was left untested.

Although successful in the experimental settings, the procedural generality did not necessarily translate to differentiated analyses or effective treatment outcomes outside of the laboratory (e.g., Hagopian et al., 2013). The procedures that had become reliable during experiments did not capture the range of unique stimulus arrangements naturally present in the contingencies reinforcing problem behavior. These individual differences were unintentionally expunged from experiments and were instead replaced by a set of average experiences that were common to all participants but specific to none. In addition, the precise and standardized procedures that had been such a boon to scientists identifying functional relations were often cumbersome and impractical to clinicians working in home, clinic, and school settings (Hanley, 2012; Oliver et al., 2015; Roscoe et al., 2015). Researchers then began modifying the core components of the standard EFA to better address the concerns of clinicians and aid in the transition of an experimental technology to more practical applications in ecologically relevant settings.

Initial modifications to the standard EFA were designed to increase the specificity and relevance of the analysis. They included adding additional uniform conditions apart from attention and escape conditions, such as a tangible condition (e.g., Day et al., 1988), incorporating idiosyncratic or preferred reinforcers into test conditions (e.g., Carr et al., 1997; Mueller et al., 2005; Schlichenmeyer et al., 2013), and opening the contingency class to include less-dangerous precursor behavior (Borrero & Borrero, 2008; Smith & Churchill, 2002). Later modifications of the standard EFA changed core components of the analysis to address specific clinical concerns (e.g., efficiency, ecological relevance, safety), some of which resulted in the development of novel EFA formats (Fig. 26.1). The key characteristics of these novel EFA formats are briefly described below.

Latency-Based EFA

One broad concern with EFA methodology is that the rate-based measures common to experimental analyses preclude some socially significant responses from these assessments. Responses may be excluded from an EFA because the topography is too dangerous to be allowed to occur (e.g., eye-gouging) or because assessing the topography with a rate measure adds confounds to the experiment (e.g., elopement). Thomason-Sassi et al. (2011) circumvented these problems by making one change to the standard EFA methodology while maintaining all of the core components. This change resulted in what is now known as the latency-based EFA. The latency-based EFA relies on the same multi-element condition presentation characteristic of standard EFAs but uses latency-to-the-first-response in place of rate

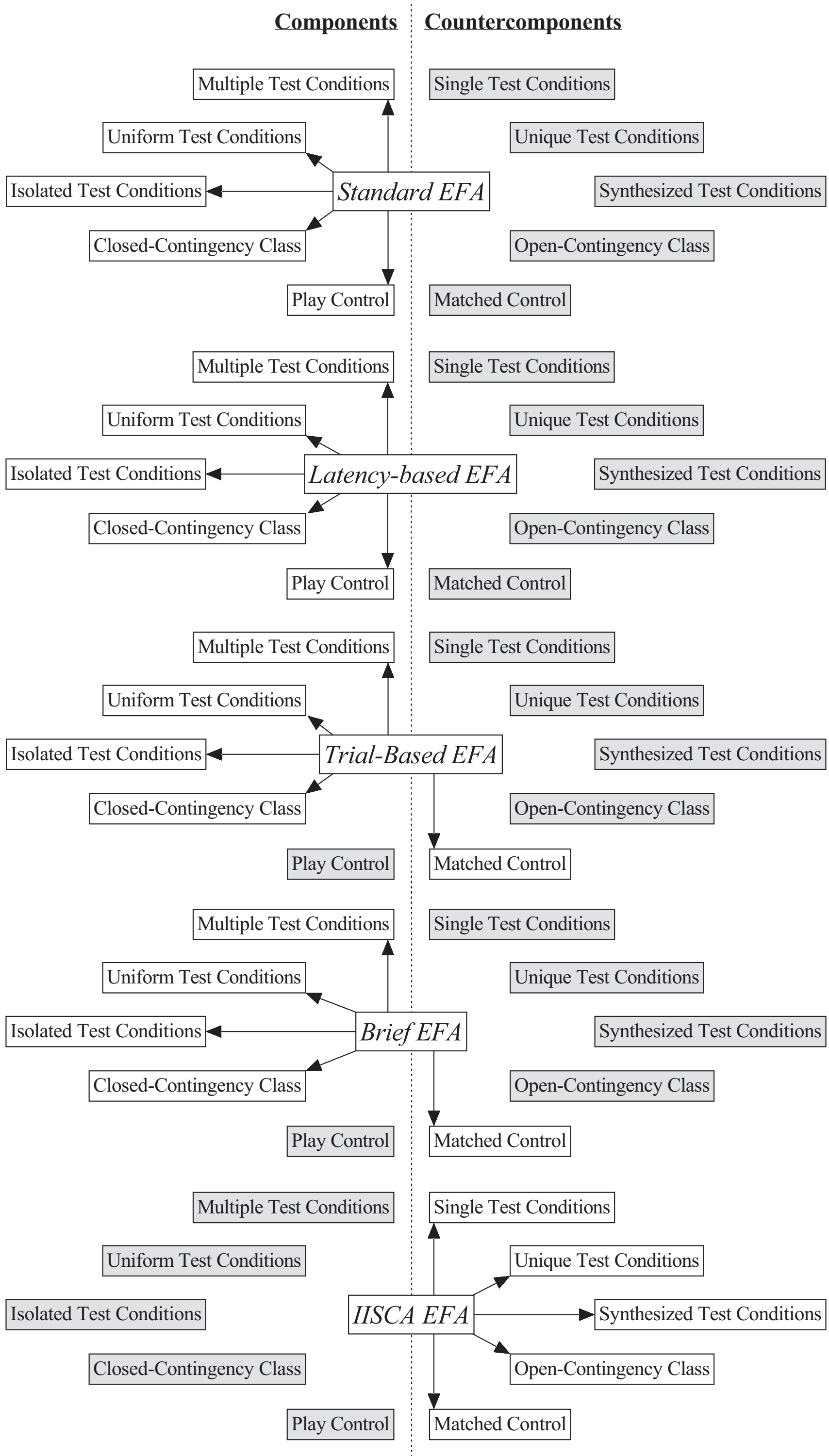

Fig. 26.1 EFA components and countercomponents

measures. During test conditions, an experimenter presents an EO that remains in place until an instance of target behavior occurs. Condition-specific reinforcement is then delivered contingent on this response. Following the conclusion of the reinforcement interval or the session's time limit, the next session is initiated.

By measuring response latency, Thomason-Sassi et al. (2011) achieved differentiated analyses for their participants in analogue settings in less time than the standard EFA and with fewer instances of problem behavior observed before achieving differentiation. These results have since been replicated in residential facilities, hospitals, and schools across various topographies of SIB, aggression, noncompliance, and elopement (e.g., Hansen et al., 2019; Lambert et al., 2017; Neidert et al., 2013; Perrin et al., 2018). Treatments for problem behavior informed by latency-based FAs have also been successful in replacing problem behavior with skills (e.g., Caruthers et al., 2015; Falcomata et al., 2016; Lambert et al., 2017).

Trial-Based EFA

Because the EFA is an analogue of conditions found outside of the laboratory, there is a significant risk that any effects observed within the experimental setting will not generalize to the target treatment context (Mace, 1994). The use of general categories of reinforcement in place of individual, context-specific stimuli may also preclude desired treatment effects in the natural environment (Carr, 1994; Horner, 1994). Sigafoos and Saggers (1995) developed the trial-based EFA format to address this concern in the classroom setting, where problem behavior could be assessed under ecologically relevant conditions. The researchers managed to maintain most of the core components of the standard EFA while replacing only the play control condition with a matched control. The trial-based format was conducted by embedding trials of three uniform test conditions (i.e., attention, escape, tangible) into two students' daily routines. Trials consisted of two 1-min segments, with the first segment serving as the test and the second serving as the control. During the first segment, a putative establishing operation was in place, and the first instance of problem behavior resulted in the presentation of the second segment, noncontingent access to the reinforcement matched to the establishing operation. Because the assessment was conducted under the same conditions where treatment would eventually occur, the trial-based format increased the confidence that any effects observed during the analysis would also transfer to the treatment context.

These procedures have since been replicated: across public school, head start, and special education settings; with children with and without intellectual and developmental disabilities; when implemented by parents, graduate students, teachers, and paraprofessionals; and across severe and emerging problem behavior topographies (Fahmie et al., 2020; Gerow et al., 2019; Rispoli et al., 2014; Ruiz & Kubina, 2017). More recently, trial-based EFAs have also been used to inform treatments for elopement and vocal scripting (Lambert et al., 2017; Rispoli et al., 2018). Although trial-based EFAs have been used across a variety of settings, the components of each are relatively static. All trial-based EFAs included the characteristic set of trials split into test and control segments, as well as standard EFA conditions that were adapted to participants' individual preferences. Experimenters generally conducted between 10 and 20 trials during each trial-based EFA, and trial segments usually lasted between 30 s and 1 min. The brevity of this analysis offers an improvement over the extended time taken to conduct a standard EFA. A recent study by Dowdy et al. (2021) comparing interrater reliability of the trial-based FA found that a panel of experts could reliably identify problem behavior function for three participants after 10, 15, and 20 trials of the trial-based FA had been completed, suggesting that total assessment time need not take more than 10 min of a participant or implementer's time.

Brief EFA

Even though the standard EFA provided empirical evidence of a behavior's sensitivity to consequences, this procedure was not widely adopted into clinical practice. Achieving a differentiated analysis with a standard EFA initially required behavior analysts to conduct equal amounts of 15-min sessions for any conditions included in the analysis. These sessions were not usually completed in one sitting, often resulting in hours of functional assessment time spread across weeks or months. Clinicians reported that these procedures were too time- and resource-intensive to be incorporated into regular work schedules, and as a result, they primarily relied on descriptive assessments and structured interviews to identify purported reinforcers for problem behaviors (Axelrod, 1987; Doss & Reichle, 1989). To demonstrate that the EFA could be modified to meet the challenges of providing assessment services in an outpatient clinic, Northup et al. (1991) modified the EFA to develop what would eventually be known as the brief EFA format.

Northup et al. (1991) made four changes to the standard EFA, including one main modification to a core component to develop the brief format. First, the researchers reduced the duration of all sessions from 15 min to a range of 5–10 min. Second, rates of a predetermined replacement behavior were measured during sessions in addition to problem behavior. Third, participants were exposed to only one to two sessions of each condition during the assessment. The final modification was the substitution of the play control condition with a matched control whereby the implicated contingency was reversed to support the replacement behavior. Otherwise, all components of the standard EFA remained the same. Participants were exposed to social negative, social positive, and alone conditions, and brief access to the purported reinforcer in each condition was contingent on one topography of severe problem behavior (aggression). These modifications allowed Northup et al. to complete an EFA with three individuals with intellectual or developmental disabilities within one 90-min outpatient visit. At the end of the outpatient visit, the experimenters also demonstrated that each participant's replacement behavior was sensitive to the same consequence(s) as their aggression, providing some direction for later treatment efforts.

Northup et al. (1991) demonstrated that EFAs could be made more practical for clinicians by greatly reducing the time needed to conduct an analysis and identifying one replacement behavior for future function-based treatments. Initial replications of these procedures showed some generality with respect to analysis outcomes (e.g., Derby et al., 1992), but the failure of later researchers to consistently achieve correspondence between brief and standard EFA outcomes raised questions about the level of experimental control demonstrated by the brief FA (Kahng & Iwata, 1999).

Interview-Informed Synthesized Contingency Analysis (IISCA)

Concerns about the standard EFA have occasioned a variety of different FA formats. These formats were created by changing only one component of the standard EFA, making each format well suited to accomplish a goal of analytic efficiency, safety, or utility while leaving all other components of the EFA intact. Preserving most elements of the standard EFA while changing one or two component parts enables experimenters to carefully evaluate the effect of their change on the outcomes of the analysis. However, this may also limit what the analysis itself can achieve. Optimizing any one particular component of an EFA based on the standard format will greatly increase the effectiveness of that component, but those outcomes are unlikely to carry over to the other components of the analysis. For example, designing an incredibly efficient EFA does not guarantee that participants are safer within that analysis. Likewise, optimizing an EFA for experimental precision does not guarantee clinical utility. It follows, then, that individual components of the analysis can be greatly improved in isolation, but comprehensive improvements in analytic safety, utility, and efficiency can only be achieved through all-encompassing changes to the standard EFA format.

Hanley et al. (2014) introduced an EFA format called the interview-informed synthesized contingency analysis, or IISCA, which combined multiple modifications to the individual components from the EFA formats described above to create one comprehensive EFA aimed at increasing safety and efficiency. The combination of these components resulted in a format that shares minimal procedural similarities with the standard EFA apart from the systematic manipulation of establishing operations and contingent delivery of reinforcement following behavior (i.e., ABC model). Thus, the IISCA represented a complete departure from the core components, now relying on the full set of five countercomponents. Whereas the standard EFA alternates between a play control condition and multiple uniform test conditions, each designed to assess the effect of one set of antecedents and consequences on one response topography, the IISCA alternates between brief (3–5 min) matched test and control sessions. These conditions assess the sensitivity of multiple forms of problem behavior to one unique reinforcement contingency composed of synthesized establishing operations and reinforcers reported to co-occur in the natural environment by caregivers. Incorporating the unique establishing operations and consequences caregivers report to co-occur with problem behavior (i.e., unique test conditions) ensures that the analysis conditions are more similar to the conditions that maintain problem behavior under ecologically relevant settings.

In one sense, using synthesized contingencies increases the clinician's confidence that a functional relation has been established because the synthesized contingency accounts for all other plausible alternatives of behavior change. In another sense, this modification may lack the precision some researchers are interested in achieving because the isolated effects of each establishing operation and purported reinforcer on behavior are unclear (Fisher et al., 2016). The question then becomes, *what level of specificity regarding reinforcement is necessary*?, with applied researchers and clinicians likely leaning to answer that question, *the level in which informs the most effective treatment while maintaining elements of pragmatism and practicality.* Thus, the likely outcome is not so easily parsed between a dichotomy of synthesized or isolated conditions but a continuum of synthesis that is suitable for the individual and informed by caregiver reports of the problematic context as a whole.

The procedures and outcomes of Hanley et al. (2014) have since been replicated across settings, cultures, problem behavior topographies, and participant characteristics (Coffey et al., 2020). Researchers have also continued to further modify the IISCA to better suit the needs of particular individuals or settings. These additional modifications have in turn created novel IISCA formats modeled after the EFA formats described above. A shorter version of the IISCA, the single-session IISCA, was developed to further reduce the time clients spend in assessment (Jessel et al., 2019), and trial- and latency-based IISCAs were developed to better capture ecologically relevant contingencies and assess elopement, respectively (Curtis et al., 2020; Jessel et al., 2018b). Combining pre-existing EFA formats exemplifies the flexibility of the EFA technology and may further enhance the clinical utility of EFA procedures that were once almost entirely an experimental model.

Evaluating Control During EFA

Evaluating the outcomes after conducting an EFA has engendered its own avenue of research because the standard EFA model required advanced training to visually analyze. The overlap between multiple test conditions rapidly alternating with a single control made it difficult for behavior analysts to interpret potential functional relations. In order to identify a functional relation, behavior analysts would need to compare changes in level, trend, and variability in one test condition in comparison to the control while ignoring all data from the other test conditions. This process would need to be repeated for each test condition to create independent interpretations of the influence of each isolated contingency over problem behavior. In addition, visual analysis has often been traditionally preserved as more of an art that will appropriately develop with enough practice and feedback from expert mentors. To that end, researchers began developing structured criteria to serve as aids to the more subjective process.

The original structured criteria used to supplement visual analysis of EFA results (Hagopian et al., 1997) created quantified ranges of mean rates that would be indicative of differentiated outcomes for each EFA conducted. Standard deviations were calculated based on the rate of responding in the control condition, and the structured criteria used a binary system to identify if there was or was not a functional relation based on the number of data that appeared above that standard deviation. The structured criteria were later modified (Roane et al., 2013) to improve sensitivity to EFA of varying lengths and included additional criteria related to other aspects of visual analysis such as trends. However, the interpretations remained limited to a binary outcome. Therefore, behavior analysts using the structured criteria could only establish an answer of whether or not the problem behavior is likely to be sensitive to the environmental variables but not the degree to which those variables influenced problem behavior.

The structured criteria were later adapted to create categories of differentiated levels of outcomes (Jessel et al., 2020b, c). That is, the interpretation of the results of an EFA was no longer the overly simplified "yes" or "no" answer. The structured criteria now allowed for more refined interpretations of levels of potential control. For the EFAs with interpretable control, the behavior analyst used the multilevel structured criteria to further establish if the control was strong, moderate, or weak.

The determination of level of control is dependent on two criteria: overlap between conditions and observing problem behavior during the control. The EFA has strong control if there is no overlap between the test and control conditions and no problem behavior is observed during the control condition. This relation identifies a properly motivating context in the test condition if rates of problem behavior remain elevated and stable when the putative reinforcer is contingently provided. In addition, the lack of problem behavior in the control condition provides confidence that the influence of extraneous variables has been sufficiently eliminated. A behavior analyst who has identified a strong level of control during an EFA can go on to develop an effective function-based treatment. A step lower would be an EFA with moderate control whereby there may be some overlap between test and control conditions or problem behavior during the control condition. The moderate relation indicates that there is some sort of extraneous influence, but putative reinforcers are still the central contributors to problem behavior, and the behavior analyst should still be confident that they can develop an effective treatment. Once an EFA is identified as having weak control—both overlap between conditions and problem behavior during the control—the behavior analyst must now question if they have sufficiently identified the contingency as a whole that influences problem behavior. Weak control is indicative of a need to modify the EFA or the necessary concession that any function-based treatment based on an EFA with weak control will likely be only mildly effective without supplemental procedures (e.g., arbitrary reinforcers or punishment) and may not produce meaningful change.

Being able to evaluate control during an EFA is central to a behavior analyst's training because those interpretations will have direct implications for the selection of function-based treatment procedures. For example, the process of extinction requires the general knowledge that the contingent relation between reinforcement and problem behavior should be broken; however, the procedures for implementing extinction will differ depending on which functional reinforcer is identified (Iwata et al., 1994). Furthermore, problem behavior that is sensitive to multiple reinforcers requires a far more complex understanding of extinction (Jessel et al., 2018a). That is to say, interpretations of control during an EFA are important because they will impact treatment efficacy.

Other Considerations of EFA

Multiple issues could arise when conducting an EFA such as undifferentiated outcomes or identification of sensitivity to automatic reinforcement. An undifferentiated outcome could infer multiple potential interpretations depending on the patterns of problem behavior observed. First, EFAs that include multiple test conditions could result in poor discrimination with the rapid alternation of those conditions in a multielement design. Therefore, the saliency of the experienced contingency could be improved by including arbitrary and distinctive discriminative stimuli, or the design could be modified to a reversal or pairwise comparison (Hagopian et al., 2013).

Second, the results of the EFA may not clearly rule out automatic reinforcement, and to appropriately treat, the behavior analyst will need to parse out that which is sensitive to socially mediated and automatic reinforcement. Querim et al. (2013) suggested conducting pre-analysis screening of automatic reinforcement with the conduction of multiple extended alone sessions. If problem behavior eliminates during these extended alone sessions, the behavior analyst is encouraged to search for more potential means of modifying the EFA to improve the chances of identifying socially mediated reinforcement. If problem behavior continues to occur, the behavior analyst must continue with other means for targeting this problem behavior that is sensitive to automatic reinforcement. The open-ended interview that informs the IISCA also includes questions for caregivers screening potential automatic reinforcement to address these behaviors before spending the time and resources to conduct an EFA.

Third, the EFA could also result in undifferentiated outcomes without problem behavior occurring. With the assumption being that the patients are referred for services because some level of problem behavior exists, this suggests a potential false-negative outcome, implying that there is a history of reinforcement and the EFA failed to appropriately identify this history. This is potentially the worst possible outcome because it means the behavior analyst must either (a) send the patient home without treatment, (b) continue conducting assessment and delay implementation of function-based treatment, or (c) implement treatment with powerful arbitrary reinforcers and punishers. To put this into perspective, mammograms are x-ray screenings of a woman's breast that are conducted to detect tumors that could lead to breast cancer. The physician is unable to provide appropriate treatment if the mammogram incorrectly concludes that no cancerous tumors exist (i.e., false negative). Therefore, in this case, the mistake is potentially fatal. For the most part, problem behavior will not be severe enough to reach such extreme cases as the example of breast cancer, but the implications regarding false-negative outcomes remain a cautionary analogy.

Reducing False-Negative Outcomes

Individualizing procedures incorporating contingencies informed by caregiver reports and descriptive observations have often been found to reduce the potential false-negative outcome (e.g., Bowman et al., 1997; Hagopian et al., 2007; Hausman et al., 2009). For example, Bowman et al. conducted a standard EFA for the problem behavior of two individuals admitted to an inpatient hospital. Problem behavior for both participants was infrequently observed during the standard EFA, and the behavior analysts were unable to successfully identify isolated functions of the problem behavior. Bowman et al. returned to the caregivers for idiosyncratic information regarding the context in which problem behavior occurred in the natural environment and began collecting descriptive data during observations. Informed by the parental reports and observations, the behavior analysts concluded that problem behavior was likely evoked by denials and was sensitive to honored requests as reinforcement. The subsequent individualized EFA was designed using that information and validated these conclusions with positive or negative reinforcers provided upon request for a period of time only following instances of problem behavior in the test condition. Encounters of this kind implicating the necessity of modifying standardized procedures may be more common than not.

Hagopian et al. (2013) reviewed 176 standard EFAs conducted with patients admitted to an inpatient hospital to categorize common modifications that were necessary following the common occurrence of false-negative outcomes when using standard EFA procedures. The authors found that 53% of initial EFAs were unable to identify a function for problem behavior, and the behavior analysts often employed changes to the experimental design, antecedents, consequences, or, quite commonly, a combination of procedure changes. It wasn't until tertiary EFAs were conducted did the behavior analysts reach differentiated outcomes above 85% in the 176 applications. Therefore, considering these modifications from the start could improve the efficiency of the assessment and treatment process and reduce overly extended analysis periods (Jessel et al., 2016).

Automatic Reinforcement

The EFA is strategic for determining the influence of socially mediated environmental events on problem behavior, but complications arise when the reinforcement comes directly from the behavior of the individual. Behavior analysts often provide the default category of automatic reinforcement when the results of an EFA are undifferentiated with elevated levels of problem behavior across conditions or when elevated rates are observed in an alone/ignore condition. Current EFA methodology cannot necessarily pinpoint the source of automatic reinforcement without extensive analysis. For example, after conducting a standard EFA and determining that the problem behavior of two individuals diagnosed with intellectual and developmental disabilities was sensitive to automatic reinforcement, Patel et al. (2000) extended EFA conditions to include different sensory stimuli (auditory and different tactile stimulations). Although the researchers were only able to rule out some potential stimulation, a treatment of differential reinforcement of other behavior (DRO) using preferred items that produced the hypothesized stimulation was effective in reducing problem behavior. Others have similarly designed a preference assessment to be conducted following the EFA to identify matched and un-matched stimuli that appear to produce the same or similar automatic reinforcement (e.g., Piazza et al., 2000; Rapp, 2007). However, the precision of these multiple assessments in identifying specific sources of automatic reinforcement remains in question, and the conclusions drawn from an EFA are far more likely to support the general assumption regarding the continued observation of problem behavior when socially mediated reinforcers are not forthcoming.

Finding the source of automatic reinforcement may yield an opportunity to implement function-based sensory extinction (Iwata et al., 1994), but the reliance on secondary and tertiary modified procedures calls into question the practicality of an EFA process that can produce a potentially effective intervention. The over-analytic assumption that fuels multiple and complex EFAs is that a precise identification of isolated, or pure, reinforcement contingencies may inform the best treatment; however, a more parsimonious solution is to delineate patterns of automatic reinforcement and identify treatment strategies that are likely to correspond with those patterns (Hagopian et al., 2015, 2016). This treatment utility approach allows the behavior analyst the ability to make confident EFA-informed decisions when designing a treatment following the results of only a single analysis.

Hagopian et al. (2015) delineated between three subtypes of SIB dependent on the patterns observed during standard EFA. Figure 26.2 depicts these patterns using hypothetical data in an EFA stripped to the core essentials for identifying the three subtypes. That is, the EFA needs a control condition of enriched reinforcement, a test condition without social reinforcement (alone or ignore), and a measure of self-restraint. The top panel of Fig. 26.2 identifies automatic reinforcement (Subtype 1) in which the control condition effectively suppresses SIB and, without this alternative form of stimulation, elevated rates are observed in the alone condition. This is

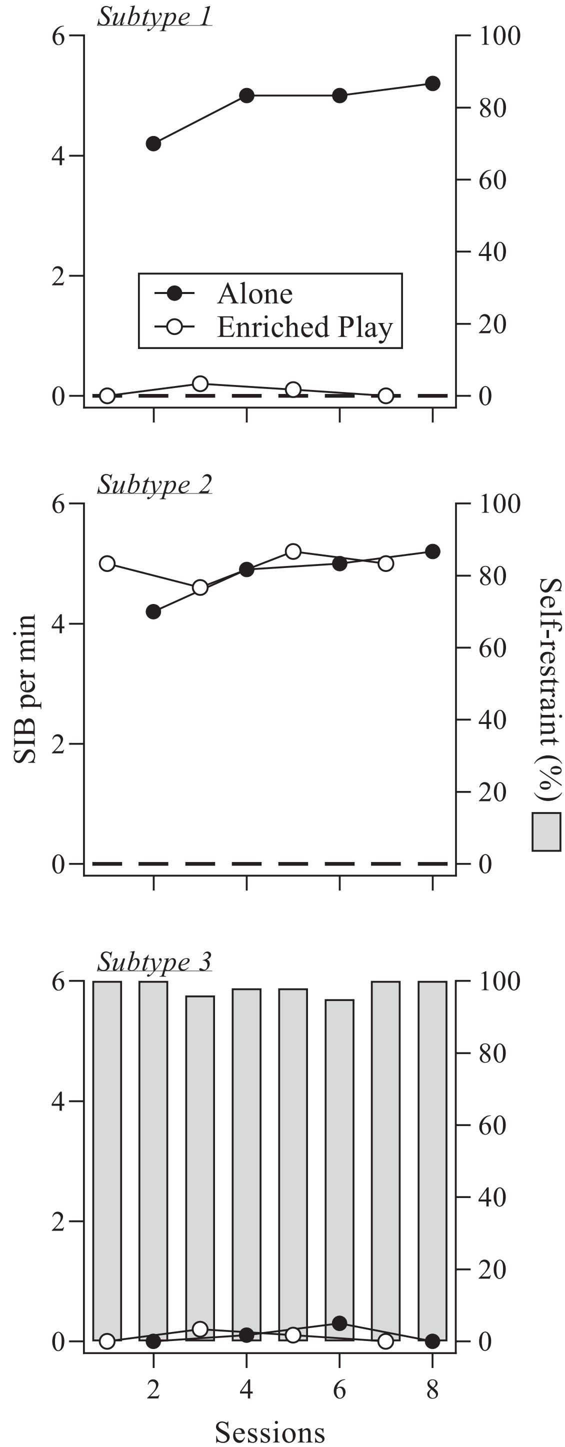

Fig. 26.2 Hypothetical data representing the three subtypes of automatic reinforcement

a highly differentiated outcome supportive of the subsequent effectiveness of reinforcement-based strategies considering that the noncontingent delivery of rich reinforcement in the control condition could compete with the automatic reinforcement obtained from the SIB. Automatic reinforcement (Subtype 2) is far more pervasive across conditions (middle panel) and, unfortunately, is predictive of a resistance to treatment and the necessity of treatment packages with multiple, more intrusive, treatment components such as response blocking, punishment, or restraint. The bottom panel provides the hypothetical pattern observed during automatic reinforcement (Subtype 3). When the patient is provided access to self-restraint, SIB tends to be low across conditions with high levels of engagement in self-restraint. Much like Subtype 2, there is little differentiation across conditions, but treatments including restraint or protective equipment are likely to be effective. Therefore, each delineated subtype of automatic reinforcement informed the selection of different treatment procedures.

Social Acceptability of Procedures

In clinical practice, EFAs are conducted to increase the likelihood of a successful intervention outcome. When clinicians identify the contingencies that evoke problem behavior, they are better equipped to begin building skills under relevant conditions than they would have been had no EFA been conducted at all. Although the ultimate purpose of the EFA is to identify a context that can be used to teach ecologically relevant skills, it is important that the quality of the analysis not be overlooked to fast-track a treatment program. An EFA's procedures should be designed with the same care and consideration for client well-being as any of the intervention procedures that it will later inform. As with any skill acquisition program, an EFA that prioritizes client well-being includes procedures that ensure client assent, happiness, safety, and dignity throughout the entire assessment process. Some strategies clinicians can use to create more considerate EFAs are briefly discussed below.

Behavior analysts are required to obtain written consent from clients prior to beginning any behavioral assessment (Behavior Analyst Certification Board, 2014). In many situations, caregivers or legal guardians will provide written consent on behalf of the service recipient because their age or disability status may legally prevent them from doing so themselves. Even if the client is not the person signing the consent forms for the EFA, their preferences and comfortability during the assessment process should still be taken into account. Behavior analysts can accomplish this by asking clients for their assent to participate in an EFA. Like informed consent, assent to participate in an EFA can be given, discussed, or revoked at any time during the assessment process. If the client and the clinician can communicate easily with one another, this assent may be written, spoken, or signed. However, nonverbal behavior might also be used as an index of client assent if clients are given a choice to participate in the assessment or to leave and participate in other activities. If different contingencies are arranged in a concurrent operant or concurrent chains procedure, a client remaining in the session space or continuing to engage with their preferred items and activities during an EFA might be interpreted as assenting to the current environmental conditions arranged by the clinician. If that same client makes any attempt to leave the session space or seems continuously discontented by the clinician's actions, these responses might be interpreted as a withdrawal of assent (see Hanley, 2010, for further discussion on objective measures of preference).

One recent example of this interpretation of client assent can be found in Rajaraman et al.'s (2022) enhanced choice model procedures. Participants in this study experienced a concurrent operant treatment model following the completion of an IISCA, where they could select to terminate services for that day, participate in the treatment process (i.e., differential reinforcement of skills and extinction of problem behavior), or take a break from the treatment procedures and "hangout" with their caregivers and preferred activities (i.e., noncontingent reinforcement). All participants selected to hangout and take a break from function-based treatment at least once during the study, but chose to spend most of their time in the treatment context. By the end of the experiment, all participants had learned communication skills, followed instructions provided by the experimenter, and emitted reduced rates of problem behavior relative to baseline. In this instance, providing participants with a clear response to make when withdrawing their assent to participate in treatment did not prevent the experimenters from teaching functional replacement skills. Programming a similar concurrent operant arrangement during an EFA may provide clinicians with an objective means to evaluate their client's assent to participate in the EFA. In the event of client nonparticipation, a concurrent chains arrangement also provides data about the conditions under which their clients withdraw consent to participate in EFAs, teaching clinicians about which procedures to avoid arranging during their analyses.

In addition to measuring client assent through concurrent operant or concurrent chains procedures, clinicians might also consider directly measuring indices of happiness, such as smiling, laughing, or emitting social bids during the EFA. Although happiness measures cannot be conflated with client assent or preference for a particular set of EFA procedures, they do provide clinicians with some objective evidence of a client's experience during an analysis. Baseline measures of happiness or engagement along with traditional problem behavior measures could also be used to inform intervention procedures by providing clinicians information on which conditions are the most likely to produce simultaneous increases in client happiness and decreases in problem behavior.

A recent study by Thomas et al. (2021), for example, found that interventions based on the function of happiness responses instead of the function of problem behavior may still result in problem behavior reduction. After conducting trial-based functional analyses for the problem behavior of four children with autism, the authors found that happiness responses were most likely to occur during the control segment of the attention condition and that problem behavior was most likely to occur during the tangible test condition. Interventions conducted based on the function of happiness (attention) produced greater increases in happiness responses and similar decreases in problem behavior relative to interventions based on the function of problem behavior (tangible). Though these data are preliminary, Thomas et al.'s study provides some evidence to suggest that including measures of happiness during an EFA may yield additional benefits to clients during later function-based treatments.

Clinicians should also consider the effects of an EFA on client responding within the broader context of their client's past experiences. Clients with a history of trauma (e.g., threat of death, see DSM-V) or repeated exposure to extremely stressful conditions (e.g., bullying) may respond differently to FA procedures than clients without a trauma history. Exposure to long extinction periods or extended alone conditions, for example, may evoke similar responding that occurred under past conditions of neglect. Additional choices for participants (e.g., whether or not to participate), safety precautions (e.g., reinforcing early), and collaborations with caregivers (e.g., soliciting input) will be necessary to ensure that clients are not re-traumatized during the assessment and treatment process (Harris & Fallot, 2001). To prevent potential re-traumatization, conversations about the potential effects of EFA procedures on client responding with all relevant stakeholders should be occurring continuously throughout the design and implementation of an EFA. It should also be made apparent that the client or any stakeholder has a right to withdraw assent or consent from the EFA process at any time.

One final consideration clinicians should make before conducting an EFA is to understand how the procedures and outcomes of that EFA will fit into the system of care that surrounds each client. Even though the EFA is brief, the client's family, clinical staff, school or residential facility, and community may all be impacted by the outcomes of this analysis. Clinicians should evaluate how well the EFA's procedures align with the values and goals of each client's care system, as well as the amount of preparation required for the EFA to run smoothly. Questions clinicians may ask themselves to begin this evaluation process include, but are not limited to: *Why are we conducting an EFA? Are caregivers and implementers* *on the same page about the EFA's procedures? How do my procedures promote the safety and well-being of my client? Do these EFA procedures meet the values and needs of the family? Are implementers sufficiently trained to conduct the EFA? How are we planning to use the results of the EFA?* Continuously and critically evaluating EFA procedures in this manner may improve buy-in with relevant stakeholders as well as ensure a safe and productive analysis.

Conclusions

Decades of research on EFA technology have led to a (a) solidified process for understanding environmental contributors to problem behavior and (b) a rich set of modifications and procedures that have helped to spur continuous research and practical applications. In fact, EFA has long been informed by practitioner-relevant elements, including concerns of safety, efficiency, and acceptability of procedures. The core components of the EFA will continue to be modified in the endless empirical search of a programmatic behavioral technology that produces meaningful improvements in problem behavior.

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27 Standard Tests and Interviews for Functional Assessment

Johnny L. Matson and Megan Callahan

Functional assessment has become a standard methodology and one of the core elements of applied behavior analysis. The experimental functional analysis (EFA; Hanley et al., 2003) was the first type of procedure developed for conducting a functional assessment. The many studies conducted on the topic were instrumental in establishing the primary maintaining variables of alone, escape, social, and tangible. Each of these four factors helps explain what is reinforcing the problem behavior and ensuring it will continue and, in many cases, continue to strengthen. A number of refinements and variations of this methodology have been developed over the years. It is an important methodology and one which will likely continue to evolve while being used frequently.

Problems exist with the EFA, as with any method. All methods have strengths and weaknesses. So, we make this statement out of a recognition of the complexities in assessing and treating human behavior versus criticism of the EFA. First, many authors have referred to the EFA as a direct assessment and checklists as an indirect assessment. In our view, and the context of the broad array of assessment methods available in Applied Behavior Analysis and psychology, we prefer the terms analogue and standardized (more on this later) assessments. Direct assessment would be an observation of a target behavior in a naturalistic setting. Analogue, conversely, involves the implementation of maintaining conditions in a contrived setting, with a structured, predetermined means of manipulating conditions by therapists who do not work with the client normally. This set of factors describes EFA and has been used to treat a range of behaviors, such as the treatment of social skills, which dates back to before the development of the EFA (Matson et al., 1980). In studies of this type, contrived vignettes are developed and provide the client an opportunity to provide a social response. Specific target behaviors such as eye contact, voice volume, tone of voice, and content of speech are assessed. The client is then given performance feedback, instruction, and reinforcement. Thus, there is a good possibility, but not definitive, that analogue data will translate to naturalistic settings.

The EFA is more suitable for high-rate behaviors. Thus, low-rate behaviors may be hard to observe since the response may simply not occur in the allotted time in the assessment room. Usually, to rise to a clinical priority, these low-rate behaviors must be of high intensity. It is possible in some instances to "induce" the target behavior. However, this presents possible issues due to concerns about injury to the staff and/or client. Another potential concern is that once rates of maladaptive behavior have been

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_27

increased, the behavior(s) may persist well after the session has been terminated.

There are many advantages of EFA over other methods of functional assessment. This topic has been covered in detail in other chapters of this volume. The purpose of pointing out limitations here is to build a rationale for increasing the number of options in the toolbox of functional assessment. The most researched alternatives are standardized tests, which will be covered next.

Standardized Tests

Standardized assessments have a long history in the field. These tests have a set number of items and a norm group based on a population similar to the person being evaluated. In 1905, Alfred Binet and Theodore Simon developed a standardized test that became the precursor to the current intelligence tests (Siegler, 1992). This measure of intelligence set a standard for many tests that came later and was a major building block in the development of the field of psychology. Standardized tests spread out to the measurement of academic skills and the broad field of psychopathology. General measures such as the Child Behavior Checklist were followed by more specific measures for ADHD, autism, anxiety, and depression, among others. Measures for challenging behaviors such as aggression, property destruction, and self-injury were also developed. Thus, the development of standardized measures to evaluate variables that maintain challenging behaviors was a natural progression with considerable historic momentum.

Standardized assessments provide an added dimension to the toolbox of functional assessment (Matson & Minshawi, 2007). Different circumstances will dictate multiple methods and/or different approaches to assessment. Therefore, the more valid and reliable methods that are available, the better. Standardized tests of functional assessment are based on maintaining variables such as escape, attention, alone, and tangible established earlier with the EFA (Iwata et al., 1982). It is the case that standardized tests of functional assessment are the easiest method to administer and are the most frequently used method of functional assessment (Ellingston et al., 1999). And, these measures have been used the most with special needs children. However, its use has expanded to other groups of children, adolescents, and adults more recently. Applications have occurred in mental health clinics, schools, and work settings (Austin et al., 1999; Sterling-Turner et al., 2001).

Motivation Assessment Scale (MAS)

The MAS and Questions About Behavior Function (QABF) are by far the most heavily researched standardized measures of functional assessment. Chronologically, the MAS appeared earlier, therefore, it will be discussed first.

The psychometrics of the MAS are mixed. Durand and Crimmins (1988) developed and first described the scale. The questionnaire has 16 items and, in the authors' words, was designed to identify "situational determinants (more recently called maintaining variables) of self-injurious behavior of persons with special needs." They asked 50 teachers about agreement on these items for persons with developmental disabilities. Teachers were tested again 30 days later. The authors report good reliability and present the MAS as an addition to, or replacement for, an EFA.

Soon after this study appeared, other authors also addressed the reliability of the MAS. Newton and Sturmey (1991) assessed 12 adolescents and adults with severe/profound intellectual disabilities. They found low correlations of items and subscale scores. Conversely, internal consistency of subscales and total scores was high. Kearney (1994) evaluated direct care staff members who evaluated 42 adults. He found moderately significant reliability across raters.

Zarcone et al. (1991) also addressed the reliability of the MAS in two groups of persons with developmental disabilities (institutionalized and school samples). A total of 55 individuals were assessed independently by either two staff or a teacher and a teacher's aide. They used the same correlation methods as Durand and Crimmins

(1988) as well as interrater reliability. Only 15% of the correlation coefficients were above .80. None of the interrater percent agreements were above 80%, the accepted minimal criteria. Thus, reliability was uniformly poor. Unacceptable interrater reliability was found on 42 topographies of five children. Also, very low levels of interinformant agreement were found.

Sigafoos et al. (1994) also reported disappointing reliability for the MAS. Maintaining factors for the aggressive behavior of 18 adolescents and adults with severe or profound intellectual disability were reported. The interrater reliability of two independent raters produced 44% reliability, which is very low. The authors concluded that the "MAS may not represent a viable alternative to more formal functional analysis procedures."

Spreat and Connelly (1996) found mixed results on reliability measures. Similarly, moderate-to-low intrarater and interrater reliability was found by Conroy et al. (1996). In their study, 20 people with intellectual disabilities with 19 raters participated.

Validity has also been addressed with the MAS. Duker and Sigafoos (1998) looked at reliability, internal consistency, and construct validity. Ninety ratings of challenging behaviors for 86 people with intellectual disabilities were reported. Reliability was poor. The structure initially established by Durand and Crimmins (1988) differed from the four factors these authors found. Thus, Duker and Sigafoos (1998) conclude that the construct validity of the MAS was ambiguous. Another study also failed to support the factor structure of the MAS. Joosten and Bundy (2008) used a Rasch analysis on data from 246 MAS tests on 67 children with autism or intellectual disabilities or both. The data failed to support the proposed unidimensional construct of the original four-factor structure. Thus, a failure to replicate the factor structure was reported (Kearney et al., 2006). Three hundred and thirty-five people with severe intellectual disabilities produced a three-factor solution versus the original four factors.

Not all of these factor analytic studies of the MAS have been negative. Bihm et al. (1991) did validate the initial MAS factor analysis with 118 people who were predominately functioning in the severe to profound range of intellectual disabilities. As with the original factor analysis, sensory, escape, attention, and tangibles were the four categories of maintaining variables. Singh et al. (1993) assessed staff of 60 residents, and teachers of 96 students in schools were evaluated. Target behaviors fell into the general area of self-injury. These authors concluded that the original MAS factor structure was "robust." One study was published that used the MAS as a means of determining the change in self-injurious behavior when Naltrexone was administered as a treatment. They found no change in self-injury and correlations on the MAS.

Well, the data on the psychometric properties are mixed. From our view, the MAS has worth, should be considered as a viable measure, but when used, should be part of a functional assessment battery. For those interested in the MAS, some modification in the items on the scale seems to be in order. Also, the developers deserve credit for establishing the first widely used standardized measure of behavior function.

Questions About Behavior Function (QABF)

The rationale for developing the QABF is to build on the experimental functional analysis with a simpler, faster way to achieve similar results in identifying maintaining variables of identifying challenging behaviors. A number of standardized scales have been developed to achieve this goal. In this writing, the most frequently studied scale with the best psychometrics is the QABF (Matson et al., 2012).

The first published paper on the QABF was by the Matson group (Matson is the first author of this chapter, as a point of transparency). Paclawskyj et al. (2000) assessed 34 adults with intellectual disabilities living in an institutional setting. The first author, who was a PhD student in clinical psychology at the time, interviewed a staff member who knew the client for 6 months or longer. Test–retest data were collected. The scale consists of 25 items, 5 items for each of the 5 subtests: attention, escape, nonsocial, physical, and tangible. The scale can be completed in about 20 minutes. Reliability for all items was good to excellent.

Bienstein and Nussbeck (2009) studied the properties of a German version of the QABF. These authors looked at reliability. Cronbach alphas were run and were good (.84–.62) Interrater reliability was fair, with intraclass correlations of .65–.58. Also, a factor analysis was conducted. A five-factor solution identical to that reported in the original study was found. In a study on the Spanish version, factor analysis also mapped onto the five original factors noted in Paclawskyj et al.'s (2000) study. Also, good test–retest was found. This study was a large one, with 300 participants with intellectual disabilities and 328 challenging behaviors.

The psychometric properties of the QABF have also been studied by Freeman et al. (2007). They studied an outpatient sample of 91 children with intellectual disabilities. Problem behaviors they displayed included physical aggression, self-injury, and property destruction. They found that the QABF had fair-to-good internal consistency, strong corrected item-total correlations, and acceptable interscale correlations.

Nicholson et al. (2006) also studied the psychometric properties of the QABF. They addressed 118 challenging behaviors of 40 young people with severe intellectual disabilities. Interrater reliability, internal consistency, and construct validity were addressed. Interrater reliability for individual items and subscale score was modest. However, interrater reliability of rankings of subscale scores was excellent, exceeding that reported by other similar measures. Interrater agreement was higher for higher rates of behavior and lower for maladaptive versus disruptive behaviors. Internal consistency was high for total score and all of the subscale scores. Factor analysis yielded the same five factors established in the original study. A single item on the repetitive nature of challenging behaviors did not fit into the five-factor solution. The authors conclude that the QABF presents specific advantages over other standardized measures for functional assessment.

Matson et al. (1999) studied the validity of the QABF with 398 people in a developmental center who evinced intellectual disabilities. These adults exhibited one of these challenging behaviors: self-injurious behavior (n = 118), aggression (n = 83), or stereotypies (n = 197). Professionals conducting the evaluations had a master's degree in clinical psychology and experience working with people who displayed intellectual disability. The focus of Experiment 1 of this study was to determine the percentage of people who had a clear function, which was defined as subscales with a minimum score of 4 out of 5 items on a given factor. Also, of the remaining 4 subscales, a sufficient number of item endorsements to meet the 4 out of 5 criteria were needed to establish a second function. Eighty-four percent of the total sample had a clear function. Target behavior percentages were 83% for self-injury, 74% for aggression, and 93.3% for stereotypies. In Experiment 2 of this study, 180 people from the original 398 individuals were evaluated. Half of the sample, 90 people, were in the treatment group, and 90 individuals were randomly assigned to the control group. The treatment group had behavioral plans that were based on the maintaining variables established with the QABF. For example, challenging behaviors that were maintained by attention included teaching communication skills, while challenging behaviors maintained by nonsocial elements were treated with environmental enrichment and social skills. Controls were administered as an intervention consisting of interrupting the challenging behavior, blocking, and redirection. The treatment group showed statistically significant improvements for self-injurious behaviors, aggression, and stereotypies after 6 months of intervention. Participants displaying self-injury showed a 66% decrease in the treatment group and 21% for controls. For aggression, a 59% decrease was noted for the treatment group and 19% for controls. People displaying stereotypies had a 54% decrease for the treatment group and 15% for the controls. All three comparisons showed a statistically significant difference between groups. And, to our knowledge, this was the first large-scale controlled study to demonstrate the superiority of interventions based on functional analysis. These data are more impressive when one considers that these were adult clients with long-standing high rates of these three maladaptive behaviors.

Other efforts to establish the validity of the QABF have also been published. Watkins and Rapp (2013) compared an experimental functional analysis to QABFs completed by parents of people with autism spectrum disorder who evinced challenging behaviors. With five of the six participants, the experimental functional assessment and the QABF identified the same function, and for the sixth client, both assessments identified a dual function.

Twenty-seven adults living in a developmental center and exhibiting intellectual disability served. All of the clients had problems of sufficient severity to warrant a treatment plan (Smith et al., 2012). Twelve people had one challenging behavior and 15 evinced two target behaviors. The QABF and MAS were given for each target behavior, thus for 15 individuals, 2 QABFs and 2 MAS were administered. One hundred and thirteen staff who had worked at least six months at the center severed as evaluators/informants. Typically, five respondents evaluated each target behavior. Twenty-five graduate students were trained to administer the QABF and MAS. Reading and discussing the test manuals, role-playing administration procedures, and receiving feedback on their performance were included. Staff and student ratings were compared. The QABF resulted in a slightly better agreement.

For experiment two, eight individuals from study one were selected for inclusion. In addition to the QABF and MAS data, experimental functional analyses were conducted. The EFA was similar to Iwata et al. (1982). All eight clients were administered three conditions: attention, alone, and demand. All participants were also exposed to a play/control condition, and six of the participants were administered a tangible condition. One to six sessions occurred daily. The sequence was alone, attention, play, tangible, and demand. Sessions were 10 minutes in length and occurred three to five times per week. A total of 20–25 sessions were conducted for each individual. For the seven people who had clear functions established with the EFA, six corresponded to the QABF, while EFA results corresponded to four people based on MAS scores. Thus, the QABF proved to be the superior standardized measure of maintaining variables.

Fee et al. (2016) have also compared QABF and MAS results to an EFA and also a functional assessment interview. Twenty-four children who were between 2 and 12 years of age participated. Target behaviors in the analysis included screaming, aggression, stereotypies, hand flapping, teeth chattering, and elopement. The brief functional analyses were carried out in an exam room of an outpatient hospital clinic. The room had a camera and one-way mirror for observation. The QABF and MAS were sent to the children's homes five weeks before the functional analysis interview. These interviews were conducted with caregivers by phone.

The Brief Functional Analysis conditions lasted five minutes and included tangible, attention, and demands. When QABF results were compared to the Brief Functional Analysis, agreement was 67% and was 65% for the MAS. Results are not in line with the previous study and may be due to using a different type of EFA and using phone versus direct interviews with the standardized scales.

In another study comparing multiple methods of conducting functional assessments, 13 people with profound intellectual disability were served. Target behaviors included self-injury, aggression, tantrums/verbal aggression, and stereotypies (Paclawskyj et al., 2001). The EFA was based on the methods described by Iwata et al. (1982). Five conditions were presented: attention, demand, tangible, alone/ignore, and toy play. The alone condition was not employed for the three people who were aggressive. The therapist sat next to or behind the client, and one or two observers collected data from the far side of the room. Observers did not interact with the participant until the session had been terminated. In the attention condition, the therapist sat near the client reading a magazine. Verbal and physical attention followed the occurrence of a target behavior. For the toy play condition, preferred items were available, and the therapist provided attention once every 30 seconds contingent on no target behaviors for 5 seconds. For the demand session, the therapist asked the client to fold towels or stack cups, for example. There was a three-step series of prompts going from verbal, modeling, and physical guidance. For the alone sessions, the therapist sat behind the client or out of his/her sight. Target behaviors were ignored. A preferred object was given to the client for two minutes prior to initiating the tangible condition. The item was then removed and then given to the client for 30 seconds every time a target behavior occurred. The QABF and MAS were administered one month or less after the completion of the experimental functional analysis by a PhD student in clinical psychology. The QABF and experimental functional analysis were in agreement 56% of the time, and the experimental functional analysis and MAS were in agreement 44% of the time.

A psychometric study comparing the QABF and the MAS was reported by Shogren and Rojahn (2003). They tested 20 adults with intellectual disabilities. Problem behaviors displayed by these clients included aggression, property destruction, and self-injury. Test–retest, internal consistency, and interrater reliability were calculated. The authors concluded that both scales had good psychometrics, and that the psychometrics were similar across scales.

May et al. (2014) looked at the psychometrics of the QABF and found negative results. They evaluated the problem behaviors of 45 students in a K-12 school for children with developmental disabilities. The children and adolescents were 7–19 years of age and had attended school for at least a year. Problem behaviors assessed with the QABF were off-task behavior, noncompliance, verbal aggression, and physical aggression. Each target behavior was assessed by the classroom teacher and two paraprofessionals. The teachers had been working with the students for at least 6 months. One teacher had a master's degree and the remainder had bachelor's degrees in special education. Paraprofessionals had high school to associate degrees. Item correlations ranged from weak to strong. Their data did not support a five-factor solution. The authors conclude that formal training may be needed to produce reliable and valid results. We concur and argue that any functional assessment approach would require formal training, with experimental functional analysis requiring much more training than standardized assessment methods, such as the QABF. This point would seem to be particularly relevant with raters who have high school educations. The fact that the current data are at odds with numerous other studies by multiple research teams would seem to underscore this point.

Various parameters of maintaining challenging behaviors have also been evaluated using the QABF. Matson et al. (2005) addressed pica, rumination, food stealing, food refusal, aggression, and self-injury at mealtime. Informants for 125 with feeding problems and severe to profound intellectual disabilities served. Behavior functions most commonly associated with problematic feeding were identified. These data are important for treatment implications since they provide the most important maintaining variables to focus on initially.

In another paper, severe challenging behaviors of adults with intellectual disabilities were assessed with the QABF. Self-injurious behavior, stereotypies, aggression, pica, and rumination were evaluated. With the exception of aggression, nonsocial was the most commonly identified function (Applegate et al., 1999). High-rate and low-rate behaviors and the effect of frequency of self-injury and aggression were assessed. Because of the difficulty to employ experimental functional analysis with very severe and/or very low-frequency behavior. The focus on standardized measures such as the QABF is beneficial in these instances.

At the time of this writing, the standardized measure with the most and best empirical support is the QABF. Very good reliability and validity have been established. Additionally, data have been replicated across multiple research teams in various settings with multiple participant groups. However, no one method will work in all instances for these complex problems. Thus, several additional methods have been developed and are needed. They will be reviewed next.

Functional Assessment Checklist (FACTS)

The FACTS is a semi-structured FBA interview for use by teachers in school settings (March & Horner, 2002). The measure was a streamlined version of a large manual that was not empirically validated: the Functional Assessment Observation (O'Neill et al., 1997). The interview allowed for event-based measurement of problem behaviors and the identification of antecedents such as presenting tasks and consequences such as teacher attention and task removal. Data analysis involved identifying frequently occurring antecedents and consequences. FACTS interviews from 63 informants for nine student target behaviors were collected for this chapter.

A series of reliability and validity measures were obtained. Thirteen of 63 informants were evaluated on test–retest reliability, with the FACTS being readministered from 5 to 7 days after the initial assessment. Strong test–retest reliability was established for antecedent, functions, and total statements. Moderate reliability was noted for setting events. All 63 students had FACTS completed by five to eight staff members. Moderate reliability of .50–.88 was obtained. Interobserver agreement was obtained for nine students. One-hundred percent agreement was found.

Validity was also addressed in this study. Some of their validity was based on an eye test. McIntosh et al. (2008) contend that content validity is established by noting that the format and items are similar to what is found in other functional behavior assessment interviews. Process validity was noted as another valuable construct. But, this methodological approach has not been addressed with the FACTS. Convergent validity, however, was addressed. Good convergent validity was reported. These data are certainly helpful. However, a big need exists for additional research. The measure does not have sufficient empirical support to recommend it at this point.

Functional Analysis Screening Tool (FAST)

The FAST is a 16-item scale measuring antecedent and consequent events of challenging behaviors. Four categories were established: (1) social-positive reinforcement, such as access to tangibles and attention; (2) social-negative reinforcement in the form of escape; (3) automatic reinforcement/self-stimulation; and (4) automatic-negative reinforcement (e.g., escape pain and/or discomfort). These conditions were based on a review the authors had done looking at maintaining conditions discovered in numerous empirical studies. They combined the tangible and attention conditions that are separate in the MAS and QABF. A copy of the scale is available in Iwata et al. (2013).

The initial reliability data were for 151 people with ID or autism. Some of the participants had more than one target behavior. As a result, 196 behaviors were assessed by parents, relatives, teachers, teacher aides, and direct-care staff. Education of the evaluators ranged from high school to a master's degree. The authors calculated observer agreement based on item-by-item comparisons between pairs of informants. They note 80% agreement as the minimal acceptable standard. With the FAST, 71.5% agreement was obtained. The authors characterize this reliability as moderate at best. As noted by Iwata et al. (2013), without acceptable reliability, validity cannot be established.

In a second study examining the FAST, it was compared to the QABF and FACT (more on the FACT later). Zaja et al. (2011) evaluated 130 adults who attended a day program in the United States. Clients had been diagnosed with ID and other physical and mental health problems. Senior day program staff ($n = 29$) were the raters. All three scales were completed for each target behavior. The reliability for the QABF and the FACT was acceptable to good. The FAST has poorer reliability scores than the other two measures. Convergent and discriminant validity were better between the QABF and FACT than results for the FAST compared to the other two instruments. Thus, given the disappointing psychometrics of the FAST, it cannot be recommended for use at this time.

Functional Assessment for Multiple CausaliTy (FACT)

The FACT is a 35-item measure developed to identify a hierarchy of behavioral functions for persons with ID, autism, and other developmental disorders. This is significant since it is the only functional assessment measure to help establish the order in which multiple functions for behavior are included in treatment for a given person. Of course, this is not an issue for a client who displays only one function for a target behavior. Thus, the FACT would not be used in all instances where maintaining variables are identified.

A forced-choice procedure is used with the FACT. Each item gives the informant two choices, with each representing a different function. Items are rotated so that each item has been paired with all items. Frequency of endorsement shows the overall validity of each item. Relative frequency of endorsements is used to establish treatment priorities.

Psychometric qualities of the FACT were established by Matson et al. (2003). Participants were 297 persons with ID and/or autism. They ranged in age from 9 to 85 years old. The FACT was completed for each significant behavior problem, which ended with 409 completed scales. FACTs were administered to direct care staff by master's level mental health professionals. Factor analysis produced five factors: escape, self-stimulation, attention, tangible, and physical. A second-factor analysis was then replicated with a second sample with 197 people with ID and/or autism. This sample ranged in age from 16 to 85 years old. In this study, 307 FACTs were completed. This replication study yielded the same five factors established in Study 1. Internal consistency was also very good with .88–.92. This study is particularly rigorous. While future research would certainly be warranted, at present there are sufficient data to recommend the FACT for use.

Questions About Behavioral Function in Mental Illness (QABF-MI)

The same 25 items from the QABF were used in the current study. The difference was the population studied. One hundred and thirty-five direct care staff from three inpatient psychiatric facilities with serious and persistent mental illness were assessed. The participant-to-item ratio was just over 5 to 1, which is optimal for a factor analysis. A principal component procedure was used for factor extraction. The QABF-MI items corresponded 100% to the QABF. Thus, based on the QABF and these data, the QABF-MI appears to be a methodologically sound functional analysis scale.

Teacher Functional Behavioral Assessment Checklist (TFBAC)

The TFBAC was evaluated with 89 first through third graders. Good-to-excellent agreement was found for teachers' multiple ratings of problem behaviors. The authors conclude that the scale was reliable for identifying problem behaviors. There was evidence of convergent validity of problem behaviors, although a lack of evidence for the validity of the purported maintaining functions of these behaviors was found.

Functional Analysis Checklist (FAC)

The FAC is another checklist developed to establish and maintain variables (Sturmey, 2001). The study was conducted with individuals in behavior therapy programs in a state school population. Interrater and test–retest reliability was uniformly poor.

Descriptive Functional Assessment

The focus of this study was to identify low-rate, high-intensity behaviors using descriptive data (Radford & Ervin, 2002). These authors note that aggression and violence are typical in school settings. Only one participant, a 13-year-old male with ADHD, served. He had exhibited low rates of aggression toward peers in his school. Methods and procedures were multifactorial. A comprehensive review of archived data including office referrals for aggression and previous school records. Also, data were assessed to determine if the target behavior was more likely to occur in unstructured parts of the school day such as recess. Also, data were assessed to see if negative peer interactions such as teasing, name-calling, or physical aggression resulted in higher rates of the target behavior. These data were used to develop intervention plans.

A less structured approach was also described by Hoff et al. (2005) in a school classroom for an adolescent who had been diagnosed with attention deficit hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD). Assessment methods included teacher interviews, student interviews, and direct observation in the classroom. An intervention, that the authors reported was successful, was based on the information derived from these evaluations.

In another study, using informal functional assessment, Toogood and Timlin (1996) found poor agreement with the experimental functional assessment. These authors looked at the function of 121 challenging behaviors of 20 people with ID. They also make the point, which is still pertinent, that staff training is very important to ensure accurate functional assessment.

Love et al. (2009) evaluated 32 children ages 2–12 years who were diagnosed with autism, Asperger's syndrome, or Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS). Data were collected at a university outpatient clinic over a four-year period. Two methods of assessment were used initially: the FAST (It has already been noted in this chapter that the FAST does not have acceptable reliability) and a semi-structured interview. A caregiver was included to discuss information about antecedents and consequences and about when challenging behaviors typically occurred. Next, caregivers were trained to record environmental events based on professional committees' establishment of maintaining variables using the FAST and the interview described above. Each instance of the low-rate challenging behavior, caregivers recorded the environmental events that occurred at the same time in a narrative format. One of two doctoral-level psychologists reviewed these narrative descriptions and established a maintaining variable or variables. Attention from others proved to be the maintained variable in most cases.

Another study where multiple functional assessment methods were used by Stage et al. (2006). They evaluated three schoolchildren in kindergarten, first grade, and ninth grade. Measures and methods included the Functional Assessment Checklist for Teachers, the Student-Directed Functional Assessment Interview, the Functional Behavior Assessment Checklist, and an Adaptive Functional Assessment Interview. Experimental conditions were manipulated in the classroom setting to establish maintaining variables as well. The scaling methods varied in reliability but proved useful in establishing and maintaining variable to consider during the classroom manipulations.

Scatterplots

Another method that can be helpful in establishing patterns of behavior and maintaining variables is the scatterplot. First described by Touchette et al. (1985), it consists of a grid. The vertical axis lists time in segments (hours, half hours, minutes), while the horizontal axis represents successive days. After the data are plotted, empty cells represent no occurrence, and a filled-in cell indicates the occurrence of the target behavior. The authors warn that the data that are visually presented need to be accurate and easily interpreted. In the text of the chapter, the authors give examples of how the scatterplot can be used. For those interested in this methodology, it is recommended that they consult this article.

One example is a 14-year-old girl, Joan, with aggression dating back a decade. She lived in a residential facility for adolescents with autism. Her challenging behaviors were severe enough that she had to be removed from ongoing activities. The focus of the scatterplot was to establish maintaining events. Joan was monitored for aggression during all waking hours, seven days a week. Over a three-week period, assaults typically occurred from one to four in the afternoon, Monday to Thursday. During these hours, Joan was in prevocational and community living classes. She was involved in one-to-one training in the morning. The authors concluded from this data that demands were not a trigger. Thus, her afternoon group activities were changed to one-to-one. Activities such as listening to stories and trying on cosmetics were provided and changed every 15 minutes. This approach proved to be effective in decreasing challenging behaviors.

Kahng et al. (1998) note that the scatterplot is a frequently used method of establishing patterns of challenging behaviors. In their study, 20 people living in residential settings participated. Clients' programming consisted of vocational or academic classes, speech or physical therapy, and other constructive activities. Self-injurious behaviors were recorded as occur or does not occur during 30-minute intervals. Visual inspection was made to identify patterns of problem behavior across days. Various maintaining variables were noted, such as sensitivity toward specific staff or activities. The authors caution that for all-day assessments, interval recording for all day should be at least 30 minutes in length. An additional modification of the scatterplot is described by Bosma and Mulick (1990). They contend that data can be evaluated more efficiently by using see-through slides of individual scatterplots that can be overlaid. They conclude that important relationships, which might otherwise be overlooked can be visually detected in this manner.

Scatterplots were also used in a study by Maas et al. (2009). They evaluated seven adults with ID. Depending on each individual's living arrangement, target behaviors were recorded by direct care staff or parents. Cells were intervals of two hours with data collected on 28 consecutive days. These seven people with confirmed Prader–Willi syndrome were compared to a control people of five people with ID who had no known genetic conditions, epilepsy, or use medication that may have an effect on daytime sleepiness and functioning. People with Prader–Willi syndrome displayed more excessive daytime sleepiness than controls. The target behaviors were more likely to occur when daytime activities were not scheduled.

Another study using largely informal methods is described by Linville et al. (2010). They had 148 participants who were rated longitudinally. The focus was on relationships between couple relationships, parenting methods, parental depression, and their children's challenging behaviors. The child's behavior was evaluated twice, one year apart. Each child and an adult were videotaped while engaging in standardized tasks: free play (15 minutes), a clean-up task (5 minutes), a delay of gratification task (5 minutes), four teaching tasks (3 minutes for each of the four tasks), a second free play session (4 minutes), a second clean-up task (4 minutes), the presentation of two inhibition-inducing toys (2 minutes each), and a task involving making lunch. Problem behaviors were assessed on the following criteria: parent gives child choices for behavior change where possible, parents use clear language regarding behavior change, the caregiver uses a calm voice, parent adjusts situations to enhance interest, success and comfort by the child, when the child misbehaves or is off task the parent redirects to more appropriate behavior, and verbal instructions are used to make tasks more manageable. When these data were used to inform treatment, better effects were found relative to controls.

Another functional assessment is described by Todd et al. (2008). Four elementary school-aged boys served as participants. They were chosen due to frequency of office visits, teachers affirming that the child's problem behaviors frequently disrupted classroom activities as well as parental and student assent. A 20–40-minute interview was conducted with each child's primary teacher. The FACTS (which was discussed earlier) interview helped identify problem behaviors, antecedent events that correlate highly with the occurrence or nonoccurrence of challenging behaviors. Direct observations were also used with an ABC chart (antecedent-behavior-consequence). Data were confirmed when the FACTS and ABC information matched. Target behaviors were being in the wrong location, talking out, noncompliance, talking to peers, being disruptive, and having negative physical or verbal interactions. These data were used to inform treatment, which was effective.

Final Remarks

The focus of this chapter has been functional assessment methods that fall outside the realm of experimental functional analysis. Obviously, researchers and clinicians see a need for these various methods, given the number of authored papers and the range of strategies that have been described. Unfortunately, there is no systematic data that have been collected regarding how often these methods are used in an applied setting. Nonetheless, it is likely that these methods are in widespread use. Also, given many discussions with teachers and psychologists, it is often the case that those people administering the measures may have inadequate expertise/training in these methods of assessment. Given the level of expertise and the labor-intensive nature of EFAs, they will be confined largely to university settings. Thus, a research focus on how to train and monitor methods other than EFAs in applied settings should be a top priority.

To date, functional assessment has been limited largely to special populations and challenging behaviors. Children and adolescents have also been studied much more frequently than adults. The focus should be oriented to more populations and more problems (e.g., anxiety, PTSD). What is referred to as “triggers” with mental health problems may in fact be maintaining variables conceptualized a bit differently. In any event, data to this point are promising, but much is still to be learned.

Conflict of Interest Dr. Matson’s wife is the sole owner and sells the QABF.

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28 Quantifying Outcomes in Applied Behavior Analysis Through Visual and Statistical Analyses: A Synthesis

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Five adults with intellectual disabilities who attended a day-training center were prescribed with physical exercise. Krentz et al. (2016) aimed to increase walking in these adults. The authors began with a baseline phase in which they recorded the number of laps completed in one hour by each adult. During the treatment phase, the adults earned tokens for each lap completed and could exchange these tokens for a preferred item at the end of the one-hour session. The researchers observed an increase in the number of laps by each adult during the token reinforcement phase relative to baseline. After a few treatment sessions, baseline conditions were reinstated, i.e., the adults stopped receiving tokens. The authors observed that the laps completed by each adult decreased until their frequency was comparable to the one observed during the initial baseline. The study was completed with a return to the treatment phase in which participants again received tokens for walking laps. The results showed that walking was low during the baseline phase, increased during the treatment phase, decreased during the return to baseline, and increased once again during the final treatment phase for all participants. The authors concluded that token reinforcement was effective in increasing walking among their adult participants.

The study described above exemplifies a reversal design involving repeated and frequent measures of behavior (i.e., number of laps walked), the experimental manipulation of an independent variable (i.e., introduction and withdrawal of token reinforcement for walking), and replications within and across subjects (see chapter on single case design in this volume). Single-case experimental designs (SCED) allow the practitioner to evaluate the effects of an intervention using repeated behavioral measurements across sessions and conditions. This is in sharp contrast to group designs that often focus on the aggregated effect of a treatment on an entire group. A single-subject approach allows the

ABA España, an affiliated chapter of the Association for Behavior Analysis International, provided material and in-kind support to the first author for developing this manuscript through a research contract with The University of Auckland (Project no. CON02739). The authors thank Dr. Juan Botella-Ausina for his assistance.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_28

practitioner to monitor individual performance on a session-by-session basis, potentially drawing cause–effect links between experimental manipulation (i.e., treatment) and behavior (What Works Clearinghouse, 2020). Single-subject designs are particularly well-suited to practitioners and clinicians as they engage in practice-oriented research. Single-subject designs can accommodate large between-subject variations commonly encountered in practice (e.g., level of baseline performance, dataset size, topographical variations across participants, etc.). In addition, intervention procedures and SCED may be modified on an ongoing basis in the event of limited or no improvements in performance (Kratochwill & Levin, 2014; Kratochwill et al., 2010).

Single-subject designs have been criticized for being subject to selection bias, relying on visual analysis for treatment outcome evaluation, and not accommodating to mainstream inferential statistics. Moreover, there has been no methodological requirement for reporting on all participants initially screened or selected for participation in behavior–analytic studies. Some have criticized that this practice may have led to publication bias, whereby positive results are more likely to be reported and published. This threat was confirmed by Sham and Smith (2014), who observed that the effect size in a selection of applied studies was on average 20% greater in published relative to unpublished studies. Recent suggestions for extending methodological standards borrowed from the medical sciences, including consecutive client admission (Hagopian, 2020) and intention-to-treat analysis (see for example Taylor et al., 2019), provide the tools for overcoming patient selection bias in SCEDs.

The reliance on visual analysis has been criticized as an unreliable and pre-quantitative approach to data analysis (e.g., DeProspero & Cohen, 1979). A major justification for visual analysis lies on the *effective* dimension of the field of applied behavior analysis (Baer et al., 1968). In the hopes of prioritizing socially valid interventions, behavior analysts have traditionally focused on interventions producing large effects that can be evident from the visual inspection of the time series and are less likely to induce Type I errors (false positives). Moreover, statistics were seen at the time as a distracting sophistication due to the frequent mismatch between clinical and social significance (see for example Michael, 1974). These factors led to a decades-long rejection of mainstream inferential statistics in applied behavior analysis.

These concerns are now gradually coming to the fore as behavior analysis produces service models that ought to be weighted and prioritized by health and policy decision makers, causing a need for quantitative and widely intelligible summaries of scientific evidence. Visual analysis allows a good understanding of emerging patterns in the data, whereas statistical analysis can help to quantify the magnitude of effects, study co-variables, and synthesize evidence from multiple individuals and studies. In addition, structural visual analyses and visual aids minimize subjectivity and Type-I errors while visually analyzing SCED datasets.

In this chapter, we will briefly review the various approaches to quantifying outcomes in SCED and how new developments in statistics can support the process of *mainstreaming* SCEDs into the outcome research literature by combining visual and statistical analyses. In the next sections, we will describe techniques to evaluate SCEDs using visual and statistical analyses and also outline the potential synergies between the two for the purposes of quantifying, comparing, and pooling treatment effects. We recommend that the reader is familiarized with Chaps. 24 (Single-Case Designs), 29 (Treatment Integrity), and 30 (Social Validation). Concepts from these sections will be used throughout the current chapter.

Visual Analysis

How Does It Work?

Session-by-session SCED graphs provide the most common basis for conducting a visual analysis. While there are numerous graph formats in applied behavior analysis (e.g., line graphs, bar graphs, cumulative record, scatter plot), the line graph is predominant in applied behavior analysis for displaying non-cumulative behavior recordings over time. In a line graph, the *y*-axis represents the dependent variable (i.e., the behavior of interest) and the *x*-axis typically represents time (i.e., sessions, days). Letters in alphabetical order are often used to denote the various conditions in a SCED and its graphic display. For example, an ABAB design represents two A conditions and two B conditions. *A* typically refers to the baseline condition, whereas *B*, *C*, … denote successive treatment conditions. A transition from one condition to another is represented using a phase change line on a graph (see a set of guidelines for graph construction to minimize bias in Cooper et al., 2019; Kubina et al., 2017; see also Chap. 24).

Data graphing and visual analysis go hand-in-hand throughout a behavior change project and they are considered essential processes for both ongoing clinical decision-making and evaluation of the intervention effect. Specifically, a major aim of a visual analysis is to identify whether there was a change in the behavior of interest and whether that change could be reliably attributed to the intervention. Intervention effects in SCEDs are primarily evaluated for their clinical significance[1] (i.e., focus on large effect sizes *à la* Baer et al., 1968). A visual analysis involves the evaluation of data patterns both within and across phases or conditions.[2] In the following sections, we will revise the main dimensions of within- and across-phases visual analysis.

Within-Phase Visual Analysis

Treatment effects are assessed relative to baseline. As a first step, the visual analyst would evaluate *steady-state responding* in the initial baseline phase. During steady-state responding the dependent variable is expected to present low variability and no discernable trends. The presence of high variability and/or trend within baseline threatens the baseline logic and may result in the researcher extending the baseline phase (until steady state is attained) or modifying the study procedures in order to ensure baseline stability. In order to allow for timely phase change decisions, it is recommended that visual analyses are conducted on a continuous basis following the data collection process as closely as possible.

A visual analyst focuses on three major dimensions of the visual display of the data within a phase or condition: (a) *level*, the average amount of behavior; (b) *trend*, directional movement of the data over time; and (c) *variability*, data variation across the time series that cannot be attributed to trends. In effect, the visual analysis will provide information about how much behavior occurs (level), how the behavior changes over time (trend), and how much change do we see in the behavior that cannot be clearly attributed to the independent variable or to existing trends. The What Works Clearinghouse standards (2020) suggest that a minimum of five data points in each phase or condition are needed before introducing a new phase in order to properly appreciate level, trend, and variability (see also Maggin et al., 2013).

Level

The level is the overall or average amount of behavior within a condition with reference to the *y*-axis (Barton et al., 2018). *Floor* (zero), *low*, and *high* are common qualifiers of the level of behavior (see Fig. 28.1a). The level within an SCED phase is often estimated using the mean or median (see Fig. 28.1b). The mean is highly sensitive to outliers. Therefore, in the presence of outliers or significant variability, the median is recommended. However, computing phase level may be informative only to the extent that the data has no trend and relatively low variability. Behavior analysts are mostly concerned with changes in level that may be revealed over the course of an intervention, whereas the mean (or

[1]This is in sharp contrast to group designs, which often focus on statistical significance and abstract effect size metrics.

[2]We will use the terms phase and condition interchangeably. *Phase* may be more appropriate for independent variable manipulations comprising a continuous time series, whereas *condition* may be more appropriate for multielement designs where treatments are implemented briefly as part of discrete alternating sessions.

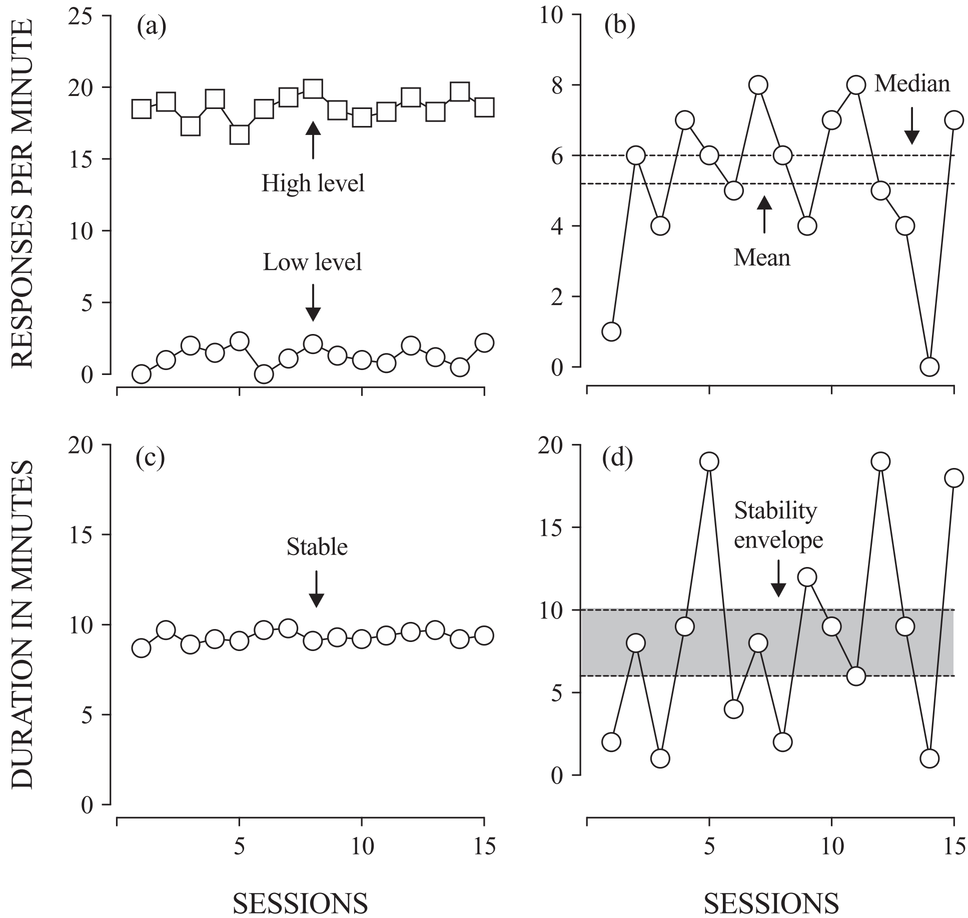

Fig. 28.1 Some graphical examples of common visual analysis scenarios

median) change in level may have little practical relevance.

Trend

Trend refers to the directional movement of data over time. Trend may be *accelerating, decelerating*, *increasing*, *decreasing*, *therapeutic, counter-therapeutic,* or *null* if absent. Visually detecting trends within a condition can offer information about the progressive improvement (or worsening) of the target behavior, and it may be the basis for phase change decisions. For example, (a) a therapeutic trend during baseline (i.e., a trend in the expected direction of the intervention) may indicate that the introduction of treatment is premature or unnecessary, (b) a counter-therapeutic trend during baseline (i.e., a trend opposing the expected direction of the intervention) or no trend may warrant the introduction of treatment, and (c) a therapeutic trend during treatment may indicate that the treatment is having the intended effect and that termination of treatment before its effect becomes asymptotic may be premature.

Fig. 28.2 (upper panel) presents a decreasing trend of vocal requests during baseline followed by an increasing trend after the onset of the treatment phase. While data stability is considered optimal before making a phase-change decision (i.e., steady-state responding), a baseline phase composed of a counter-therapeutic trend may be acceptable on occasions when it is not practically possible to wait for steady-state responding. The inception of an opposing trend immediately after treatment implementation is a form of effect demonstration—even though comparing mean levels would suggest no effect. Steep localized trends

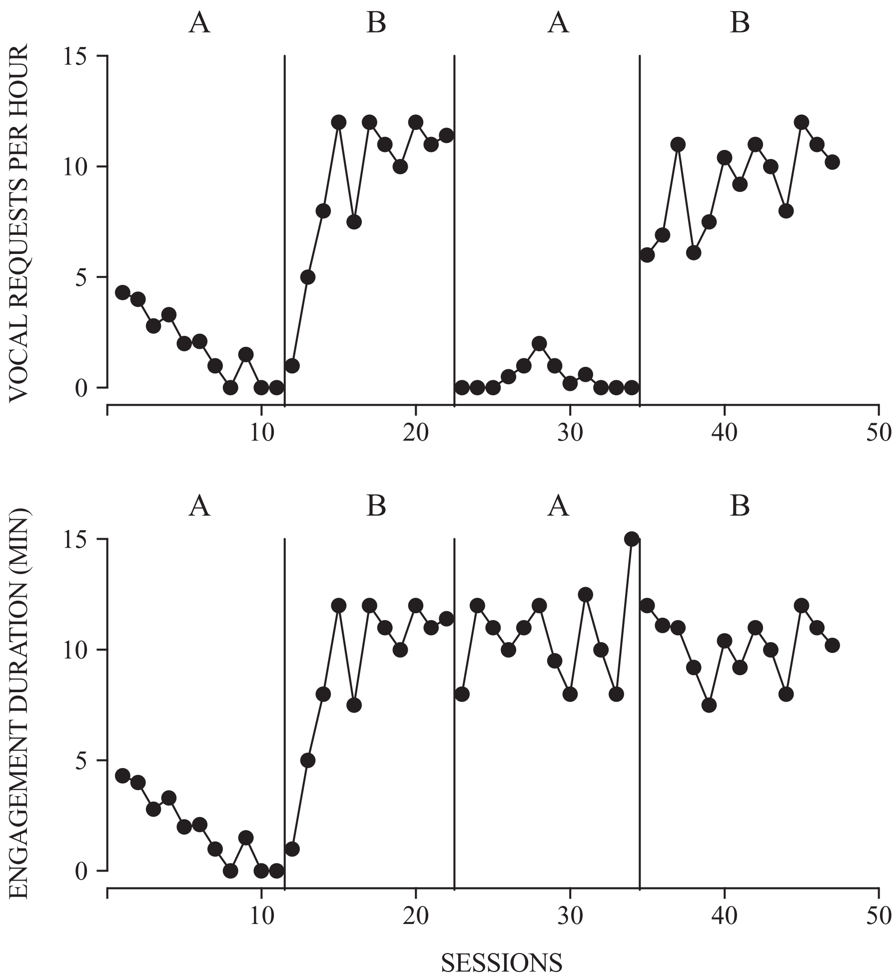

Fig. 28.2 Examples of local trend (first B phase) and non-reversibility (second A phase, lower graph)

observed upon the implementation of treatment (or the reversal to baseline conditions), as the ones shown in Fig. 28.2 (first B phases), are sometimes called *transition trends* and should not affect the ascertainment of behavior level once the trend is replaced with steady-state responding.

Discontinuing a study phase with an ongoing trend, while compatible with effect demonstration, may limit the researcher's ability to assess the intervention maximum effect and the stability of the intervention effect. Phase change or cessation decisions may be pre-determined by socially valid mastery criteria. For example, educational interventions focusing on behavior accuracy may require two successive sessions or blocks of trials with 80% of correct responses or more as a mastery criterion. This criterion can be portrayed in the graph as a horizontal mastery criterion line aiding visual analysis.

Trend can be appreciated visually or estimated through trend lines. A variety of techniques can be used to calculate trend lines, including the split-middle line method or a simple regression line. Most graphing software packages (e.g., Prism GraphPad, SigmaPlot, SPSS) can compute regression trend lines seamlessly. The split-middle method (Cooper et al., 2019, pp. 149–150) relies on the median and is therefore less sensible to outliers than linear regression lines.

Variability

In the context of a visual analysis, variability may be defined as the extent to which the data points within a condition vary randomly. It may also be defined as the fluctuation of data around the trend or level line (Barton et al., 2018). It can be referred to as *stable* or *variable*.[3] Fig. 28.1 presents examples of stable and variable baselines. As is the case with level and trend, variability can be ascertained by visually inspecting the data. Crying duration in Fig. 28.1c seems fairly stable upon visual inspection. Variability may be augmented or minimized by the scale of the *y*-axis. In order to prevent a false appreciation of variability, it is recommended that the graph scale reflects the range of socially relevant variations of the dependent variable. In addition to visual analysis, some authors recommend computing a *stability envelope* to visually portray variability. According to Ledford et al., 2018, on occasions when ≥80% of the data points are within ±25% of the median, the data may be described as stable. For example, for the time series in Fig 28.1(d) (*Me* = 8), the stability envelope would range from 6 and 10. There are only five values within the envelope (33%); therefore, the time series may be considered variable. For time series with an increasing or decreasing trend, the stability envelope may be calculated around the trend line, instead of the median. Similarly, Hagopian et al. (1997) suggested using criterion lines below and above the control condition as the basis for identifying intervention effects (see section "Visual Analysis: A Case Study" later in this chapter).

Within-phase variability is indicative of weak experimental control (i.e., weak functional relationship between the treatment and the target behavior). Therefore, variability in the data will hamper our ability to draw conclusions from it. Variability may also be interpreted differently in different experimental designs. For example, a greater level of variability is to be expected in a study with few data points per condition, where steady-state responding is unlikely. Similarly, multielement designs typically present greater variability than study designs where the independent variable is not quickly alternated, and are, therefore, less vulnerable to carryover effects. Whenever possible, it is recommended to identify the sources of unexplained variability, for example, by using different data paths for sessions conducted at home vs. sessions conducted in the community or sessions conducted by different therapists, etc.

A visual analysis of variability often weights more observations conducted relatively later in a particular phase (i.e., towards the right of the graph). Namely, variability occurring before steady-state responding is attained can, to some extent, be ignored if it can be reasonably attributed to the gradual effect of the baseline or intervention conditions (e.g., gradual effect of discrimination, reinforcement, habituation, and extinction processes). By contrast, continued unexplained variability over an extended period of time suggests that key sources of variation remain unidentified, which could take the researchers back to the drawing board. The research setting may also affect the visual analyst judgment of variability. For example, we would expect more unexplained variability in studies conducted in ecological settings (e.g., classroom, home environment), where the opportunities to produce the target behavior may vary greatly (see for example Valbuena et al., 2015).

Visual Analysis Across Phases

Conducting a visual analysis across study phases can help to establish (a) whether there was a change in the target behavior across conditions and (b) whether this change was caused by the intervention. The What Works Clearinghouse standards (2020) offer specific criteria to evaluate a treatment effect. For example, the standards require at least three demonstrations of the intervention effect by considering changes in level, trend, and variability across adjacent phases in a reversal designs (or across participants, behaviors, or contexts in a multiple-baseline design). In the following sections, we will consider immediacy, overlap, and consistency as specific dimensions of a visual analysis comparing side-by-sade phases.

Immediacy

Immediacy may be defined as the amount of time elapsed since the implementation of treatment (or

[3] Bailey and Burch (2017) use the terms high and low *bandwidth* to denote high or low variability during visual analyses.

the reversal to baseline conditions) to an identifiable change in behavior. Immediacy may be defined with reference to either the initial change of the dependent variable and/or the maximum change of the dependent variable. Visual analysts focus on the first few sessions after the implementation of treatment to assess immediacy. For example, in multi-element designs, lack of immediacy could result in frequent dips in the intervention effect, or worse, undifferentiated data paths across conditions.

Abrupt changes in behavior upon the introduction of a new condition may seem ideal. However, abrupt or gradual changes in behavior are both acceptable from an internal validity perspective assuming the delay in behavior change is minimal (see several examples in the phase transitions of Fig. 28.2). Moreover, abrupt changes in a behavioral time series may be partially attributable to the degree of data aggregation. For example, computing responses per minute in 5-min sessions can more easily result in a gradual phase transition than computing responses per hour in 12-hour sessions (Fahmie & Hanley, 2008). Also, the nature of the underlying behavioral process may be key to obtaining gradual or abrupt changes in behavior (e.g., discriminated change in behavior allocation vs. shaping).

Overlap

Overlap refers to the extent to which the level and range of behavior are comparable across adjacent conditions. The greater the overlap, the lesser the confidence in a functional relation between treatment implementation and changes in behavior. Presence of variability during baseline and treatment phases greatly increases the likelihood of overlap. Overlap can be computed quantitatively by way of the percentage of non-overlapping data points (PND) and similar indices (see section on Non-overlap and Other Non-parametric Indices). On occasions when overlap is present, it is important to evaluate whether it changes along local transition trends or whether overlap affects the entirety of the phases under analysis. In the latter scenario, our confidence in identifying a functional relation will diminish. For example, the reversal design in Fig. 28.2 (lower graph) presents a failed baseline reversal (i.e., the second baseline phase fails to verify the level of behavior found in the initial baseline). The overlap between the treatment phases and the second baseline implies lack of experimental control. However, the level of overlap in this particular scenario does not suggest an absence of effect, but rather a failed replication or *non-reversibility event*. Experimental control can be restored by accompanying non-reversible effects with between-subject replications (cf. multiple-baseline design across participants, see Chap. 24).

Consistency

Consistency refers to the extent to which the level of behavior in a particular phase can be verified in subsequent phases featuring the same treatment and the extent to which treatment effects can be replicated through multiple within-subject and between-subject replications. For example, in an ABAB reversal design, the transition between baseline and treatment is repeated. Therefore, the ABAB design provides an opportunity to *verify* baseline and treatment levels and to *replicate* the effect of treatment. Specifically, the ABAB design allows for the evaluation of the effectiveness of the intervention at three different moments in time: transition from first baseline to first intervention, from first intervention to second baseline, and from second baseline to second intervention. The closer the treatment effect across replications, the greater the consistency. Highly consistent intervention effects enhance our ability to identify a functional relation. For example, the treatment replications in the upper graph of Fig. 28.2 are reasonably consistent, whereas the replication was unsuccessful in the lower graph.

Non-reversible behavior changes, such as language acquisition, are not amenable to within-subject replications (e.g., reversal design). Yet, it is still possible to assess treatment consistency across participants. For example, the consistency across participants is high in the first baseline-to-treatment transition for both datasets in Fig. 28.2, even though the treatment effect was not reversible for the lower dataset.

Reliability of Visual Analysis

While visual analysis is the most common method for analyzing SCEDs in applied behavior analysis, studies on its reliability and validity have been limited. Ninci et al. (2015) conducted a meta-analysis and a moderator analysis of SCED studies reporting the interrater reliability of visual analysts. Overall, they found a moderate level of interrater reliability (0.76). Their moderator analysis suggested that the visual analyst's level of expertise did not improve interrater reliability, whereas providing consistent interpretation instructions, visual aids, and consistent training enhanced interrater agreement. In addition, Kahng et al. (2010) found consistent interpretations of SCED line graphs among well-trained visual analysts. However, they utilized relatively simple low-variability line graphs in their study. Other studies are less optimistic about the reliability of visual analysis (see for example Wolfe et al., 2016).

Consistently with Ninci et al. (2015), the use of structured guidelines for visual analysis may increase its reliability and reduced the potential for Type I errors. For example, Hagopian et al. (1997) proposed a set of guidelines for visually analyzing multielement designs used in the functional analysis of problem behavior. Their guidelines have been used in several reviews, allowing visual analysts to attain over 90% interrater agreement (see for example Cox & Virues-Ortega, 2016). Moreover, Fisher et al. (2003) developed the dual-criteria (DC) and conservative dual-criteria (CDC) method to aid visual inspection of SCEDs. Broadly defined, the DC method involves calculating the mean and trend lines for baseline data and extending these lines over the subsequent phases. Next, the number of points in the successive data path(s) that fall above or below both lines is counted and compared to a cut-off value based on a binomial distribution. The CDC is a more stringent variation of the DC method, wherein the mean and trend lines are increased or decreased by one-fourth of a standard deviation (Fisher et al., 2003). The DC and CDC methods are intended to provide a more objective and reliable basis to conduct visual analyses. In yet another example, J. M. Ferron et al. (2017) have proposed the *masked visual analysis* as a means to minimize the risk of Type I errors (i.e., probability of finding an effect when there is none). We discussed masked visual analysis in the section on statistical analyses that produce a *p* value as the main outcome (p. 529). In addition to using structured criteria, using automated tools to ascertain level, trend, and variability may also enhance the reliability of visual analysis (see for example De et al., 2020; Manolov, 2020). More research is needed to validate the various approaches that have been proposed to enhance the reliability of visual analysis, including supplementing visual analysis with statistical analyses discussed later in this chapter.

Visual Analysis: A Case Study

We will illustrate the use of structured criteria for visual analysis with the guidelines proposed by Hagopian et al. (1997) for functional analysis of problem behavior. These criteria have been revised by Cox and Virues-Ortega (2016). We will apply these revised criteria to four multielement SCEDs reported by Conners et al. (2000) (a fully re-graphed version of the data is available in Fig. 28.3). Before implementing these criteria, the visual analyst would draw in the functional analysis graphs the upper criterion line (UCL), defined as the mean plus the standard deviation of the play (control) condition; and the lower criterion line (LCL), defined as the mean minus the standard deviation of the play condition (Fig. 28.3). The revised Hagopian et al. criteria are summarized in Table 28.1. Table 28.2 presents a synthesis of the revised criteria as used with the participants in Conners et al. (2000). Below, we combine the structured visual analysis with some commentary on the within-phase (level, trend, variability) and across-phase (immediacy, overlap, consistency) dimensions of visual analysis.

The only test condition in Annette's functional analysis that met the criterion for differentiation was attention (*D1: observations above the UCL minus observations below the LCL*

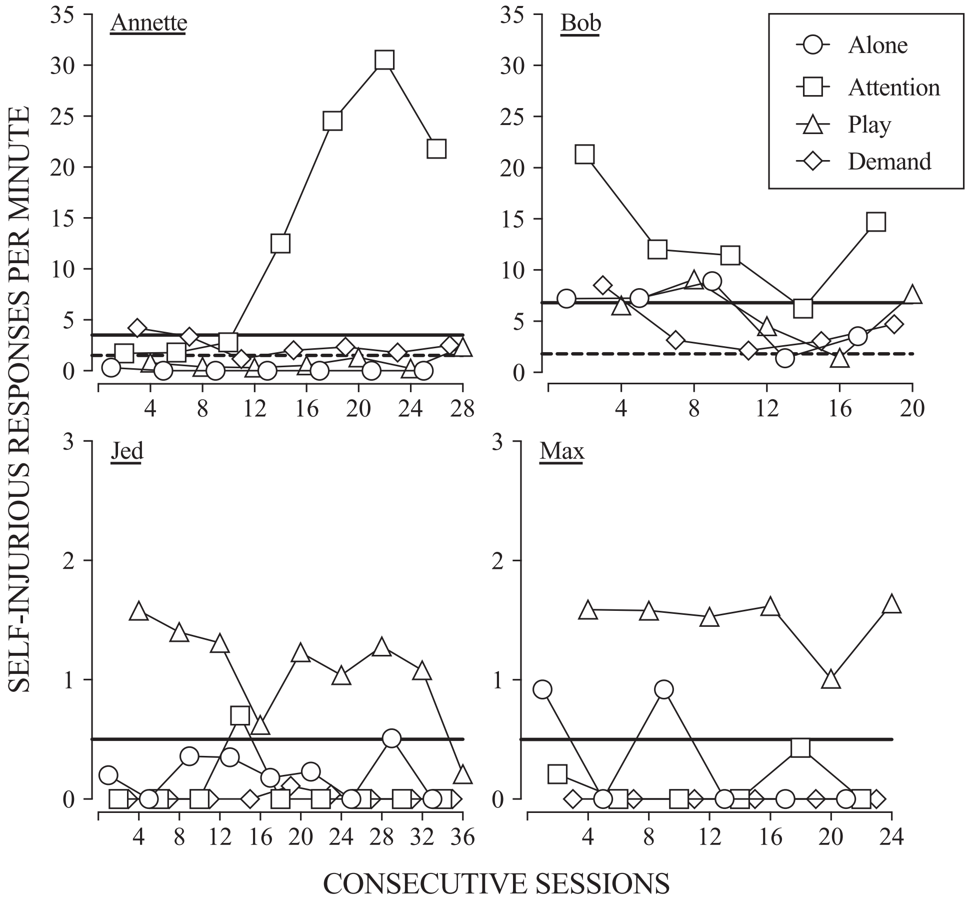

Fig. 28.3 Cases of attention-maintained (Bob and Annette) and escape-maintained (Max and Grey) self-injury. *Notes.* Solid and broken horizontal lines denote the upper and lower criterion lines for the play condition (Hagopian et al., 1997). Originally re-graphed data (Source: Conners et al. (2000))

equal at least half of the observation in the time series). In addition, attention met the criteria for an upward differentiated trend (*T2: all observations above the UCL are in the second half of the assessment*). Therefore, the outcome of the visual analysis is *attention*. The visual inspection shows that alone, play, and demand, all present steady-state responding at zero or near-zero levels. The variability and overlap of the effect of attention (and its lack of immediacy and consistency) may be almost completely attributed to a local transition trend, possibly following the discriminative learning process present in functional analysis.

For Bob's functional analysis, both alone and attention met the D1 criterion for differentiation. Yet, alone also met the criterion for a downward undifferentiated trend (*T1: among the observation above the UCL, fewer than 2 data points [or 20% of the time-series] occur in the second half of the assessment*). Therefore, alone should be discarded as a differentiated test condition. The outcome of the assessment is *attention*. In sharp contrast with Annette's functional analysis, Bob's presents a U-shaped trend that is identifiable to various extents in all conditions. This trend may explain some of the variability in the assessment in addition to the partial overlap of the fourth attention session. Variability is also evident by

Table 28.1 Structured criteria for the visual analysis of a multielement design functional analysis. (according to Hagopian et al., 1997, Cox & Virues-Ortega, 2016)

General criteria	
D1	Criterion for differentiation: points above the UCL line minus points below the LCL ≥ 5
D2	If play LCL is 0 or lower, zeros counted as below the lower line.
D3	If the play's UCL is below 0.5, draw the upper criterion line at 0.5.
D4	If no play/control condition and the highest condition is attention, demand, or tangible (or any two-term combination of these) set LCL and UCL to 0 and 0.5, respectively.
D5	For % of intervals or % of session duration, the maximum UCL is 100%, any 100% data point will be considered above the UCL.
D6	If there are less or more than 10 data points per condition use criteria proportionally, e.g., 50% of data points above UCL vs. 5 data points above UCL. Invoke D6 only if there are at least 2 data points per condition. (D1 is relevant to A3, T1, and T2.)
Automatic reinforcement	
A1	Alone is the highest and is significantly higher than play (is the highest condition in most series).
A2	Behavior is higher in conditions with lower external stimuli (one or more of alone, attention, tangible) relative to those with higher stimuli (one or more of play, demand).
A3	All conditions are high and relatively stable with no overall trends (mean of all conditions is above 1.5 per min [or 15% intervals] and less than 5 zero points).
Trends	
T1	Downward trend (undifferentiated): If less than two data points above the UCL occur in the second half of the assessment. This rule does not apply to demand and tangible if responding adapts to an efficient rate (e.g., every 30 s in demand).
T2	Upward trend (differentiated): All 5 data points above the UCL are in the second half of the assessment, ignore points below the LCL.
T3	Overall trend (differentiated): condition that is consistently higher than play.
Low rate or magnitude	
LR	1. Most of the data points are low across all conditions AND 2. More than half of the high sessions occur in a test condition AND 3. More than half of the behaviors occur in the same condition as #2 AND 4. At least one of the high points in the condition identified in #2 should occur in the second half of the assessment.
LM	Condition meets criterion for differentiation (D1) by a small amount, then raise UCL by 20%. LM1 can be used only if T2 is not applicable.
Multiple control	
M1	Multiple meet criterion for differentiation and alone does not have the highest mean.
M2	M1 applies to all test conditions, then ignore alone.
M3	Two differentiated conditions and alone are the lowest (compute means); outcome: multiply controlled (i.e., automatic plus a social contingency).

Notes: Series = every alone-attention-play-demand sequence; *LCL* = lower criterion line (play condition mean minus its standard deviation); *UCL* = upper criterion line (mean of the play condition plus its standard deviation)

the relatively wide range defined by the LCL and UCL. Otherwise, the effect of attention is immediate and consistent.

Table 28.2 Structured visual analysis for Annette, Bob, Jed, and Max

	Revised Hagopian criteria		
	General	Specific	Outcome
Annette	D6		Attention
Alone			
Attention		D1, T2	
Demand			
Bob	D6		Attention
Alone		T1	
Attention		D1	
Demand			
Jed	D2, D3, D6		Demand
Alone			
Attention			
Demand		D1	
Max	D2, D3, D6		Demand
Alone			
Attention			
Demand		D1	

On occasions when the UCL is below 0.5, the UCL is arbitrarily set at 0.5 (D3). This is the case for Jed and Max. For both of these participants, only demand met the criterion for differentiation (D1), making this condition the outcome of the functional analysis. Attention, demand, and play present steady-state responding at near-zero levels for both datasets. The effect of demand is more consistent and demonstrates less overlap for Max. By contrast, Jed's demand time series presents two *dips* that overlap with some of the undifferentiated conditions. This lack of consistency may be attributed to the effect of demand being less immediate for Jed—to explore this possibility further, the effect of longer demand sessions or the presence of within-session trends could be evaluated. Even though the effect of demand is differentiated in both participants, the relatively low rate of problem behavior could have easily become undifferentiated in the presence of higher response variability in the other conditions of the assessment.

Synergy Between Statistical and Visual Analyses

Arguments for and Against

Applied behavior analysts moved away from inferential statistics in part due to the treatment of within- and between-subject variation as residuals (error). By contrast, variation is often meaningful in applied behavior analysis. Specifically, the continuous analysis of a time series at the individual level is critical to deliver services in applied behavior analysis. For example, one participant may respond to a reinforcement-based intervention (e.g., token reinforcement) within one session, whereas another may require 10 sessions for the intervention to reach its peak, yet a third participant may show no effect whatsoever prompting a swift change in course on the part of the interventionist (e.g., conducting new preference or reinforcer assessments, changing the ratio requirement of the token economy, etc.). An idiographic approach requires a continuous feedback loop between intervention effect monitoring and procedural adjustments. This continuous process may not be possible solely by evaluating aggregated effects *after* the intervention.

Another argument against statistics in applied behavior analysis poses that statistical significance is heavily influenced by sample size, data variability, and data distribution. These three aspects made traditional inferential statistics ineligible for small-*n* experimental designs. Specifically, the modest number of participants in single-subject experimental designs negates *significant* results, even for hugely effective interventions. Moreover, analyzing trends as well as variability as a form of random variation or error can penalize bona fide effects of behavior–analytic interventions, where variability can be attributed to the gradual effect of the independent variable (i.e., trends) or procedural fine-tuning (i.e., ideographic approach).

Finally, single-subject datasets cannot accommodate traditional data distributions including the normal distribution due to the limited number of observations often reported in SCEDs. Fortunately, statistical developments over the last few decades can help to address some of these concerns.

Statistics are needed to enter the high-stakes outcome research literature upon which decisions for treatment policy and treatment prioritization are often made (see for example Keenan & Dillenburger, 2011, for a discussion). Effect size metrics and inferential statistics are sorely needed in applied behavior analysis, if not to compete, at least to achieve a common language with randomized controlled trials (RCT) and other group-based designs. On the other hand, statistical analyses should acknowledge the ideographic, hierarchical, and longitudinal nature of behavior–analytic interventions.

Statistical Techniques

Statistical techniques in SCED remain an active area of study where widely accepted methodological recommendations are lacking. In the following section, we evaluate a selection of the most promising (and a few of the most popular) statistical techniques that have been developed for SCEDs. In the interest of brevity, we have classified the analytical techniques and effect size metrics for SCEDs in four groups: non-overlap and other non-parametric indices, mean-based effect sizes, analyses producing a *p* value as the main outcome, and regression-based analyses (a more detailed classification has been proposed by Manolov & Moeyaert, 2017). Below, we present samples of the most commonly used analyses within these groups. Systematic comparative summaries of these techniques can be found in Tables 28.3 and 28.4.

Non-overlap and Other Non-parametric Indices

Non-overlap indices focus on a key feature of across-phase visual analysis by quantifying the extent to which the range of variation in baseline and treatment phases overlap. The greater the overlap, the less confident one can be in the treatment effect. These indices are easy to compute, require minimal training, and have been widely used in the literature. In addition, they do not impose data distribution assumptions (e.g., normality). Yet, they are subject to numerous sources of bias. First, some of these indices are computed on the basis of a selection of the observations. For example, the percentage of non-overlapping data points (PND) is obtained by computing the percentage of data points during treatment that is above the highest baseline data point. Second, with few exceptions, the value of a non-overlap index is not indicative of the magnitude of the effect but simply of the level of overlap. For example, an intervention increasing the level of baseline responding by 100 can produce a relatively lower non-overlap index compared to another intervention increasing responding by 1.5, assuming that the former incurs on greater overlap. Moreover, outliers can easily bias these indices as they often cause overlap. Additional limitations to non-overlap indices include their limited use in meta-analysis or moderator analysis (other than by averaging). They are not amenable to inferential statistics, or the analysis of co-variables, and they do not produce *p* values, although it is possible to obtain confidence intervals for some of them (Parker & Vannest, 2009). Moreover, there has been limited research on what represents a small, medium, or large non-overlap index. Parker and Vannest (2009) obtained percentiles of common non-overlap indices, providing some basis to ascertain effect magnitude (Table 28.3). Some non-overlap indices are less biased than others. For example, the NAP (non-overlap of all pairs), the PAND (percentage of all non-overlapping data points), and the Tau-*U* include all the values in the time series in the calculation process and are less vulnerable to the effect of outliers.

The log-response ratio is a non-parametric effect size index based on proportional change of rates of behavior across contiguous study phases (Pustejovsky, 2015). Log-response ratio effect sizes do not rely on often unverified parametric assumptions, setting them apart from mean-based effect sizes. Unlike non-overlap indices, it has been proposed to be fully amenable to meta-analysis (Pustejovsky, 2018).

Mean-Based Effect Sizes

The standardized mean difference (SMD) is the difference between the intervention level and baseline level in standardized units. In other words, the difference between the intervention and baseline mean is divided by the pooled within-case standard deviation (or the standard deviation of baseline). This is similar to Cohen's *d* developed for group studies (Cohen, 1992). Cohen's *d* can be corrected for small sample size bias (the standard deviation for each group is weighted by the sample size), which is Hedges' *g*. A version of Hedges' *g* was developed for use with SCEDs and is known as the *between-case standardized mean difference* (BC-SMD;

Table 28.3 Key characteristics of selected single-subject effect size metrics and analytic techniques

	Concept	Range of usable values	Key references
Non-overlap and other non-parametric indices			
NAP	*Non-overlap of all pairs*, percentage of data that improve from the baseline phase to the intervention phase	$P_{10} = 50\%$; $P_{25} = 69\%$; $P_{50} = 84\%$; $P_{75} = 98\%$; $P_{90} = 100\%$	Parker and Vannest (2009)
PND	*Percentage of non-overlapping data*, ratio of number of Phase B data points above the lowest/highest data point in Phase A divided by Phase B total data points	Range, 0–100%; >70% effective intervention; 50–70%, questionable effectiveness; <50% no observed effect.	Parker and Vannest (2009), Scruggs and Mastropieri (1998)
PAND	*Percentage of all non-overlapping data, m*inimum number of data points removed from Phase A and/or Phase B to eliminate all overlap between phases.	$P_{10} = 60\%$; $P_{25} = 69\%$; $P_{50} = 82\%$; $P_{75} = 93\%$; $P_{90} = 100\%$	Parker et al. (2007), Parker and Vannest (2009)
Tau-*U*	Non-overlap index that accounts for changes in level and trend in Phase B. It has the ability to correct for baseline trend	$P_{25} = 0.56$; $P_{50} = 0.84$; $P_{75} = 1.00$ (with baseline trend correction)	Brossart et al. (2018), Parker et al. (2011), Tarlow (2017)
Log-response ratio	Metric based on proportionate change	Not available	Pustejovsky (2015)
Mean-based effect sizes			
WC-SMD	*Within-case standardized mean difference*, difference between the baseline and treatment means divided by the baseline standard deviation	Range, $-\infty$ to $+\infty$; very small, 0.01–0.19; small, 0.20–049; medium, 0.50–0.79; large, ≥0.80	Busk and Serlin (1992)
BC-SMD	*Between-case standardized mean difference*, difference between treatment and baseline means divided by the square root of the sum of the variance of observations within cases plus the variance of observations between cases	Range, $-\infty$ to $+\infty$; very small, 0.01–0.19; small, 0.20–049; medium, 0.50–0.79; large, ≥0.80	Hedges et al. (2012), Pustejovsky et al. (2014)
Analyses producing a p value as the main outcome			
Randomization test	Probability of the rank of the actual baseline and treatment observations relative to all possible permutations of ranks	Same as a one-tailed Type I error probability. If $p \leq 0.05$, then the distribution of higher (or lower) treatment observations is statistically significant	Heyvaert and Onghena (2014)
Masked visual analysis	Probability that an independent visual analyst correctly guesses the true intervention sequence order	Same as a one-tailed Type I error probability. If $p \leq 0.05$, then the distribution of higher (or lower) treatment observations is statistically significant	Ferron and Jones (2006)
Regression-based analyses			
Hierarchical linear modeling and Cohen f^2 effect size	Variance explained by purposely selected hierarchical factors (e.g., behavior, subject, treatment). The Cohen f^2 effect size can be computed by comparing a target model with a reference model	Range, $-\infty$ to $+\infty$; small, 0.02–0.15; medium, 0.15–0.34; large, ≥0.35	Lorah (2018), Van den Noortgate and Onghena (2003)

Table 28.4 Standards of selected single-subject effect size metrics and analytic techniques

	NAP	PND	PAND	Tau-*U*	LRR	WC-SMD	BC-SMD	RT	MVA	HLM
Feasibility and acceptability										
Calculation software available	•	•	•	•	•	•	•	•	•	•
Interpretation guidelines available	•	•	•	•		•	•	•		
Minimal training needed	•	•	•			•		•		
Value proportional to magnitude	•		•	•	•	•	•		•	•
Widely used		•				•				
Sensitivity to single-case datasets										
All data-points computed	•			•	•	•	•	•	•	•
Amenable to zero/near-zero baselines	•	•	•	•			•	•	•	(•)
Amenable to all major single-subject designs	•	•	•					•		•
Amenable to short time-series	•	•	•	•					•	•
Amenable to varying length time-series		•	•	•		•	•	•		•
Some robustness against autocorrelation							•			•
Some robustness against local trends					•					(•)
Some robustness against within-phase trends				•						•
Some robustness against the effect of outliers			•	•		•				•
Weights no. of between-subject replications							•		•	•
Weights no. of within-subject replications							•			•
Weights steady-state responding										(•)
Statistical standards										
Allows for the assessment of co-variables						•	•			•
Amenable to inferential statistics						•	•			•
Meta-analysis/moderator analysis possible	•				•	•	•		•	•
Does not assume normality	•	•	•	•	•			•	•	
Does not rely on central tendency	•	•	•	•	•		•	•	•	•
Provides effect size variance					•	•	•		•	•
Minimal floor/ceiling effects			•	•	•	•	•			•
Confidence intervals/*p* values provided	•		•	•	•	•	•	•	•	•

Notes: Major single-subject designs include reversal, multielement, multiple-baseline, and changing-criterion designs. Parenthesis indicate that the standard can be met if modelled. Local trends denote carryover effects, multiple-treatment interference, and phase transition trends. *BC-SMD* = Between-case standardized mean difference; *HLM* = Hierarchical linear modeling; *LRR* = Log-response ratio; *MVA* = Masked visual analysis; *NAP* = Non-overlap of all pairs; *PAND* = Percentage of all non-overlapping data; PND = Percentage of non-overlapping data; *RT* = Randomization test; *WC-SMD* = Within-case standardized mean difference

Pustejovsky et al., 2014). BC-SMD can also be characterized as a regression-based metric, as it is estimated using a two-level hierarchical linear model; Level 1 is a within-case regression model and Level 2 is between-case variation in regression coefficients (Pustejovsky et al., 2014). Because the difference between the baseline and intervention data is standardized using both the within- and between-case standard deviation, BC-SMD is assumed to be on the same scale as group designs, therefore, Cohen's *d* scale can be used for interpretation. Two additional SCED metrics standardized mean difference are the mean phase difference (MPD; Manolov & Solanas, 2013) and mean baseline reduction (MBLR; Campbell, 2004). Both formulas for MPD and MBLR are similar to Cohen's *d* but without the standard deviation denominator. Thus, they are unstandardized mean difference metrics.

Analyses Producing a *p* Value as the Main Outcome

We have selected the non-parametric randomization test and masked visual analysis to illustrate this category. The randomization test estimates the probability of the observed sequence in level changes across phases, relative to the null hypothesis (i.e., no changes in level across phases). Levin et al. (2012) provide a practical example:

> [S]uppose that there are 8 alternating A and B phases (i.e., an ABABABAB design), each consisting of one or more outcome observations per phase. Further suppose that it had been predicted that the intervention (B) phases would yield generally higher outcome observations than the baseline (A) phases. With 8 total phases, 4 A and 4 B, there are 8!/4!4! = 70 possible assignments of 4 observations (or means based on multiple observations per phase) apiece to two groups, A and B. For each possible assignment, the mean difference between the B and A observations is calculated, yielding a permutation distribution of 70 mean differences. Now suppose that the actual mean difference (i.e., the mean difference produced by the study's 4 actual B phase observations and 4 actual A phase observations) turned out to be the third largest of all 70 mean differences. Assuming that the 70 mean differences are all equally likely, the probability of obtaining a mean difference as large as or larger than the one actually observed is 3/70 = 0.043, with a pre-designated one-tailed Type I error probability (α) of 0.05, would be a statistically significant result. (p. 604)

Ease of calculation, fitness to all major SCEDs (including the multielement design), and lack of data distribution assumptions are distinct advantages of randomization tests. However, the power of randomization tests is diminished in multielement designs using a fixed condition alternation order (Levin et al., 2012), which is a common approach to functional analysis (e.g., Hammond et al., 2013). In addition, a randomization test is fully compatible with other statistical techniques, including non-overlap effect sizes, mean-based effect sizes, and regression-based analyses (see a practical illustration of this combined approach in Heyvaert & Onghena, 2013).

Ferron and Jones (2006) have proposed using randomization strategies as part of a masked visual analysis process with the aim of reducing Type I errors (see also Ferron et al., 2017). For example, in a multiple-baseline design with four participants, the experimenter would hide phase transitions in the graph and randomize the order of the participants within the graph. The experimenter would then ask an independent visual analyst to guess the time points at which the intervention started for each participant. In this example, the probability of correctly guessing the order in which the intervention started for each participant by chance equals $\frac{1}{n!} = \frac{1}{24} = .042$, where n is the number of participants in the multiple baseline design. Therefore, if a visual analyst correctly identifies the order of the intervention sequence, this would ensure that the Type I error is below 0.05. Moeyaert et al. (2020) have developed a user-friendly mobile app to conduct masked visual analysis.

Regression-Based Analyses

Different types of regression-based approaches have been used for SCEDs such as ordinary least squares (OLS; Huitema & McKean, 2000), generalized least squares (GLS; Swaminathan et al., 2014), and multilevel models (Van den Noortgate & Onghena, 2003). OLS is a parametric approach that can quantify the change in level between baseline and intervention phases, as well as the change in trend (Huitema & McKean, 2000). Additional parameters can be added to the model depending on the research question (e.g., it can be used to estimate the baseline level at the start of data collection, the trend during baseline, and the changes in trend and/or level). However, OLS makes several assumptions, including the assumption of normality, homoscedasticity (equality of variances across conditions), and independence of errors. In instances where these assumptions may be inappropriate to make (e.g., if heteroscedasticity or autocorrelation is present), the GLS approach is a more viable and appropriate alternative. GLS is similar to OLS, except that it can reflect count data such as frequency or rate (Declercq et al., 2019) and account for autocorrelation by adjusting the residuals (Swaminathan et al., 2014). Like OLS, GLS is able to reflect both change in slope and change in level together in one model and provide separate estimates of these regression parameters.

Hierarchical linear modeling is an extension of single-level regression analysis and accounts for the nesting of measurement occasions within participants. This modeling approach can be used to estimate change in level and/or slope for individual participants and across participants. As such, HLM is able to estimate between-case differences in intervention effectiveness. If a large amount of between-case variance is found, moderators can be added in an effort to explain variability in intervention effectiveness between participants.

Dataset produced in behavior–analytic studies can be characterized as having a hierarchical or multilevel structure. Levels can be construed as key aspect of the data source that may determine different aspects of the variability. For example, in a study including several multiple baseline designs across behaviors for three participants, some of the differences observed in the behavior may be explained by differences within participants across sessions (i.e., variability across time points) and by differences between participant characteristics (variability across subjects). In addition, subject personal characteristics (e.g., diagnostic group, age, standardized outcomes) may also be included as covariates within the multilevel analysis.

An exciting aspect of multilevel analysis is its flexibility. It is possible to add as many levels to the analysis, as it would be conceptually and statistically appropriate.[4] It is also possible to add a *study* level in order to generalize intervention effectiveness across similar studies, thereby conducting a meta-analysis (Moeyaert, Ferron, et al., 2014a). It is also possible to compute the effect size of key predictors in HLM (e.g., treatment status) and to compare the goodness of fit of various models (Lorah, 2018).

Statistical Analysis: A Case Study with a Two-Level Hierarchical Model

Among the various statistical approaches described to evaluate treatment effects in single-subject data, multilevel analysis or hierarchical linear modeling (HLM) has various distinct advantages. First, acknowledging the hierarchical nature of SCED data can, potentially, minimize unexplained variance and effect underreporting (Baek et al., 2014; Moeyaert et al., 2014a, 2017). In addition, the ability to add predictors can account for characteristics of SCED, which have been ignored in alternative approaches. For example, few of the traditional effect size metrics discussed here have been adapted to multielement designs; one of the most common research designs in applied

[4] Adding a specific level might have conceptual sense, but if that factor has few units, then the estimates could be biased and it might be preferable to omit that level.

behavior analysis (Virues-Ortega et al., 2016). The case study below illustrates the use of multilevel analysis in the functional analyses by Conners et al. (2000) and exemplifies the synergistic use of visual and statistical analyses in SCEDs (see section "Visual Analysis: A Case Study").

We will consider two hierarchical levels: measurement occasions (Level 1) are nested within subjects (Level 2). *Behavior* refers to the amounts of behavior measured in responses per minute. *Subject* identifies each of the four participants. The key predictor for the behavior level is *treatment status*. For the purposes of this analysis, the differentiated conditions of the functional analysis (attention for Annette and Bob, and demand for Jed and Max) are considered as target treatment conditions, whereas undifferentiated conditions (i.e., alone, play, and demand for Annette and Bob; and alone, attention, and play for Jed and Max) will be considered nontarget treatment conditions. Therefore, we created the variable *treatment status (tts)* as a dummy variable, coded as 1 for the sessions of differentiated conditions and 0 for the sessions of undifferentiated conditions. *Session* refers to the ordinal session number for each participant. The behavior level, Y_{ij}, is the behavior level of participant (j) at measurement occasion (i). The independent variable, tts_{ij}, is a dummy variable, indicating the treatment status of participant (j) at measurement occasion (i). Therefore, β_{0j} indicates the expected behavior level for participant j during the undifferentiated condition and β_{1j} indicates the expected change in behavior level between the undifferentiated and differentiated condition for participant j. The within-participant errors (e_{ij}) are assumed to be homogeneous and normally distributed, with a lag1 autocorrelation. A lag1 autocorrelation indicates that two consecutive errors are correlated, which is likely in repeated measures design. The level 1 model is displayed in Eq. 28.1:

$$\text{Level 1 (within participants)}:$$
$$Y_{ij} = \beta_{0j} + \beta_{1j} D_{ij} + e_{ij} \text{ with } e_{ij} \sim N\left(0, \sigma_e^2\right) \quad (28.1)$$

The level 1 parameters (at the right side of the equation sign in Eq. 28.1) are allowed to vary at the second level as it is to be expected that behavior levels during the undifferentiated treatment (β_{0j}'s), as well as changes in level between the undifferentiated and differentiated treatments (β_{0j}'s), vary between participants. Therefore, these parameters are a function of an overall average effect across participants (reflected by the θ's) and individual differences (reflected by the u's). This is reflected in the Level 2 model, displayed in Eq. 28.2:

$$\text{Level 2 (across participants)}:$$
$$\begin{cases} \beta_{0j} = \theta_0 + u_{0j} \\ \beta_{1j} = \theta_1 + u_{1j} \end{cases}$$
$$\text{with} \begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_{u_0}^2 & \\ \sigma_{u_0 u_1} & \sigma_{u_0}^2 \end{bmatrix} \right), \quad (28.2)$$
$$\text{and } e_{ij} \sim N\left(0, \sigma_e^2\right)$$

θ_0 refers to the overall behavior level during the undifferentiated condition across the J participants. The deviation of participant j from the overall level θ_0 is indicated by u_{0j}. These deviations are assumed to be normally distributed around 0 with a variance of u_{0j} As such, $\sigma_{u_0}^2$ represents the between-participant variance of the behavior level during the undifferentiated conditions of the functional analysis. Similarly, θ_1 refers to the overall change in behavior level between the undifferentiated and differentiated conditions across the J participants. u_{1j} refers to the deviation of participant j from the difference in level. These deviations are assumed to be normally distributed with an average of 0 and variance $\sigma_{u_1}^2$. Thus, $\sigma_{u_1}^2$ represents the between-participant variance of the change in level. Likewise, the within-participant errors, e_{ij} are assumed to be normally distributed around 0 with a variance of σ_e^2. Therefore, σ_e^2 indicates the within-participant error variance. The within-participant errors (i.e., e_{ij} 's) are assumed to be correlated. By substituting the Level 2 equations into the Level 1 equation, the combined two-level hierarchical linear model can be written as:

Table 28.5 Design matrix for one participant

Name	Participant	Treatment status (tts)	Session	Behavior (beh)
Bob	1	0	1	7.21
Bob	1	1	2	21.32
Bob	1	0	3	8.52
Bob	1	0	4	6.53
Bob	1	0	5	7.26
Bob	1	1	6	12.01
Bob	1	0	7	3.17
Bob	1	0	8	9.10
Bob	1	0	9	8.91
Bob	1	1	10	11.44
Bob	1	0	11	2.14
Bob	1	0	12	4.52
Bob	1	0	13	1.39
Bob	1	1	14	6.24
Bob	1	0	15	3.06
Bob	1	0	16	1.43
Bob	1	0	17	3.55
Bob	1	1	18	14.72
Bob	1	0	29	4.70
Bob	1	0	20	7.65

$$y_{ij} = \theta_0 + u_{0j} + \left(\theta_1 + u_{1j}\right) D_{ij} + e_{ij} \text{ with } \begin{bmatrix} u_{0j} \\ u_{1j} \end{bmatrix} N\left(0, \Sigma_v\right), e_{ij}\ N\left(0, \sigma_e^2\right) \quad (28.3)$$

The basic two-level HLM approach introduced in Eq. 28.3 is promising and its appropriateness in summarizing SCED data has been empirically validated through large-scale Monte Carlo simulation studies (e.g., Ferron et al., 2010).

We evaluated the current multilevel model (presented in Eq. 28.3) using the statistical package *R* for Mac (Urbanek et al., 2020). Table 28.5 presents the coding of the design matrix for one randomly selected participant (i.e., Bob). For a detailed discussion on how to appropriately setting up the design matrix, see Moeyaert, Ugille, et al. (2014b). The *R* code for the proposed analyses is displayed and described in Fig. 28.4. The results of the two-level HLM analysis are presented and described in Fig. 28.5. The output indicated that the difference in behavior level between the target and non-target conditions is estimated to be 5.86, and is statistically significant, $\hat{\theta}_1 = 5.86$, $t(103) = 2.07$, $p = 0.04$. This analysis provides a quantitative indication of functional analysis differentiation in this context. However, the same analysis could be used to quantify treatment effects. We encourage the interested reader to check Becraft et al. (2020) for a tutorial on using multilevel models and Rodabaugh and Moeyaert (2017) for additional information.

Conclusion

Some researchers have argued that the use of visual inspection alone as a standard for demonstrating functional relations may inhibit communication with researchers from other fields unaccustomed to this methodology (Falligant et al., 2020). The modest interrater agreement indices reported in the literature (Ninci et al., 2015), in addition to other sources of bias present in SCED, call for more stringent methodological standards for visual analysis in SCED as applied

```
install.packages ("nlme")
library("nime")

regl_AR_HE<-Ime(beh ~ tts, random=~tts |name,data=raw, na.action="na.omit",
            correlation=corAR1(form=~ 1|name),weights = varIdent(form = ~1 |
tts),
            control=list(opt = "optim",
            optctrl = list(method = "REML ")))

summary (regl_AR_HE)
```

In order to run the two-level hierarchical linear model, the R package *"nlme"* needs to be installed *[install.packages("nlme")]* and loaded *[library ("nlme")]*. The package *"nlme"* allows running a linear mixed effects model. The function *"lme()"* is called and between the brackets the specific model is defined, together with some optional arguments. The behavior outcome score (*"beh"*) is regressed on the dummy coded treatment variable (*"tts"*, or the dummy coded variable indicating the undifferentiated versus differentiated condition). The intercept and *"tts"* are allowed to vary between participants (indicated by random =*~tts|names*). The argument *"data=raw"* indicates that we are using the data saved in the dataframe *"raw"*. The next argument *"na.action="* is needed in case there are variables with a missing score (na = not applicable). The *"correlation=corar1"* argument indicates that we are modelling a lag1 autocorrelation per participant (*"|name"*). The "weights" defines that the within-participant variance is heterogeneous (i.e., a different amount of variance in the treatment versus non-treatment condition is modeled). Lastly, the control and *optCtrl* define that the restricted maximum likelihood estimation approach is used (which is recommended when working with a small number of observations). The obtained output is saved in *"reg1_AR_HE"* (but any other name can be chosen) and a display of this output is obtained by running *"summary(reg1_AR_HE)*. The obtained output is included in Figure 5.

Fig. 28.4 *R* code for a two-level hierarchical linear model with lag1 autocorrelation and heterogeneity of variances

```
Linear mixed-effects model fit by REML
     Data: raw
     AIC          BIC          logLik
     479.0524     500.3599     -231.5262

Random effects:
     Formula: ~tts | name
     Structure: General positive-definite, Log-cholesky parametrization
                 StdDev       Corr
(Intercept)             2.443743     (intr)
tts              5.029188     0.579
Residual         1.347879

Correlation Structure: AR(1)
     Formula: ~1 | name
     Parameter estimate(s):
     Phi
     0.2855608
Variance function:
     Structure: Different standard deviations per stratum
     Formula: ~1 | tts
     Parameter estimates:
     0            1
     1.000000     5.131597
Fixed effects: beh ~ tts
           Value        Std.Error    DF     t-value      p-value
(Intercept)       1.672828     1.236072     103    1.353341     0.1789
tts        5.858234     2.825021     103    2.073696     0.0406
Correlation:
     (Intr)
tts  0.576

Standardized within-Group Residuals:
Min        Q1           Med          Q3           Max
-2.84792960       -0. 21736258 -0.09689296   0.08955786   2.87216994

Number of Observations: 108
Number of Groups: 4
```

The first part of the output provides goodness of fit indices (i.e., AIC, BIC and the Log Likelihood). These indices can help to choose between multiple competing nested models. The smaller the values for the fit indices, the better the model fit. The hierarchical liner model is very flexible. For instance, different functional forms for the trend (e.g., linear trend, quadratic trend, etc.) and/or autocorrelation can be specified. The model can also be expanded by including participant-specific covariates (e.g. gender, age, etc.). Competing models can be compared using these fit indices. The next part of the output indicates the random components estimates, i.e., the estimate of the between-participant variance of behavior level in the non-differentiated condition (i.e., $\sigma^2_{u_0} = 2.44^2$), the between-participant variance of changes in behavior level (i.e., $\sigma^2_{u_1} = 5.03^2$), the covariance between the non-differentiated and differentiated condition ($\sigma_{u_0 u_1} = 2.44 \times 5.03 \times 0.60$), and the within-participant variance. The within-participant variance is estimated separately for the non-differentiated (i.e., $\sigma^2_e = 1.35^2$) and the differentiated treatment condition [i.e., $\sigma^2_e = (5.13 \times 1.35)^2$]. This indicates that most variance is due to difference in behavior level between-participants, and within the treatment condition. The next lines in the output provide an estimate of the lag1 autocorrelation (Phi = 0.29). This value indicates that there is a decent amount of correlation between two consecutive errors. Next, the fixed effect parameter estimates are provided. The estimated behavior level during the non-differentiating condition is 1.67 and not statistically significantly different from 0 [$\hat{\theta}_0 = 1.67$, $t(103) = 1.35$, $p = .18$]. The difference in behavior level between the non- differentiating and differentiating condition is estimated to be 5.86, and is statistically significant at the .05 level [$\hat{\theta}_1 = 5.86$, $t(103) = 2.07$, $p = .04$]. The within-participant standardized residuals indicate that the median error is close to 0, and that there are no significant outliers (as the standardized errors range from -2.85 to +2.87). The last line of code indicates that there is a total of 108 observations, nested within 4 participants.

Fig. 28.5 *R* output for a two-level hierarchical linear model with lag1 autocorrelation and heterogeneity of variances behavior analysis enters the high-stakes outcome research arena.

We expect that the status of visual analysis and SCED as mainstream methods of treatment evaluation and data analysis will be established more firmly as progress continues in the following fronts: (a) widespread evaluation of methodological quality in SCED (as it is customary for RCTs), (b) widespread evaluation of the interrater reliability of visual analysts (as it is the case for interobserver agreement or treatment fidelity), (c) widespread use of intention-to-treat analysis and/or consecutive case reporting, (d) widespread use of structural guidelines for visual analysis (e.g., Hagopian et al., 1997; Fisher et al., 2003), and (e) widespread use of statistical analyses and meta-analysis-compatible effect size metrics *in conjunction with* visual analysis.

Progress in these various fronts would require a level of consensus in the field that is yet to be achieved. However, the basic elements to attain these standards are already well understood. A challenge of particular importance for incorporating statistical analysis in SCED results from the limited sensitivity of the available statistical techniques to the logic of SCEDs. For example, practically no statistical technique properly models steady-state responding, weights within-subject replications, or provides an estimate of carryover effect (Table 28.4). These SCED-specific features ought to be modeled in a unified theory of SCED data analysis. In this respect, hierarchical models offer the greatest flexibility to researchers and practitioners to assess these various effects. The practical conjunction of statistical and visual analyses may depend on the theoretical consistency of these two approaches to data analysis and data interpretation.

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29 Precursor Behaviors to Severe Challenging Behaviors

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Introduction

Challenging behavior in children is common during various developmental stages. While most children will outgrow these issues, behavioral intervention is required when a challenging behavior persists or occurs at such a high frequency or intensity that it has serious repercussions for the individual (Powell et al., 2006). However, there are some challenging behaviors that present a number of safety risks to the individual and/or caregivers during assessment and treatment. These severe challenging behaviors can be more difficult to address due to their intensity, frequency, or harmful nature. To minimize potential risks, practitioners often intervene on the precursor behaviors that reliably precede episodes of severe challenging behavior. Precursor behaviors are considered milder or innocuous behaviors that belong to the same response class as the severe challenging behavior, meaning they have the same maintaining contingency (Smith & Churchill, 2002). By assessing for and treating these precursor behaviors, severe challenging behaviors can be reduced or eliminated altogether (Fritz et al., 2013).

This chapter will first provide a brief overview of challenging behavior and give examples of more severe challenging behavior observed in individuals with developmental disabilities. Next, the ethical and practical considerations of treating severe challenging behavior will be examined. Precursor behaviors will then be defined, and the theoretical perspectives behind these behaviors will be discussed. Strategies for identifying precursor behaviors, including the precursor functional analysis, will be evaluated. Finally, this chapter will review some of the function-based treatments for precursor behaviors that have been successfully demonstrated within the literature.

Challenging Behavior

All individuals have engaged in challenging behavior at some point in their lives. In fact, it is developmentally normative for children and adolescents to engage in certain forms of challenging behavior at various stages of development (Ogundele, 2018). Infants and toddlers, for example, will exhibit tantrums, hyperactivity, non-compliance, and even aggression as they are still acquiring social–emotional competence and self-regulation (Powell et al., 2006). On the other hand, it is not uncommon for adolescents to act

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_29

defiant and demonstrate more risk-taking and impulsive behaviors due to pubertal development and increased peer pressure (Milkman & Wanberg, 2012). While many behavioral topographies are part of typical childhood development, it is the "persistence, intensity, and pervasiveness" of challenging behavior that becomes a cause for concern and can result in the need for professional support and intervention (Powell et al., 2006, p. 26).

During the early childhood years, it can be tricky for some practitioners to differentiate between challenging behaviors that are developmentally appropriate and those that are more worrisome (Dunlap et al., 2006). When identifying a challenging behavior, it is important to consider how the problem behavior impacts the person's physical well-being, socialization, and educational outcomes (Gore & Umizawa, 2011; McTiernan et al., 2011). In view of this, two definitions of challenging behavior have been proposed. Smith and Fox (2003) defined challenging behavior as "any repeated pattern of behavior, or perception of behavior, that interferes with or is at risk of interfering with optimal learning or engagement in pro-social interactions with peers and adults" (p. 5). Another commonly recognized definition of challenging behavior comes from Emerson (2001). He defined challenging behavior as:

> Culturally abnormal behavior(s) of such intensity, frequency or duration that the physical safety of the person or others is likely to be placed in serious jeopardy or behavior which is likely to seriously limit use of, or result in the person being denied access to, ordinary community facilities. (p. 3)

These definitions are more useful than a topographical list of behaviors (e.g., aggression, elopement) because they define challenging behavior by its impact on the quality of life of the person and others (Oliver et al., 2003).

While it is estimated that 10%–15% of typically developing preschoolers engage in some form of mild-to-moderate challenging behavior (Campbell, 1995), research has found that individuals with developmental disabilities are at a greater risk for displaying challenging behavior that is more severe and persistent over time (Lory et al., 2020). In fact, studies have shown that children with intellectual disability (ID) are three to seven times more likely to engage in challenging behavior when compared to their neurotypical peers (Alimovic, 2013; de Ruiter et al., 2007). The higher rates of challenging behavior among individuals with developmental disabilities are thought to be associated with communication and social challenges in this population (Buschbacher & Fox, 2003; Holden & Gitlesen, 2006; Sigafoos et al., 2003). For individuals with ID, prevalence estimates of challenging behavior have ranged from 48% to 60% (Simó-Pinatella et al., 2019). However, this prevalence rate increases substantially with a secondary diagnosis of autism spectrum disorder (ASD; McCarthy et al., 2010; McClintock et al., 2003). As a matter of fact, challenging behavior occurs far more frequently among autistic individuals than individuals with other developmental disabilities (Gregori et al., 2020). The reported prevalence of challenging behavior among individuals with ASD varies, but it has been found to be as high as 82% (Murphy et al., 2009) to 94% (Jang et al., 2011; Matson et al., 2009).

Severe Challenging Behavior

Among the various topographies of challenging behavior, there are some forms that are more dangerous than others because they pose a risk to the health and safety of the individual and caregivers. These severe challenging behaviors can cause physical harm to the individual or others, and they are estimated to be present in 10%–15% of the developmental disability population (Lowe et al., 2007). An operational definition of severe challenging behavior proposed by Qureshi and Alborz (1992) includes any behavior that:

(a) Has at some time caused more than minor injuries to [the individual] or others
(b) Has at some time resulted in the destruction of the [individual's] immediate living or working environment
(c) Behaviour [sic] occurring *at least weekly* which either:

(i) Places [the individual] in physical danger
(ii) Requires intervention by more than one member of staff for control
(iii) Causes damage which cannot be rectified by immediate care staff
(iv) Causes at least an hour's disruption
(d) Has caused disruption lasting more than a few minutes at least daily. (p. 139)

Severe challenging behaviors are often easy to recognize because they are highly disruptive, harmful, and/or destructive (Chandler & Dahlquist, 2014). Examples of severe challenging behavior include, but are not limited to, aggression (e.g., hitting, pinching, scratching, biting, pulling hair), self-injurious behavior (e.g., head banging, self-hitting, self-biting, bruxism, eye gouging or poking, hair pulling), property destruction (e.g., window breaking, throwing furniture or objects, breaking or hitting objects), inappropriate sexual behavior (e.g., public masturbation, touching or grabbing the genitalia of others), pica or coprophagy, and vomiting or rumination (Lowe et al., 2007; Lydon et al., 2015).

Beyond the risk of injury to the individual and those around them, severe challenging behavior can have a number of other deleterious effects. First, severe challenging behavior will often prevent an individual from being fully integrated into the general education classroom or community (Agran et al., 2018). Individuals with severe challenging behavior are also more likely to experience intrusive and restrictive practices such as seclusion or restraint (Webber et al., 2011). Sadly, these aversive practices can result in emotional trauma, injury, or even death to the individual receiving such treatment (Ferleger, 2008; Tilli & Spreat, 2009). In addition to this, the misuse of medication as a form of chemical restraint to manage severe challenging behavior can lead to adverse side effects such as agitation, nausea/vomiting, lethargy, and tics (Matson et al., 2000). Severe challenging behavior can also have a negative effect on the emotional well-being of those close to the individual. Research has found that these behaviors in children with developmental disabilities are a strong predictor for parenting stress, which can lead to parent depression, poorer physical health, and family or marital problems (Neece & Chan, 2017). It has also been discovered that severe challenging behavior is a strong predictor of stress and burnout among support workers (Ryan et al., 2019). Overall, these findings would suggest that severe challenging behavior has a negative impact on the quality of life of individuals with developmental disabilities and their caretakers.

Treatment and Assessment Considerations

Without effective intervention, challenging behavior is likely to persist across the lifetime of an individual with developmental disabilities, which in turn can hinder their socialization, education, and inclusion (Matson & Rivet, 2008). Two commonly used approaches for treating severe challenging behavior are function-based intervention and crisis management (Stevenson et al., 2019). Crisis management, or emergency intervention, is the use of restrictive procedures in response to an episode of severe challenging behavior that is typically not included within the individual's Behavior Intervention Plan (Webber et al., 2011). While crisis intervention strategies have been shown to be effective for some individuals, there is a lack of research demonstrating their effectiveness for individuals with developmental disabilities (Stevenson et al., 2019). There are two possible reasons for this. First, crisis management procedures often include language-intensive activities such as debriefing or planning sessions, which may be difficult for individuals with language delays (Stevenson et al., 2019). Furthermore, crisis interventions rarely take into consideration the function of the severe challenging behavior, so they will often inadvertently reinforce the behavior rather than reduce it (Ryan et al., 2007). Research has found that function-based interventions are more effective in diminishing challenging behavior than non-function-based approaches (Ingram et al., 2005; Hurl et al., 2016).

Function-based intervention is considered the best practice for treating severe challenging behavior, and there are decades of empirical research to demonstrate its efficacy across a wide range of behaviors, diagnoses, and settings (Weddle & Carreau, 2018). Function-based approaches are effective in reducing challenging behavior because they acknowledge and address the idiosyncratic variables that are maintaining the behavior (Hurl et al., 2016). To identify these variables, a variety of indirect and direct assessments can be implemented within a systematic process known as the functional behavior assessment (FBA; O'Neill et al., 2015). While some studies have demonstrated that indirect and direct assessments can accurately determine the maintaining function of challenging behavior (Lewis et al., 2015), there is other evidence to suggest that direct or descriptive assessments have low validity, although they are commonly used in clinical practice (Tarbox et al., 2009; Wightman et al., 2014). Of the various FBA methodologies, the experimental functional analysis (EFA) is considered the most accurate assessment and is generally considered the "gold standard" for determining behavioral function (Hanley et al., 2003).

The EFA is the most precise method for informing function-based intervention because it is the only assessment that can provide an empirical demonstration of the causal relationships between challenging behavior and environmental variables (Lerman & Iwata, 1993). During the EFA, the practitioner systematically manipulates antecedent and consequent events within highly controlled conditions to determine which variables are maintaining the challenging behavior (Iwata et al., 1982/1994). During the assessment, the individual is exposed to a variety of test conditions, in which the maintaining variables are present, and a control condition, where these variables are absent (see Chap. 26). There is a substantial corpus of research that has demonstrated the validity of the EFA for evaluating challenging behaviors and developing effective function-based treatments (Beavers et al., 2013; Hanley et al., 2003).

Despite the proven effectiveness of the EFA for identifying functional relations, there are some ethical and practical considerations with its use for severe challenging behavior. First, the traditional EFA approach may not be appropriate for high-intensity, severe challenging behavior that occurs so infrequently (e.g., once per day), that it is unlikely to be evoked during the EFA sessions (Fahmie & Iwata, 2011). While some researchers have attempted to address this issue by extending the duration of the sessions (e.g., all-day functional analysis; Kahng et al., 2001), this is not always ethical or feasible. This modification might be considered unethical because the individual is exposed to states of deprivation (e.g., social attention withheld) for extended periods of time (Tarbox et al., 2004). Furthermore, this adaption to the EFA may not be practical within organizations where resources are limited (Tarbox et al., 2004).

Another ethical consideration with the use of the traditional EFA is that the severe challenging behavior is purposefully evoked and reinforced during the test conditions. While this is necessary to demonstrate a functional relationship, temporary increases in the severe challenging behavior pose a safety risk to the individual and others (Smith & Churchill, 2002). In a retrospective review, Kahng et al. (2015) found that the rate of injuries to individuals tended to be higher during EFA sessions than outside of them. Considering this, parents or schools may be reluctant to approve such procedures (Najdowski et al., 2008). To mitigate the potential risks associated with the traditional EFA, a number of variations have been developed. These include the brief functional analysis, functional analysis with protective equipment, latency functional analysis, and trial-based functional analysis (Lydon et al., 2012). Another strategy is to apply the experimental contingencies to more benign topographies of behavior that are members of the same response class as the severe challenging behavior (Smith & Churchill, 2002). Research has shown that the assessment and treatment of these innocuous behaviors can help to reduce or prevent severe challenging behavior (Fahmie & Iwata, 2011).

Precursor Behaviors

Early studies have demonstrated that if one topography of challenging behavior is punished or placed on extinction, collateral increases in other forms of problem behavior may be observed (Goh & Iwata, 1994; Lerman et al., 1999; Sprague & Horner, 1992). This response variability could suggest that the challenging behaviors are members of the same response class, meaning that they are maintained by the same consequence (Catania, 2013). There are at least a dozen studies to illustrate that different topographies of challenging behavior often belong to the same response class (Warner et al., 2020). Members of a response class covary, meaning that the probability of one behavior being emitted is directly related to the probability of the other behaviors occurring (Sprague & Horner, 1992). This would imply that the behaviors form a response class hierarchy, where the ordering of each topography is determined by response effort, schedules of reinforcement, and the probability of punishment (Lalli et al., 1995).

The hierarchical nature of challenging behavior has been demonstrated by several researchers using extinction analyses (e.g., Harding et al., 2001; Lalli et al., 1995; Lieving et al., 2004; Magee & Ellis, 2000; Richman et al., 1999). In these studies, when extinction was applied to milder topographies of a response class, there were predictable increases in more severe topographies. Similarly, when the milder behaviors were reinforced, the likelihood of the individuals engaging in severe challenging behavior was reduced. In summary, different topographies of challenging behavior belonging to the same response class tend to occur in a predictable temporal order. By applying contingencies to initial, milder members of the response class hierarchy (e.g., crying), subsequent and more severe members (e.g., self-injury) can be reduced or eliminated (Dracobly & Smith, 2012).

While this research supports the theory that milder forms of challenging behavior are earlier members of a response class hierarchy, there is another possible explanation for this phenomenon. It is also feasible that some of these preceding topographies are initial links within a response chain (Heath & Smith, 2019). Simply put, these early behaviors do not produce the maintaining consequence themselves, but they serve as discriminative stimuli for the severe challenging behavior that produces reinforcement. This was demonstrated by Hagopian et al. (2005), who used a conditional probability analysis to show that stereotypy reliably occurred before episodes of eye poking. When the stereotypy was blocked, eye poking was substantially reduced, but when eye poking alone was blocked, both behaviors continued to occur in more than a third of the intervals. This indicated that stereotypy was the earlier link within the response chain, and by interrupting this response, the probability of the terminal response (i.e., eye poking) was reduced.

From both theoretical standpoints, the treatment of initial milder topographies is hypothesized to prevent or alleviate episodes of more severe challenging behavior. These lesser problematic behaviors are often referred to as precursor behaviors. Smith and Churchill (2002) defined precursor behaviors as "behaviors that are observed to frequently precede the problem behavior" (p. 126). For a behavior to be classified as a precursor, it must have a "temporal and probabilistic relation" to the challenging behavior of concern (Fahmie & Iwata, 2011, p. 993).

Precursor behaviors can vary from person to person. Nevertheless, Fahmie and Iwata (2011) revealed that the most common precursors reported in the literature were unintelligible vocalizations, object-directed movements, and self- or non-directed movements (Fahmie & Iwata, 2011). This was supported by Silbaugh and Falcomata (2018), who found that the majority of reported precursors were non-vocal and vocal responses. Regarding precursor-target relations, Fahmie and Iwata (2011) discovered that unintelligible vocalizations were most likely to occur before aggression and property destruction. Property destruction was also likely to be preceded by non-specific vocalizations. The most common precursors to self-injurious behavior were self- or non-directed movements (Fahmie & Iwata, 2011). However, despite these findings, practitioners should not rule out the potential for other precursor topographies. Like all operant behaviors, precursor behaviors are idiosyncratic to the individual, and there is a wide range of possible topographies. Before a practitioner can treat precursor behaviors, it is first necessary to identify their form and function to determine if they belong to the same response class as the more severe challenging behavior.

Identification of Precursor Behaviors

Progress has been made in recent decades in developing and validating assessment methods for response class hierarchies. Such assessments provide information regarding the structure of a response class hierarchy, including the relative probability of class members, the range of topographies, and the strength of each behavior (Silbaugh & Falcomata, 2018). Using these assessments, practitioners can investigate the hierarchical nature of challenging behavior in order to identify the precursors that reliably precede other members within the response class and the relative severity of topographies across the response class (Silbaugh & Falcomata, 2018). Understanding the structure of response class hierarchies and identifying precursor behaviors can help to improve intervention outcomes, minimize the recurrence of challenging behavior, and prevent unwarranted changes to treatment to address previously unseen topographies (Silbaugh & Falcomata, 2018). Furthermore, by empirically investigating response class hierarchies, more severe topographies of challenging behavior can be identified, and interventions targeting milder topographies can be developed, thereby limiting the occurrence and reinforcement of severe challenging behavior during assessment and treatment (Lalli et al., 1995; Langdon et al., 2008).

Until recently, it has been suggested that limited synthesis and examination of this research has impeded the application of these assessments in practice. To address this limitation, Silbaugh and Falcomata (2018) evaluated the current literature on methods for identifying and characterizing response class hierarchies and precursor behaviors. Based on the defining features of these assessment procedures, the authors developed a classification system for the methods and examined the evidence base for each. Methods were classified as either indirect assessments, direct descriptive assessments, structured consequence-based assessments, or experimental analyses.

Indirect Assessments

Indirect assessments involve interviewing respondents to obtain information about the precursor behaviors. These informants should be individuals who know the person well and are familiar with their behavior of concern, such as caregivers (e.g., Fritz et al., 2013; Smith & Churchill, 2002) or teachers (e.g., Herscovitch et al., 2009; Langdon et al., 2008). During these assessments, precursor behaviors are explained to the respondents using non-technical language (e.g., "warning signs that problem behavior is likely to occur"; Langdon et al., 2008, p. 808). Then, respondents are asked to identify these behaviors; if there is more than one topography, they may be required to rank these behaviors as primary, secondary, or tertiary precursors (e.g., Herscovitch et al., 2009).

According to Silbaugh and Falcomata (2018), there are a few benefits to indirect precursor assessments. First, these assessments are relatively straightforward to complete, with limited time or training resources required. Furthermore, in contrast to other methods, indirect precursor assessments do not require the systematic programming of contingencies for the precursor behaviors. While this method can provide valuable information to the practitioner, indirect precursor assessments are not without limitations.

There are only a few examples of indirect precursor assessments within the literature, and it has been suggested that this method is susceptible to inaccuracies (Herscovitch et al., 2009). Some precursor behaviors, for example, may be subtle or bear limited resemblance to the challenging behavior, making them more difficult for the informants to identify (Fritz et al., 2013). In addition, if a response occurs at such a high rate (e.g., stereotypy) that it precedes multiple different behaviors, it may incorrectly be identified as a precursor to the challenging behavior. Informants may also be influenced by particularly salient or recent instances of severe challenging behavior and are less inclined to remember precursors during episodes where the more severe topography was absent (Dracobly & Smith, 2012). While consulting with multiple respondents may ameliorate some of these challenges, this would increase the time and resources required to conduct such assessments.

Direct Descriptive Assessments

Direct descriptive assessments involve collecting data on the severe challenging behavior and any precursor behaviors that occur immediately before it. This may be done during planned direct observations of these behaviors or through the secondary analysis of data collected during an EFA or treatment evaluation (Silbaugh & Falcomata, 2018). Many of these methodologies evaluate the temporal relationships among members of a response class by calculating the probabilities that the challenging behavior and precursor behaviors will occur during specified time frames.

Comparative Probability Analysis

Comparative probability analyses examine correlations between potential precursors and the challenging behavior by calculating the conditional probability of each behavior. These assessments can be employed alone (e.g., Apamo-Gannon, 2016) or in conjunction with other precursor assessments (e.g., Dracobly & Smith, 2012). Each occurrence of the challenging behavior and precursor behavior is an anchor point from which these probabilities are calculated (Borrero & Borrero, 2008). The probability of a precursor given the challenging behavior is calculated by observing whether the precursor behavior occurs within a predetermined number of seconds before the anchor point of the challenging behavior (e.g., 10 s; Borrero & Borrero, 2008). Similarly, the probability of the challenging behavior given a precursor is calculated by observing whether the challenging behavior occurs within the same number of seconds after the anchor point of the precursor behavior. These probability values are calculated for each episode of precursor behavior and challenging behavior, and from these, an overall conditional probability percentage is determined.

Lag-Sequential Analysis

Lag-sequential analyses examine similar response–response correlations. These assessments calculate the second-by-second probability of a precursor behavior occurring within a specific time frame immediately prior to and following an episode of challenging behavior (e.g., 60 s; Dracobly & Smith, 2012). Within this time frame, each 1-s interval is scored for the presence or absence of the precursor behavior. The number of intervals with the precursor behavior is divided by the total number of intervals with the challenging behavior to determine the conditional probability value. A similar analysis is also conducted to determine the second-by-second probability of the challenging behavior occurring during each 1-s of the given time frame immediately before and after an episode of precursor behavior.

Within lag-sequential analyses, conditional probabilities are compared to unconditional probabilities. The unconditional probability of the challenging behavior is calculated by dividing the total number of challenging behavior episodes by the number of opportunities to engage in the challenging behavior (Borrero & Borrero, 2008). In comparison to this unconditional probability, an increase in the probability of the precursor during intervals immediately prior to the challenging behavior and a subsequent decrease in the probability during intervals immediately following the challenging behavior suggest that the response is a reliable precursor behavior (Borrero & Borrero, 2008). Similarly, an increase in the probability of the challenging behavior during intervals immediately following the precursor and a decrease in the probability during intervals immediately prior to the precursor suggest that the challenging behavior reliably occurs after the precursor behavior (Borrero & Borrero, 2008).

Transitional Probability Analysis

Transitional probability analyses examine the relationship between precursor behaviors and challenging behavior within the context of daily activities (Langdon et al., 2008). Data are collected during direct observations of the individual engaging in activities that are reported to evoke the challenging behavior. Each observation is divided into a series of equal intervals of time, and five transitional probabilities are calculated. With each episode of precursor behavior, a new observation interval begins, and the following probabilities are calculated: (a) the likelihood the precursor is immediately followed by the challenging behavior, (b) the likelihood the precursor is immediately followed by another precursor, and (c) the likelihood the precursor is immediately followed by any other behavior (Langdon et al., 2008). Similarly, with each episode of challenging behavior, a new observation interval begins, and the following probabilities are calculated: (a) the likelihood the challenging behavior is immediately followed by another challenging behavior, and (b) the likelihood of the challenging behavior occurring when neither the precursor nor another challenging behavior was seen in the previous observation interval (Langdon et al., 2008).

The previous three analyses are considered more accurate precursor assessments than other descriptive or indirect assessments because they identify precise temporal relationships between behaviors within a response class hierarchy (Silbaugh & Falcomata, 2018). Thus, they can provide more valuable information regarding specific response–response correlations. However, while there is no requirement to program contingencies for the precursor behaviors, these assessments still require extensive time and resources to complete. Furthermore, it is important to note that the descriptive information generated by these precursor assessments is only correlational in nature and may warrant further validation through experimental analyses (Silbaugh & Falcomata, 2018).

Relative Latency Assessment

The relative latency assessment can also be employed to identify the temporal relationships between the topographies of challenging behavior within a response class hierarchy. In this assessment, the relative latency until each topography of challenging behavior is recorded following the initiation of a trial with the relevant establishing operation (e.g., a demand; Richman et al., 1999). To evaluate the temporal relationships between different behaviors, the responses are ranked based on their average latency until occurrence.

Silbaugh and Falcomata (2018) reported several benefits of the relative latency assessment. First, various topographies comprising the response class hierarchy can be identified through this assessment. Another benefit of using this method is that it can characterize temporal relationships between behaviors during or after an ongoing EFA or treatment evaluation, which can save time and resources. Furthermore, unlike consequence-based assessments, there is no requirement for programmed contingencies within this assessment. Limitations of the relative latency assessment include the indirect nature of relative latency as a measure, and the potential need to video record sessions to ensure accurate data collection (Silbaugh & Falcomata, 2018).

Structured Consequence-Based Assessments

Structured consequence-based assessments of precursor behavior involve the direct manipulation of antecedents and consequences and the subsequent analysis of data (Silbaugh & Falcomata, 2018). The various topographies within a response class are observed and analyzed within reinforcement and extinction conditions, providing an empirical demonstration of the response class hierarchy. These assessments differ from experimental analyses in that they do not display data in equal-interval graphs in order to identify the function of the precursor behavior using visual analysis (Silbaugh & Falcomata, 2018). Rather, bar graphs may be used to display the absolute latencies of various topographies, supporting the visual inspection of temporal relationships between behaviors (e.g., Lalli et al., 1995). Alternatively, data may be displayed in an equal-interval line graph, but only to characterize the nature of the response class hierarchy (e.g., Lieving et al., 2004), to assess the response covariation among mild and severe behavior responses (e.g., Shukla-Mehta & Albin, 2003), or to assess the response covariation between precursors and challenging behavior (e.g., Langdon et al., 2008).

Extinction Analysis

The extinction analysis and its variations are commonly employed within the literature and are effective for identifying the hierarchical relationship among topographies within a response class (Lalli et al., 1995). Prior to the extinction analysis, the topographies of the response class and its hypothesized function are identified through a functional assessment. The response topographies are then ranked in terms of frequency, from most frequent to least frequent. Extinction is first applied to the most frequent response topography, while all other topographies are reinforced until a reduction in the most frequent behavior is observed. Extinction is then applied sequentially to the other response topographies based on their relative frequencies (e.g., Magee & Ellis, 2000). By examining the changes in the frequency of each behavior while contingencies are systematically manipulated, the practitioner can empirically confirm the presence of a response class hierarchy (Richman et al., 1999).

A benefit of the extinction analysis is that a hypothesis regarding the organization of the response class hierarchy is not required prior to assessment. This method is also useful because it can be employed as a function-based treatment for severe challenging behavior (Silbaugh & Falcomata, 2018). By identifying and reinforcing early members of a response class while simultaneously placing the challenging behavior on extinction, the individual is less likely to engage in the more severe topography. However, this intervention does not teach any new skills, so it would be inappropriate when a replacement behavior needs to be taught. Due to the nature of this method, it can be used to examine within-session patterns of resurgence among behaviors placed on extinction (Silbaugh & Falcomata, 2018).

Latency-Based Extinction Analysis

The latency-based extinction analysis examines the latencies of different topographies within a response class to determine if the behaviors are hierarchically related (Silbaugh & Falcomata, 2018). During the assessment, one topography is reinforced at a time, while the remaining topographies are placed on extinction. The latency to the first occurrence of each member of the response class is recorded. If a hierarchical relationship exists between the topographies, the earlier responses will occur in a hierarchical sequence during the sessions where the last response is reinforced (Lalli et al., 1995). Similarly, when applying the contingency to responses earlier in the sequence, subsequent topographies are less likely to occur as reinforcement is taking place earlier in the sequence (Lalli et al., 1995). A benefit of this method is that it can be completed in only a few brief sessions. It can also identify more appropriate responses to reinforce during treatment, which can help to reduce the overall time of intervention (e.g., DeRosa et al., 2013). A limitation of the latency-based extinction analysis is that it cannot control for sequence effects, therefore, its internal validity may be threatened (Silbaugh & Falcomata, 2018).

Brief Latency-Based Extinction Analysis

Within the brief latency-based extinction analysis, reinforcement is arranged for one topography during a single session, while the other topographies are placed on extinction. The latency to the first occurrence of each topography is recorded, and a different topography is reinforced within each subsequent session (Mace et al., 2011). A response class hierarchy is identified if there is an escalating sequence of topographies when reinforcement is made contingent upon the last response. In contrast, when reinforcement is provided for earlier responses in the hierarchy, escalation is less likely to occur (Mace et al., 2011). An obvious benefit of this method is that it can be completed in a brief number of trials, so there are only a few instances of challenging behavior being reinforced. It is also suggested that this method can shorten the time to the initiation of treatment, as the findings can be used as a baseline (Mace et al., 2011). Like the extinction analysis, this assessment does not require a prior hypothesis of the hierarchical organization of the response class (Silbaugh & Falcomata, 2018).

Severity-Based Extinction Analysis

The severity-based extinction analysis assumes that more severe topographies of behavior are likely to follow less severe topographies. It employs an extinction analysis to assess the response covariation among members within a response class hierarchy (Silbaugh & Falcomata, 2018). Initially, reinforcement may be provided for all topographies within the response class. Then, during subsequent sessions, reinforcement is only delivered contingent upon more severe topographies, while less severe topographies are placed on extinction (Shukla-Mehta & Albin, 2003). A response class hierarchy is demonstrated if there is differential responding under these circumstances (e.g., higher frequency of severe topographies when less severe topographies are placed on extinction).

The extinction analysis and its variations can provide useful information regarding the full range of topographies within a response class, the position of these topographies within the hierarchy, and the covariation among these behaviors (Silbaugh & Falcomata, 2018). However, a limitation among these four methods is that challenging behavior is reinforced, including more severe topographies, which can present ethical concerns. These methods may also require video recording of the sessions to obtain more accurate measurements of the behaviors, which may require more time and staff resources (Silbaugh & Falcomata, 2018).

Precursor Analysis

A precursor analysis is employed to experimentally demonstrate the relationship between a precursor behavior and challenging behavior (Langdon et al., 2008). During this assessment, sessions mimic the environmental settings likely to trigger the challenging behavior (e.g., instructional demands, lack of attention), and an extinction contingency is differentially applied to the precursor behavior across phases. For example, Langdon et al. (2008) conducted a precursor analysis across two phases. In the first phase, both the precursor and challenging behaviors were reinforced. In the second phase, only challenging behavior was reinforced, and the precursor behavior was placed on extinction. In Phase 1, the precursor behavior occurred more frequently, while in Phase 2, the challenging behavior occurred more frequently. This indicated that both behaviors were maintained by the same consequence.

The precursor analysis can be useful in identifying various topographies within a response class and potential targets for intervention. By confirming that a precursor behavior belongs to the same response class as the challenging behavior, an appropriate function-based treatment can be developed to prevent escalation from the precursor to the more severe topography (Silbaugh & Falcomata, 2018). Another benefit of the precursor analysis is that it involves fewer conditions and sessions than both the EFA and precursor functional analysis. Nevertheless, this assessment may reinforce severe challenging behavior, and this method cannot empirically demonstrate the behavioral function of the precursors or challenging behavior, only that they belong to the same response class (Silbaugh & Falcomata, 2018).

Trial-Based Structured Precursor Assessment

The trial-based structured precursor assessment is an objective and brief method for identifying precursor behavior (Silbaugh & Falcomata, 2018). At the beginning of the assessment, caregivers are asked to identify the severe challenging behavior and any potential precursor behaviors. The assessment itself is conducted in a discrete trial format, with conditions similar to those within an EFA. As most challenging behavior is maintained by either positive or negative reinforcement, attention and demand conditions are typically presented within the assessment (Fritz et al., 2013). However, based on the caregiver's reports, a tangible condition may also be included if necessary. Contingent on the first instance of severe challenging behavior, the trial-specific consequence is delivered, and the trial is terminated. Once the behavior has not been observed for 30 s following the delivered consequence, or the behavior does not occur within 5 min, the next trial begins (Borlase et al., 2017). The duration of each trial is 5 min or until the first instance of severe challenging behavior. The criterion for the completion of the assessment is 10 trials with the challenging behavior. Where challenging behavior occurs within all 10 initial trials, additional trials with non-contingent access to reinforcement (i.e., play condition) are conducted to obtain a comparison (Fritz et al., 2013).

To ensure accurate analysis, all trials are videotaped, and the videos are used to identify and define potential precursors and to score their occurrence/non-occurrence during each trial. The following four conditional probabilities are then calculated: (a) the probability of the precursor given the challenging behavior, (b) the probability of the precursor given the absence of the challenging behavior, (c) the probability of the challenging behavior given the precursor, and (d) the probability of the challenging behavior given the absence of the precursor (Borlase et al., 2017; Fritz et al., 2013). Unconditional probabilities for both the precursor and challenging behavior are also calculated. A response is identified as a precursor behavior if it meets the following criteria. First, the probability of the challenging behavior given the precursor behavior must be greater than both (a) the probability of the challenging behavior given the absence of a precursor behavior and (b) the unconditional probability of the challenging behavior. Additionally, the probability of the precursor given the challenging behavior must be greater than both (a) the probability of the precursor behavior given the absence of a challenging behavior and (b) the unconditional probability of the precursor (Borlase et al., 2017; Fritz et al., 2013).

According to Silbaugh and Falcomata (2018), the trial-based structured precursor assessment is time-efficient, especially for low-rate challenging behavior, and it may be better than other precursor assessments for minimizing the occurrence and reinforcement of challenging behavior. Additionally, a wide range of topographies within the response class hierarchy can be identified, including precursor behaviors that have been underreported or inaccurately reported. However, the trial-based structured precursor assessment may be relatively resource intensive, and like the other assessments, there are ethical concerns with the reinforcement of severe challenging behavior (Silbaugh & Falcomata, 2018). This method may also yield false positives for some individuals (Fritz et al., 2013).

Summary of Assessments

In summary, the practice guidelines suggested by Silbaugh and Falcomata (2018) are as follows. Regarding the time available to complete a precursor assessment, indirect precursor assessments and the brief latency-based extinction analysis are considered highly efficient. The latency-based extinction analysis and the trial-based structured precursor assessment are considered moderately efficient, while all the direct descriptive assessments, the precursor analysis, the extinction analysis, and its variations are considered to have low efficiency. In relation to internal validity, the extinction analysis and its variations, the precursor analysis, and the trial-based structured precursor assessment are all considered to have medium-high to high validity. The direct descriptive assessments have moderate internal validity, and the indirect precursor assessments have low internal validity.

Overall, the current research suggests that direct descriptive assessments and structured consequence-based assessments are useful for identifying response class hierarchies and precursors to severe challenging behavior. However, given the correlational nature of their outcomes, these precursor assessments can only provide preliminary evidence of behavioral function (Heath & Smith, 2019). To confirm maintaining contingencies and demonstrate functional equivalence among precursor behaviors and challenging behaviors, practitioners should consider employing an experimental analysis (Silbaugh & Falcomata, 2018).

Precursor Functional Analysis

While the assessments described above are effective for identifying precursor behaviors and their temporal relationships among other members within a response class, they cannot demonstrate a maintaining contingency (Silbaugh & Falcomata, 2018). The EFA is the only assessment that can yield empirically based conclusions regarding the function of challenging behavior (Lerman & Iwata, 1993). A functional relation is demonstrated when the behavior is reliably evoked during at least one test condition for which the maintaining contingencies are present, while it is absent during the control condition for which the contingencies are absent (Fahmie et al., 2013). Using the results of an EFA, the practitioner can develop an appropriate function-based treatment to address the severe challenging behavior. Research has shown that treatments based on EFA outcomes are the most effective at decreasing or eliminating challenging behavior (Beavers et al., 2013; Hanley et al., 2003).

While the results of the EFA permit the design of such treatments, ethical concerns are raised when conditions are arranged to evoke severe challenging behavior (Hastings & Noone, 2005). Another concern is the possibility of strengthening severe challenging behavior during the EFA process. Studies have illustrated an increase in the rate of challenging behavior outside of the EFA setting as the result of this assessment (Call et al., 2012, 2017; Hastings & Noone, 2005; Shabani et al., 2013). Due to the concerns surrounding the reinforcement of such topographies, researchers have endeavored to address these challenges through adaptations to the traditional EFA methodology (Hanley, 2012). One such variation is the precursor functional analysis (PFA).

The PFA was first implemented by Smith and Churchill (2002) as a means to reduce the risks of conducting an EFA for self-injurious behavior and aggression. Initially, the authors conducted a traditional EFA with the participants to identify the maintaining function of their severe challenging behaviors. Then, these procedures were replicated during the PFA. The test conditions of the PFA modeled the conditions first outlined by Iwata et al. (1982/1994). Like the traditional EFA, these test conditions (i.e., alone, attention, demand, tangible) were systematically arranged to create an establishing operation for the challenging behaviors. However, during the PFA, the contingencies for each condition were placed on the earlier and less severe topographies within each participant's response class (e.g., screaming, crying, vocalizations). For example, during the demand condition, when Participant A engaged in foot stomping, screaming, grabbing, and/or falling, the task was removed, and the trial ended.

The results of this study suggested that the function of the precursor behaviors could be accurately identified through the PFA and that these maintaining contingencies matched the identified function of the severe challenging behaviors (Smith & Churchill, 2002). Thus, the precursors and challenging behaviors identified for each participant shared a common maintaining contingency, and functional equivalence was demonstrated. Furthermore, by providing the maintaining reinforcer for the precursor behaviors, the more severe topographies were greatly reduced or eliminated during the PFA (Smith & Churchill, 2002). These findings are pivotal because they indicate that the PFA presents a sound methodology for identifying the operant function of severe challenging behavior while simultaneously reducing the risks to clients and practitioners (Heath & Smith, 2019).

Several studies have replicated these findings in both schools and clinics, and across individuals with various developmental disabilities, thereby establishing the external validity of such procedures (Borlase et al., 2017; Borrero & Borrero, 2008; Dracobly & Smith, 2012; Fritz et al., 2013; Herscovitch et al., 2009; Najdowski et al., 2008). Among these studies, all but two (i.e., Dracobly & Smith, 2012; Najdowski et al., 2008) validated the findings of their PFAs by also conducting traditional EFAs that identified the same maintaining function for a majority of their participants. Beyond the reduction in risks associated with EFA procedures, the PFA has several other benefits. First, it has been suggested that the PFA can be used to clarify the results of undifferentiated EFAs. For example, Slaton et al. (2017) conducted traditional EFAs with nine participants with ASD and found that the outcomes were only differentiated for four participants, meaning that the function of their challenging behavior had been clearly identified. When the authors implemented additional PFAs, the function was identified for an additional two participants. Another potential benefit of the PFA is that this method can expediate the assessment process by producing rapidly differentiated outcomes (Heath & Smith, 2019).

Despite its merits, the PFA also has notable limitations. First, the PFA is considered resource intensive, given the time it takes to complete, and the required training needed to implement the test conditions (Silbaugh & Falcomata, 2018). The PFA can also unintentionally add other topographies of challenging behavior to the response class if these responses are incorrectly hypothesized as precursors and subsequently reinforced during the PFA process (Silbaugh & Falcomata, 2018). And like the structured consequence-based assessments, the PFA is not appropriate when the reinforcement of severe challenging behavior is unacceptable (e.g., episodes of life-threatening self-injurious behavior). It is also important to mention that the PFA can only make inferences about the contingencies maintaining severe challenging behavior, as they cannot provide a direct demonstration of functional relations for more severe topographies (Heath & Smith, 2019). Similarly, unless an EFA for severe challenging behavior is conducted alongside the PFA, the functional equivalence of the precursor behaviors cannot be confirmed (Silbaugh & Falcomata, 2018). For this reason, any PFA-based conclusions regarding a common contingency among the response class members should be made with caution unless an EFA is also conducted. Finally, the PFA can sometimes give rise to false negatives when the precursors meeting the reinforcement contingency end up masking other precursors within the response class (Fritz et al., 2013).

Interestingly, there is a lack of PFA research on precursor behaviors maintained by the access to attention or automatic functions. In their review, Silbaugh and Falcomata (2018) found that most PFAs (63%) identified an escape function for their participants, while 32% identified a tangible function. Notably, only 13% of the PFAs identified an attention function, and this could be explained by the logistics of conducting this test condition. The establishing operation for this condition is the absence of social attention. Consequently, it may be difficult for a practitioner to both withhold attention for non-target behaviors while simultaneously observing the individual for more subtle precursor behaviors (Silbaugh & Falcomata, 2018). The alone condition was tested among nine participants, but an automatic function was not identified for any of these individuals. This finding is not surprising given that it is unlikely that a more benign topography can provide the same automatically produced consequence as the more severe challenging behavior. Thus, a response class hierarchy would not develop (Fahmie & Iwata, 2011). Similarly, there is no need for an individual to proceed through a response class hierarchy to obtain reinforcement that is freely available for the least effortful and most probable response (Silbaugh & Falcomata, 2018). With this in mind, it is not feasible or even efficient to include an alone condition within the PFA.

In summary, there is a small literature base to show that the PFA is a highly valid assessment for identifying the maintaining contingencies of precursor behaviors. Using this information, the practitioner can make reliable conclusions regarding the function of severe challenging behavior without needing to implement a traditional EFA, thereby reducing the risk of harm to the individual and others. As such, effective interventions matching the theorized function of the severe challenging behavior can be developed. One treatment option is to directly intervene on the precursor behaviors that belong to the same response class as the challenging behavior. Research has shown that function-based interventions that target precursor behaviors can be effective in reducing or eliminating severe challenging behavior (Dracobly & Smith, 2012).

Treatment for Precursor Behaviors

Understanding the response covariation between precursor behaviors and challenging behavior can be profitable in the design of interventions to reduce maladaptive behaviors (Harris, 1980; Voeltz & Evans, 1982). Behavior analysis provides the technology (e.g., comparative probability analysis) by which to identify this relationship, and the methodology (e.g., PFA) to confirm the function of the precursor behaviors under consideration. Such information is invaluable for practitioners in the design of interventions, as different behaviors are often maintained by the same consequence (Harding et al., 2001; Magee & Ellis, 2000; Richman et al., 1999; Smith & Churchill, 2002).

Understanding the relationship between a precursor and challenging behavior has important treatment implications. Careful consideration must be taken when identifying a precursor behavior as either an earlier link within a response chain or a member of a response class hierarchy. As explained by Dracobly and Smith (2012), reinforcing an earlier member of a response class could diminish later topographies, while reinforcing an earlier link within a response chain could strengthen later topographies. To assess whether a response is a class member or a link within a chain, the practitioner can prevent the behavior from occurring, and observe the effects of this procedure on the next response within the sequence. If temporarily blocking the earlier topography eliminates the next behavior in the response sequence, this may suggest a response chain. If, however, this leads to an increase in the next response, this would indicate a response class hierarchy (Dracobly & Smith, 2012).

Research has suggested that precursor behaviors to automatically maintained challenging behavior are unlikely to be members of the same response class; rather, these behaviors are more likely to be linked within a response chain (Heath & Smith, 2019). For these precursor behaviors, response blocking is an empirically validated treatment that can lead to collateral reductions in the severe challenging behavior. For example, Rettig et al. (2019) found that the pica (i.e., the consumption of inedible items) of five autistic children was maintained by automatic reinforcement. The researchers implemented a response-blocking procedure for the identified precursor behaviors of each participant (e.g., approaching an item, bending over). By blocking the precursor behaviors, the researchers effectively decreased the severe challenging behavior without needing to block the pica directly. These procedures replicated an earlier study by McCord et al. (2005). This study demonstrated similar reductions in pica by implementing a blocking procedure that was only effective when applied earlier in the response chain. In other words, when the researchers blocked the precursor behavior (i.e., touching items), there were greater reductions in the challenging behavior than when they attempted to block the pica itself.

Blocking the earlier links of a response chain for automatically maintained self-injurious behavior has also proven to be effective. For instance, Hagopian et al. (2005) limited the number of intervals with eye-poking once they blocked the precursor of stereotypy. Blocking stereotypy was also found to lessen the response effort of the practitioner, as the number of episodes of challenging behavior that required blocking was greatly reduced. A similar study was conducted by Deaver et al. (2001), who used non-contingent application of mittens at bedtime and nap time for a young girl with ASD. The mittens effectively decreased the girl's hair twirling, which was identified as a precursor to automatically maintained hair pulling. The authors noted, however, that it was unclear whether this procedure was successful because it interrupted the response chain or because it resulted in sensory extinction.

While these studies demonstrated the efficacy of response blocking for precursor behaviors that precede automatically reinforced challenging behavior, the results were not always clear for participants who had multiple identified functions (e.g., automatic and social-positive reinforcement). Rettig et al. (2019) discovered that physical attention was a secondary function for one of their participants, so the blocking procedure inadvertently reinforced the child's pica. While blocking the precursors to automatically maintained challenging behavior can be effective, alternate interventions must be considered if there are different or multiple functions. This highlights the importance of identifying the function of challenging behavior prior to treatment. To confirm whether a severe challenging behavior is automatically maintained, it is recommended to begin the EFA with a single extended alone condition (Smith & Churchill, 2002). If the response continues to occur without social reinforcement, it is more than likely an automatically maintained behavior, and an appropriate function-based treatment can commence. However, if the response shows signs of extinction (e.g., burst then reduction), it is likely maintained by social reinforcement and further assessment of the precursor behaviors can be initiated (Smith & Churchill, 2002).

For precursor behaviors theorized to be members of a response class hierarchy, it is important to first conduct precursor assessments to ensure that these topographies and the challenging behavior are maintained by the same consequence. If precursor behaviors to severe challenging behavior are confirmed as members of the same response class, it is presumed that the treatment of these precursors will result in the reduction or prevention of the more severe topography (Langdon et al., 2008; Najdowski et al., 2008). Due to their functional equivalence, similar approaches for reducing challenging behavior have effectively been applied as interventions for precursor behaviors. A number of these interventions have been evaluated in the literature and will be subsequently presented. While this is not an exhaustive list, it will highlight some of the more important findings.

Researchers have suggested that challenging behavior is a form of communication (Carr & Durand, 1985). Accordingly, functional communication training (FCT) is a commonly employed intervention that aims to replace the communication system representative of the challenging behavior with one that is functionally equivalent and more socially valid. In fact, FCT is one of the most frequently published function-based treatments for challenging behavior (Gerow et al., 2018). During FCT, an appropriate communicative response is taught to the individual during evocative situations using prompting methods (Carr & Durand, 1985). Once taught, this response is differentially reinforced with the same maintaining consequence as the challenging behavior, while the challenging behavior is placed on extinction.

During FCT for precursor behaviors, the occurrence of a known precursor serves as a cue to the practitioner to prompt the communicative behavior (Langdon et al., 2008). There are multiple examples of the use of FCT for precursors to treat challenging behavior. In Najdowski et al. (2008), individualized FCT interventions were developed following PFAs that suggested the participants' precursor behaviors were maintained by access to attention or tangibles. During related evocative situations (i.e., diverted attention, toy removal), the functional communicative response was prompted following instances of the precursor behaviors. This FCT intervention was found to eliminate the precursor behaviors altogether and prevent episodes of severe challenging behavior for all three participants (Najdowski et al., 2008).

Challenging behavior maintained by negative reinforcement (i.e., escape and avoidance) is often difficult to treat with FCT, as the learning opportunity is often embedded within the occurrence of the challenging behavior. However, by implementing FCT on precursor behaviors, the functional communicative response can be taught within the given situation before the challenging behavior has an opportunity to occur. Thus, the FCT intervention acts as a proactive approach for preventing the occurrence of maladaptive behavior (Langdon et al., 2008). Langdon et al. (2008) demonstrated the positive impact of FCT on precursor behaviors by minimizing challenging behavior maintained solely by negative reinforcement. The authors found that prompting the participants to ask for a break following instances of precursor behaviors was an effective approach for reducing the challenging behavior.

Based on these findings, Langdon et al. (2008) noted that the implementation of FCT for precursor behaviors warrants consideration. It is often the case that practitioners teach communication responses based on environmental conditions (e.g., diverted attention, then prompt request for attention). For example, Lalli et al. (1995) prompted their participants to say "No" following the first instruction, then provided a 30-s break. The problem with this approach is that it does not take into consideration the individual's sensitivity to the aversiveness of the situation (Langdon et al., 2008). Just because demands are being presented, does not mean the individual should immediately be prompted to request a break. If, however, the FCT intervention is designed to respond to the emittance of precursor behaviors, then practitioners can be more sensitive to the presence of individual motivating operations and not prompt a response simply because of the presence of certain environmental stimuli.

FCT is a form of differential reinforcement of alternative behavior (DRA). Like FCT, an appropriate, alternative behavior is reinforced while the challenging behavior is placed on extinction during DRA procedures. The difference between these two procedures, however, is that the replacement behavior in DRA does not need to be a form of communication (Tiger et al., 2008). There is some research to suggest that reinforcing existing topographies within a response class can increase the efficiency of DRA procedures because the practitioner does not need to teach a novel response to reinforce (e.g., Grow et al., 2008). In the case of precursor behaviors, DRA may be particularly useful, as these behaviors are already within the individual's repertoire and often occur in the context of the challenging behavior (Heath & Smith, 2019). When DRA methodology is applied to these earlier topographies within the response class, the individual does not need to engage in the challenging behavior to meet the reinforcement contingency. An example of DRA for precursor behaviors was demonstrated by Dracobly and Smith (2012). The authors found that when contingent attention was provided for the precursor behavior (i.e., head up) of an individual with ID, his self-injurious behavior was eliminated. Interestingly, while the DRA treatment was implemented in the participant's workplace, a cessation in self-injurious behavior was also seen in his home. This demonstrates both the efficacy and social validity of DRA for precursor behaviors.

Treatment packages to address challenging behavior are also widely used in clinical practice and have been demonstrated within the precursor literature (Apamo-Gannon, 2016; Fritz et al., 2013; Wrigley et al., 2010). In a study by Apamo-Gannon (2016), a multi-component treatment package that included differential reinforcement, FCT with extinction, and response interruption and redirection was implemented to treat the precursor behaviors of a 20-year-old female with ASD. This intervention package was found to gradually reduce the participant's precursor behaviors, self-injurious behavior, and aggression to low levels. In addition, her use of functional communication increased, and results were replicated across three settings, further supporting the social validity of the intervention package.

Fritz et al. (2013), on the other hand, used the results of a PFA to guide the development of a function-based treatment that included noncontingent reinforcement (NCR), followed by the thinning of the NCR schedule with the addition of DRA. The authors found that this intervention package was a viable treatment option for reducing precursor behaviors and severe challenging behavior that were maintained by both positive and negative reinforcement contingencies. Additionally, this treatment package improved the participants' use of functional communication, demonstrating that the individuals had shifted their responding from challenging behavior to more appropriate behavior (Fritz et al., 2013).

Another notable treatment package was implemented by Wrigley et al. (2010). The authors employed a multi-component intervention to treat rumination (i.e., regurgitation and swallowing of previously consumed food) of a woman with severe disabilities. As the rumination was theorized to be automatically maintained, the first component of the intervention was the interruption of her precursor behaviors (e.g., bending over, rocking). The intervention package also included alternating periods of "walk and work" and noncontingent attention, together with differential reinforcement of other behavior for the absence of rumination. The treatment greatly reduced the participant's rumination, and an additional component analysis determined that all intervention components were necessary for treatment success. The findings of this study are important because they showed that life-threatening rumination could be diminished without the use of aversive procedures such as contingent aversive stimulation or extreme food satiation.

There are a few other examples of function-based treatments for precursor behaviors that have demonstrated positive outcomes in the reduction of challenging behavior among the literature. For instance, Kuttler et al. (1998) effectively used Social Stories™ (Gray & Garand, 1993) to reduce the precursor behaviors of a child with multiple diagnoses who engaged in severe tantrums during transitions or when he had to wait. The use of Social Stories™ reduced the precursor behaviors (i.e., vocalizations, dropping to the floor) to zero or near-zero levels. In turn, tantrum behaviors were eliminated.

This section provides evidence of the utility of designing interventions that focus on the behaviors that precede challenging behavior. In fact, there is some literature to suggest that precursor behaviors can be treated more easily than challenging behaviors themselves (e.g., Hagopian et al., 2005). The most important consideration to be extracted from the literature is that a systematic approach should be used to determine the existence of precursor behaviors and to confirm their functional equivalence with the challenging behavior. Using this information, a function-based intervention can be developed to address these precursor behaviors. Given the functional equivalence between precursor behaviors and challenging behavior, the treatment of precursors is thought to result in similar outcomes as those associated with the treatment of the more severe topography. The difference is that these treatment outcomes can be achieved more safely and efficiently with the precursor-based intervention. However, due to the limited number of studies in this area, further research is necessary to confirm whether this is the case (Silbaugh & Falcomata, 2018).

There are many advantages to intervening on precursor behaviors for both the target individual and the practitioner. In the first instance, some severe challenging behavior (e.g., self-injurious behavior) can place the individual and others in high-risk situations, and by applying interventions to the precursor behaviors, the practitioner may eliminate some of that risk (Hagopian et al., 2005; Harding et al., 2001; Harris, 1980; Richman, 2008). By intervening on precursor behaviors, practitioners can prevent the escalation to more severe challenging behavior (DeRosa et al., 2013; Lalli et al., 1995; Richman et al., 1999). That is to say, when reinforcement is provided for earlier topographies within the response class hierarchy, it becomes unnecessary for the individual to engage in the severe topography, which may also require more of a response effort and result in more physical pain (Najdowski et al., 2008). The prevention of severe challenging behavior can, in turn, reduce the use of aversive reactive strategies such as seclusion or restraint (Pritchard et al., 2011).

Furthermore, the application of interventions to precursor behaviors permits more time to deliver treatment, which may not always be available when the individual is frequently engaging in the challenging behavior. By intervening on precursor behaviors before the escalation to the target behavior, the practitioner can teach more appropriate, functionally equivalent responses that result in the same reinforcement as the challenging behavior (e.g., Langdon et al., 2008).

Some authors have also suggested that response redirection contingent upon the occurrence of precursor behavior can be used as an opportunity to teach more appropriate behaviors such as leisure activities (Rettig et al., 2019). By focusing on precursor behaviors during function-based intervention, practitioners can conduct treatments more safely and with a high level of procedural fidelity (e.g., Apamo-Gannon, 2016).

Conclusion

In conclusion, challenging behavior can lead to a number of deleterious and life-long effects for an individual without effective intervention (Matson & Rivet, 2008). Function-based intervention is considered the best practice for treating challenging behavior because it is a data-driven method that directly addresses the operant contingencies maintaining the challenging behavior (Hurl et al., 2016). While the FBA is commonly used to identify the contingencies maintaining challenging behavior, this methodology may be clinically contraindicated when the target behavior is a high-risk challenging behavior (Smith & Churchill, 2002). To address this ethical dilemma, practitioners have turned to the analysis and treatment of precursor behaviors that reliably precede the severe challenging behavior.

Understanding the role of precursor behaviors within response chains and response class hierarchies is important for clinical practice. First and foremost, by identifying precursor behaviors and characterizing their relationship with severe challenging behavior, appropriate interventions can be developed to target these more innocuous behaviors. By intervening at the precursor level, practitioners have a proactive approach that can prevent the occurrence and reinforcement of severe challenging behavior during assessment and treatment (Lalli et al., 1995; Langdon et al., 2008). Based on the findings of Silbaugh and Falcomata (2018), there are a wide range of assessment methods for identifying and classifying precursor behaviors. These methods vary in efficiency and validity, but research suggests that the PFA is a highly valid and viable approach for testing the hypotheses regarding the function of challenging behavior without risking the safety of the individual and others (Heath & Smith, 2019).

In turn, the results of precursor assessments can be used to develop individualized function-based treatments that are responsive to the behavioral cues of the individual (Langdon et al., 2008). These precursor-based interventions can lead to similar reductions in challenging behavior as treatments that directly target the problem behavior. This could save time and resources in the long run, especially when severe challenging behavior is more difficult to treat (Silbaugh & Falcomata, 2018). Furthermore, these precursor-based treatments allow practitioners to teach appropriate, replacement behaviors within the context of the challenging behavior, without having to wait for episodes of the challenging behavior to occur. As both the precursors and replacement behaviors result in the same reinforcement contingencies as the challenging behavior but require less of a response effort, the problem behavior becomes irrelevant (Najdowski et al., 2008).

However, despite the promising findings for precursor-based treatment, there are a limited number of studies that have evaluated function-based interventions for precursor behaviors. Notably, in Silbaugh and Falcomata (2018), only 10 of the 17 studies implemented some form of treatment based on the results of the precursor assessments. Even then, some of these procedures were implemented as a way to further verify the results of the precursor assessments (e.g., Magee & Ellis, 2000), rather than to treat the challenging behavior. This clearly demonstrates a gap within the literature regarding the clinical application of precursor-based treatment and more research in this area is necessary.

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30 Function-Based Treatment

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Introduction

When assessing and treating challenging behavior using behavior analytic principles, research shows that using a function-based treatment is more effective than a treatment not based on function (Ingram et al., 2005). The Behavior Analyst Certification Board Professional and Ethics Code for Behavior Analysts (BACB ECBA) requires behavior analysts to use treatments supported by research (BACB, 2020, 2.13-2.14). To determine function, behavior analysts will conduct a functional behavior assessment (FBA), which is often comprised of the following components: a record review, interviews, direct observation, and functional analysis (Cooper et al., 2020).

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Once a function is determined, the behavior analyst reviews the literature for treatments that match the function and designs a treatment plan using the best available evidence in conjunction with client preference and contextual variables (BACB, 2020, 2.09c; Benazzi et al., 2006; Spencer et al., 2012). At this point, the behavior analyst will conduct a treatment analysis, which means implementing the treatment for an amount of time long enough to determine its effects on behavior. If behavior changes in a desirable direction, the behavior analyst will then utilize some experimental method (such as reversal, multiple baseline, or multielement design) to show that the intervention is indeed what has caused the desirable change in behavior. The behavior analyst will present treatment results to the client and/or caregivers and incorporate feedback into the intervention plan. Treatment will continue in this fashion with frequent progress monitoring until the behavior reaches acceptable levels and support can be faded. However, if the treatment does not have a desirable effect on the behavior of interest, the behavior analyst will go back to the literature and select a different function-based treatment that fits the client context. This process of assessment and progress monitoring will continue until a desirable outcome is reached.

As mentioned above, in addition to function, behavior analysts are also professionally and

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_30

ethically obligated to consider contextual variables (BACB, 2020, 1.07 & 2.19). These variables should include, but, are not limited to culture, language, age, setting, and resources. Later in this chapter, we will further expand on these contextual variables. In addition to the ethical responsibility to consider these variables, research also shows that when client context and preference are considered, caregivers are more likely to implement intervention procedures with fidelity (Benazzi et al., 2006).

Finally, once function, client context, and preference are considered, behavior analysts are also required to take their own experience and expertise into consideration when selecting treatments. The BACB ECBA requires that behavior analysts practice within their scope of competence (BACB, 2020, Introduction, 1.05). This means that if a particular function-based treatment has shown desirable effects in the literature and the client and caregiver have agreed to its appropriateness and fit to their context, but the behavior analyst has no training or experience with it, then that behavior analyst must seek training and supervision or refer the client to someone with that experience. Further, if a behavior analyst is working with a client for whom they are unfamiliar with the culture, the behavior analyst should practice cultural humility (which we will discuss below) and, when possible, seek collaboration with someone who is familiar with that culture. These steps will ensure the treatment is implemented consistently with the norms and values of that culture and client.

Treatment selection for challenging behavior is an important and complex process that requires careful data collection and analysis, communication and collaboration with the client and/or caregivers, and the knowledge and expertise to implement. This chapter will break down each of these components in more detail to equip students in behavior analysis with decision-making tools and considerations for the safe, effective, and ethical practice of applied behavior analysis.

Contextual Factors and Cultural Variables

Treatment for problem behavior is provided in many places but is most commonly conducted in the context in which the individual spends a majority of their time. For example, services may be provided in an individual's classroom at school (among teachers, other students, and teaching assistants), in their home (among parents and extended family), or in the community (among community members). These everyday life settings include idiosyncratic contextual variables. Contextual variables are stimuli (e.g., people, objects, activities) and contingencies (e.g., schedules of reinforcement, punishment, and extinction) in the client's environment (Detrich, 1999; Slocum et al., 2014). The stimuli and contingencies may vary from situation-to-situation depending on the contextual variables present. For example, there are different contingencies that exist in the classroom, a grocery store, place of worship, a library, and a person's home. It is important to consider the entire context when planning for the intervention process if the behavior analyst's goal is to produce socially significant change that will maintain over time.

Treatment procedures are implemented with a diverse group of individuals, which includes various age groups, cultures, settings, socioeconomic status, citizenship, and cultural values. The make-up of populations that are served continually shifts, and behavior analysts should adapt to the needs of the families that they serve. For example, racially and ethnically diverse groups currently make up about 28% of the population (Humes et al., 2011). However, minoritized groups will make up more than half of the American population by 2044 (Colby & Ortman, 2015). A family's identity is part of the context and should be considered due to the potential variations in contingencies in their environment.

Behavior analysts and researchers are beginning to examine how they can best consider cultural variables when providing services. Frameworks are systems that describe a concept or process and are used to assist with considering culture during the assessment and treatment process. Cultural humility, a framework described by Wright (2019), is a process of "self-evaluation and critique to address power imbalances and develop mutually beneficial and non-paternalistic partnerships with communities" (p. 1)." An additional definition provided by Hook et al. (2013) is the "ability to maintain an interpersonal stance that is other-oriented (or open to the other) in relation to aspects of cultural identity that are most important to the [person]" (p. 2). A behavior analyst is never expected to learn everything about every context or culture but should be aware that there are differences and should respond to each context in a way that best fits the family's goals. The process will be ongoing, uncomfortable (for some), but it is important to always practice cultural humility in order to create the most meaningful change for the client.

Every behavior analyst, in a sense, enters services in a position of power; meaning they provide a service for a family and the loss of those services could be detrimental to the well-being of the individuals they serve. Additionally, if the behavior analyst is, for example, a white, heterosexual, male, cisgender, American citizen, serving a family from a historically marginalized group, there is an added layer of power or privilege (Bohonos 2021). It is important that behavior analysts consider how their position of power or privilege impacts treatment. The easiest way to describe privilege is the absolution of worry about things that others have to worry about on a daily basis. For example, a person who is from an upper- or middle-class socioeconomic status does not need to worry about keeping their lights on or their next meal, whereas someone from a low socioeconomic status will carry this burden. A person who is born in America or has citizenship in the United States does not have to worry about allowing professionals in their home that could jeopardize their safety in the country, leading to separation from their family. Practicing cultural humility is even more imperative when the behavior analyst/therapist is cross-cultural. Wright (2019) recommended a self-assessment on an individual level and an organizational level. Examples of some questions include, "What are my cultural identities?", "How does my own cultural background help or hinder my connection to clients/communities?", "What are my initial reactions to clients, specifically to those that are culturally different than me?", and "How much do I value input from my clients?". Furthermore, Horner (1994) published a commentary paper on the advances of functional assessment technologies. In the paper, Horner discusses that clinicians should consider culture when moving from a functional assessment to clinical intervention. Horner encourages readers to use both behavioral function and family features to develop contextually fit interventions. A contextual fit might include the culture of the family, especially if that family follows cultural practices different from those of the behavior analyst. Horner describes key features such as skills, schedules, resources, and values of the people who will be implementing the procedures.

Pritchett et al. (2020) also discuss the importance of context and understanding. One of their recommendations for behavior analysts is to practice perspective-taking to neutralize power imbalances. Perspective-taking skills allow historically marginalized groups the space to describe the history of their lived experiences. From a behavior analytic perspective, "lived experiences" are synonymous with histories of contingencies. The family reporting topographies of problem behavior, frequency, intensity, common antecedents, common consequences, and previous treatments all provide insight into the contingencies of that context. Thus, it is imperative that behavior analysts are actively listening and providing opportunities for the family to describe all contingencies present in their context (cultural context included). Missing the contingencies in the environment may prevent or create barriers for the behavior analyst's effectiveness. The literature is beginning to gain more information about how to best consider contextual and cultural variables. The following sections will discuss some examples (but not an exhaustive list) of contextual variables that are important to consider during treatment for problem behavior.

Culture

A contextual factor that is commonly overlooked is culture. Skinner defines culture in *Beyond Freedom and Dignity* as behavior that is shaped by a set of contingencies that a group of individuals follows for the survival of that group, meaning the behavior is reinforced by the group (Skinner, 1971). For example, some cultural groups share responsibilities across nuclear and extended families. The shared responsibilities across all of their family members allow for individuals' care, financial responsibilities, household chores, and emotional support. An individual is always part of a culture in some aspect. Examples of cultural variables include, but are not limited to, race, ethnicity, gender identity, sexual orientation, religion, socioeconomic status, geographic location, language, and citizenship. An individual receiving treatment can have overlapping identities which influence their behavior and contingencies around whether their behavior will continue or stop. Skinner (1971) states that social environments and culture contribute to the success of a practicing group. Because adherence to cultural practice is associated with reinforcement within a cultural community, interventions that jeopardize that reinforcement may not be adopted. Thus, behavior analysts should consider the social environments and culture of the families when treating the behavior of an individual and their family system.

Identifying these cultural variables is important in behavior analysis, particularly in the treatment process. The goal of behavior analysis is to improve the quality of life of that individual, which includes the family or surrounding contexts (Baer et al., 1968). For example, in some cultures, direct eye contact is considered aggressive and could be interpreted as disrespectful. Teaching an individual to make direct eye contact with every request may be punished or extinguished in their everyday life. Thus, behavior analyst should be tailoring the interventions to the context in which these behaviors will be reinforced and utilized day-to-day. Evaluating cultural variables in the context of the treatment process is a new and growing area. Much of the literature evaluating cultural variables is centered on language. Next, we will review some interesting ways that language can affect the treatment process.

Language Language is verbal behavior that communities use to communicate with each other. Environmental variables functionally control the acquisition of language (Skinner, 1957). Language is part of a group's culture. Every culture uses some form of language to communicate, and these languages vary across cultures. The verbal community that surrounds the individual reinforces different words. Brodhead et al. (2014) define cultural and linguistic diversity as "the social (cultural) differences between groups that may control verbal behavior" (p.2). For example, different communities reinforce different words, which ultimately is how linguistic diversity is shaped over time. Additionally, behavior analysts serve a linguistically diverse population. In fact, the US Census (2011) reports that 23,060,040 people residing in the United States speak a language other than English. Half of this population (11,116,194) speaks Spanish, and this number continues to grow. In the next section, we will discuss modifications in the treatment process that consider language when they are implemented with linguistically diverse populations.

Treatment Outcomes Language has shown to have an effect on aspects of treatment outcomes. Aguilar et al. (2016) conducted a study to identify the language preference of instructions for children with autism receiving services. The authors presented the participants with multiple language options to evaluate their preference for English or Spanish instructions. The children were given a choice of the language of instruction by presenting different microswitches. Each microswitch represented either English instructions, Spanish instructions, or no instructions. Results indicated that the participant preferred to receive instructions in Spanish.

Research has not only indicated that the language of instruction matters, but there can also be a difference in reinforcing value. Clay et al. (2020) conducted a study to evaluate the preference and reinforcing efficacy of language. The authors conducted a paired stimulus preference assessment for language followed by a reinforcer assessment to evaluate the reinforcing value of praise in English and Spanish. The preference assessment showed that there was limited to no preference for praise in one language over the other; however, when a reinforcer assessment was conducted, one participant showed slightly more responding in Spanish than in English. Slightly higher responding could indicate a slightly higher reinforcing value for praise in Spanish. The findings of the above two studies are important because if there is a preference or higher reinforcing value for one language over the other, the differences can have an effect on increasing a behavior using more salient reinforcers.

Language is also being evaluated in the context of communication responses and problem behavior. Kunze et al. (2019) conducted a study where they observed the frequency of communication responses from a speech-generated device in English and Spanish. The authors found that there were more mands evoked in Spanish than in English. The number of mands evoked and the language of the mand are important because in order for problem behavior to stay low, a mand needs to occur to access a reinforcer. For example, the mand in Spanish may have a higher likelihood of being reinforced if the mand is in the primary language that the family speaks. Now, it may be the case that the family would prefer the individual to learn the mand in the secondary language and that is okay. The family's preference takes priority. It will be important to let the family know the specific mand you are teaching so they can reinforce the mand consistently in their environment. This type of flexibility shows cultural humility while still practicing behavior analysis in an effective manner. Another study was conducted by Neely et al. (2020), which evaluated resurgence of problem behavior in bilingual individuals. The participants were taught English and Spanish mands, followed by a resurgence test. The resurgence test could simulate conditions for a learner who uses one language in one context and a different language in another context. The results showed that functional communication responses in English (taught first) resulted in resurgence of problem behavior when the communication responses were extinguished in a different context. Meaning, problem behavior may increase in another context if the languages spoken in each context don't match. The authors demonstrated that two participants needed additional teaching in Spanish in order to mitigate problem behavior. One of the participants did not require additional teaching. In summary, it is not about choosing one language over the other; rather, it is important to recognize a cultural variable such as a language cannot be ignored because it can influence the intervention process. The responsibility is on the behavior analyst to consider these variables and create an intervention plan that will best fit the needs of the individuals and family's cultural context.

Setting

Another contextual consideration for treatment is the client's setting. Individuals receive treatment in a variety of different contexts including in homes, clinics, schools, and community settings. Each setting has features that can enhance as well as create barriers for treatment implementation. As such, careful consideration of the physical environment where treatment takes place is important when developing function-based treatments. To illustrate, consider treatment that occurs in-home versus in a clinic. Given families live in their homes, we can expect more distractions and unpredictability (e.g., family members present or easily accessible toys and other non-treatment items). While we might consider these potential barriers, treatments that are successful in natural environments require less programming for generalization. Similarly, having siblings or other family members present can facilitate training on interventions for all relevant stakeholders in the child's life. In comparison, the clinic offers a much more controlled space where distractions and nontreatment items can be managed more easily. Treatment in-home may require more advance planning to ensure sessions work around family routines and schedules, that specific reinforcers (e.g., toys or edibles), program materials, and data collection materials are available that may be more readily available in clinics. It's also essential to consider the safety risks posed by the treatment context, particularly when treating problem behavior. For example, in schools, it is critical for teachers and clinicians to consider classroom safety globally. This includes the safety of the client as well as other students in the same space, and the variety of materials (including furniture, etc.) that are accessible and could become dangerous during episodes of problem behavior.

Age

In addition to culture and setting, behavior analysts must always consider the chronological and cognitive age of their client when examining context to ensure the most appropriate treatment selection. For example, offering emphatic praise and high-fives to an attention-loving preschooler will likely serve as high-quality reinforcers, but the use of those same reinforcers with an older adult who prefers a quiet space would be absolutely misguided. As with all behavior analytic treatment, there is no one-size-fits-all approach, and the consideration of client age in treatment selection is paramount. Behavior analysts have the potential to serve individuals across the lifespan, meaning they may encounter early learners as young as 18 months old (Vietze & Lax, 2020) to older adults over 65 years old (Burgio & Burgio, 1986).

Behavior analysts should be thoughtful about the variations and modifications to assessment and treatment for their clients based on their age. This includes but is not limited to the types of instructional materials, examples, reinforcers, job aids, goals, and treatment environments chosen for each client. Consider a 17-year-old client diagnosed with a mild intellectual disability receiving services to assist with their transition into adulthood. The behavior analyst should choose examples relevant to that client's cognitive skill level, as well as age-appropriate interests (e.g., these could include going to college, finding paid employment, making friends, dating, etc.). Another important consideration is the developmentally relevant milestones to a client's chronological age (for the example above, factors such as hormone and body changes, emotional impulsivity, or the ability to make decisions could contribute to the client's context; Corchado & Martínez-Arias, 2022).

It likely goes without saying that priorities and preferences change as individuals age. A person-centered approach will pave the way for behavior analysts to ensure their treatment priorities align with their clients' values (Holburn, 2001; Slocum et al., 2014). Think about your own priorities at the age of 5, 12, 18, 25, and beyond. Consider how your own priorities may change based on your decade of life, your physical and mental abilities associated with that age, your ability to wait patiently or concentrate on a difficult task, or how your physical senses have changed over the course of your life. All of these factors, and more, play a role in a client's contextual environment related to their age. As behavior analysts approach differently aged clients across the lifespan, we encourage you to get creative. Ask questions. Consult the literature. Seek insight from your team members and colleagues to help you consider the best and most supportive treatment for your client of any age.

Resources

One final contextual factor to consider in treatment selection is the availability (or lack) of resources at the behavior analyst's and their clients' disposal. Research shows that variables like treatment cost, insurance coverage, socioeconomic status, geographic location, neighborhood, school district, and access to technology can greatly affect treatment outcomes for our clients, as well as their access to treatment at large (Nieuwenhuis et al., 2017; Wilson et al., 2018). These barriers are further intensified by systems that allow for racism, classism, and other prejudices that ultimately prevent access to healthcare, adequate nutrition and education, and childcare for individuals from historically marginalized groups as well as low-income families (Cogburn, 2019; Gee & Ford, 2011; Nieuwenhuis et al., 2017).

As stated earlier in the chapter, the behavior analyst's awareness and education around these barriers will allow for more equity in treatment for all of their clients. Other resources to consider in treatment selection are the availability of staff to implement treatment, access to a variety of reinforcers and instructional materials, physical space of the treatment environment, and whether the client has reliable transportation. Once the behavior analyst has taken a thorough inventory of the available resources, they will be empowered to advocate and facilitate removing any barriers to treatment for their clients (BACB, 2020, 2.19; Carr & Lord, 2016).

One final resource consideration is the ability to adapt in times of crisis. As we author this book, we are living through the COVID-19 pandemic. This global emergency has demanded our society to change the way we do just about everything, especially education and treatment of our clients. Educators, clinicians, and behavior analysts have been challenged with the task of delivering their services via telehealth or other technological mediums (Rodriguez, 2020). This poses a large treatment barrier to clients without regular access to technology (e.g., computers, tablets, or smart phones), reliable internet, a quiet learning space, or family to help support treatment in the home. As behavior analysts continue to navigate this crisis and future unexpected events in our ever-changing world, they should remain cognizant of their clients' values and the stressors they face daily. Behavior analysts have the technology and training to make treatment feasible and accessible to their clients and families no matter what their contextual environment is (Coyne et al., 2021; Szabo et al., 2020).

Treatment Based on Function of Problem Behavior

As mentioned previously, function-based interventions are more effective than non-function-based interventions (Ingram et al., 2005). In the following sections, we will discuss treatment for four main functions of problem behavior: (a) attention, (b) automatic reinforcement, (c) access to tangibles, and (d) negative reinforcement (escape).

Problem Behavior Maintained by Access to Attention

In this section, we will discuss treatment for attention-maintained problem behavior. These behaviors are defined as those shown through a functional analysis to be maintained by social positive reinforcement in the form of attention from another person (Cooper et al., 2020). In other words, if a behavior increases when followed by attention from another person, it is likely maintained by attention. Several literature reviews have been conducted on the incidence of different topographical response classes and functional relations of problem behavior. Two reviews in particular are noteworthy. Hanley et al. (2003) found that 25.3% of problem behavior reported in the functional analysis literature was shown to be maintained by social positive reinforcement in the form of attention. More recently, Beavers et al. (2013) found that 17.2% of problem behavior reported in the literature was shown to be maintained by social positive reinforcement in the form of attention. Further, both studies also reported behaviors between 14.6% (Hanley et al., 2003) and 24.3% (Beavers et al., 2013) to be multiply maintained, which may also encompass attention as a functional reinforcer. Because of its prevalence in the literature, it is likely that behavior analysts will encounter behavior maintained by attention and thus need to be aware of various treatments and contextual considerations when selecting treatment. Before we get into the treatment of attention-maintained problem behavior, we will first discuss common antecedents and types of attention.

Functional Antecedents

For attention-maintained behavior, we must first consider antecedents that can serve as triggers to problem behavior. The most obvious antecedent is the removal of attention. For example, let's say that Maria's whining at bedtime is maintained by access to attention from her mother. Every time her mother leaves Maria's bedroom, she begins to whine, and Maria's mother always comes back in to check on her and assure her things are okay. The removal of attention could function as an antecedent which is evoking whining. Diverted attention can be another antecedent to attention-maintained problem behavior. Diverted attention is when the attention is removed and specifically diverted to something or someone else. For example, when Maria is playing in the kitchen with her mother, the phone rings. Maria's mother goes to answer the phone, and Maria begins whining. Maria's mother tells the person on the phone she will have to call them back and returns attention back to Maria. In this example, Maria's mother's attention has been diverted to someone else (i.e., someone on the phone). For some individuals, the simple removal of attention does not function as an antecedent for problem behavior; however, someone else getting the attention from another individual may function as an antecedent. For example, Maria's mother could be in a room with Maria without directly giving her attention and without Maria engaging in any problem behavior. However, if another person walks into the room and gets the mother's direct attention, this may serve as an antecedent for Maria to engage in problem behavior. For all attention-maintained problem behavior, the perceivable presence of another person functions as a discriminative stimulus that attention is available. In this way, attention-maintained problem behavior generally does not occur when the individual is alone but only in the presence of other people that could deliver attention.

Types of Attention

There are also different types and topographies of attention to consider when selecting treatment for attention-maintained problem behavior. When we describe attention-maintained problem behavior as the behavior that is maintained by social positive reinforcement, this does not mean positive or "good" attention. It simply means the addition of attention to a previous lack of or minimal attention situation. The attention received contingent on problem behavior could be both positive or negative or "bad" attention (reprimand). In fact, researchers have found that variations in the topography of attention show differentiated effects for both attention-maintained and escape-maintained problem behavior (Gardner et al., 2009; Kodak et al., 2007). When evaluating the types of attention, there are several different topographies of attention to consider: vocal, physical, proximity, eye contact, and body language. Vocal attention is a stimulus change in the environment that consists of a vocalization from one person to another, usually perceptible to the ears. It can be in the form of praise statements, reprimands, conversations, noises, expressions of annoyance, or attempts to soothe, just to name a few. Physical attention is a stimulus change in the environment that involves touch from one person to another, usually perceptible to the skin. Physical attention could be a pat on the back, a handshake, a high five, holding hands, or even a physical restraint. Proximal attention is a stimulus change in the environment that involves the nearness of one person to another, usually perceptible to the eyes. Sometimes the mere approach of someone can be the form of attention. Consider the waitress coming toward your table to take your order. Finally, eye contact and body language are also types of attention that involve a stimulus change in the environment that is perceptible to the eyes. Most of us can remember the feeling we got when we made eye contact with a crush in our adolescent years. Similarly, body language, such as gestures, can be a form of attention and a form of nonvocal verbal behavior. In addition to varying topographies of attention, behavior analysts should also consider duration when evaluating the quality of attention delivered. By manipulating these aspects of attention, we can increase or decrease the overall quality of attention provided, contingent on appropriate or inappropriate behaviors.

Treatment for Behaviors Maintained by Attention

When we look at function-based treatments for attention-maintained problem behavior, they fit into two categories: antecedent-based interventions and consequence-based interventions. The theory behind function-based interventions for attention-maintained problem behavior is somewhat simple. If attention functions as a strong reinforcer for the individual, then we can use the motivation for attention to decrease the inappropriate behavior and increase appropriate behavior (Cooper et al., 2020). For antecedent interventions, we are generally providing attention prior to onset of the target behavior. For consequence-based interventions in general, we are either providing attention for a different behavior or no longer providing attention for the target behavior, or both. The interventions described below utilize the theory of using functional motivation, and research shows these interventions have significant effects on attention-maintained behavior.

Antecedent-Based Interventions

Noncontingent Attention One of the quickest ways to reduce attention-maintained problem behavior is to reduce the motivation for attention. By providing noncontingent attention, the individual may become satiated with attention, thus reducing the value of attention as a reinforcer and the likelihood of engaging in behaviors that produce attention (Cooper et al., 2020). This strategy is usually used on a timed schedule (either fixed or variable), where attention is delivered at a preset time, regardless of the behavior that the individual is exhibiting. The risk of noncontingent attention is that delivering attention on a fixed time schedule may mean delivering attention following problem behavior and thus inadvertently reinforcing problem behavior. In our example of Maria, whose whining has been determined to be attention-maintained, we might use noncontingent attention by giving Maria verbal praise, smiles, or winks every 5 min throughout our phone call with our friend. This way, Maria is getting attention on a fixed time schedule, thus reducing the motivation for attention.

Consequence-Based Interventions

Extinction Withholding reinforcement for a previously reinforced behavior is one of the more researched consequence-based strategies for attention-maintained problem behavior (Cooper et al., 2020). For attention-maintained behaviors, it means withholding attention following the target behavior. It is important to identify the topography of attention that is maintaining the problem behavior, as even a quick reprimand or furrowed brow could serve to reinforce the problem behavior. It is also important to withhold attention only for the target behavior. Usually, extinction is used in combination with another consequence-based strategy, such as differential reinforcement of alternative behavior (see below). During the initial implementation of extinction, implementors often see an extinction burst, which is defined as a sudden increase in the target behavior following extinction (Cooper et al., 2020). Implementors of extinction need to be prepared for this, so as not to inadvertently reinforce the behavior at its highest magnitude or intensity. Further, implementors of extinction also need to consider the harm of not being able to implement extinction with 100% integrity. This can result in intermittent reinforcement of the target behavior, which can actually strengthen the response and make it resistant to extinction procedures. For example, let's go back to Maria, who is whining at bedtime to get her mother's attention. Let's say that Maria's mother decided to use an extinction procedure to reduce whining at bedtime. On Monday night, Maria begins whining around 8:30 and continues into a full-on tantrum with screaming, crying, and pounding on her bedroom door. Maria's mother knows about extinction bursts, so she bought some ear plugs to be able to withstand the noise. Around 9:30, Maria fell asleep on her bedroom floor. On the second night, Maria whined just a little but fell asleep in her bed around 8:45. This pattern continues with whining decreasing and sleep time increasing until Friday night. Maria's mom had a long day at work and didn't get home until after dinner. Maria went to bed at 8:30 and whined because she missed her mom at dinner. Maria's mother tried to stay strong but went to check on her at 9:00 because she was worried that Maria was going to make herself sick with whining. Unfortunately, this intermittent reinforcement could strengthen Maria's whining in the long run, and because Maria's mom went in after 30 min, it could have also increased the duration for which Maria will whine until she "gives up." For this reason, it is good to give parents' options when implementing extinction, and if they want to implement it, ensure they pick days and times in which they are likely to be successful.

Differential Reinforcement of Alternative Behavior (DRA) Differential reinforcement of alternative behavior is usually used when we have identified the function of the problem behavior and are able to select a functionally equivalent replacement behavior. When selecting a replacement behavior, it is important that the alternative behavior is more efficient and effective than the problem behavior (Cooper et al., 2020). In other words, it has to be less effortful and result in a greater amount of the reinforcer more often than the problem behavior. In DRA and any differential reinforcement procedure, behavior analysts want to ensure that the behaviors they want to see increase are competing for reinforcement with the behaviors they want to see decrease. Using the competition analogy, the winning behavior (in this case, the replacement behavior we want to see increase) is one that is faster and produces greater rewards than the losing behavior (in this case, the target behavior we want to see decrease). Going back to Maria, who wants her mom's attention when her mother is on the phone, a replacement behavior for whining could be writing her mom a note. However, in order for note writing to be an effective replacement, it has to result in mom's attention more often than the problem behavior. Thus, mom must respond immediately to the note and every time Maria writes a note. Eventually, once an individual is consistently engaging in the replacement behavior and the problem behavior has reduced to zero or near-zero levels, the schedule of reinforcement can be thinned to intermittent reinforcement and a delay can be systematically introduced. In the note-writing example, Maria's mom could give a signal, like holding up her pointer finger, to Maria indicating that she will respond in a minute. This provides Maria with two things, attention in the form of validation that mom is aware Maria is communicating, and an indication that there will be a slight delay to reinforcement. This is one way we can successfully thin a schedule of reinforcement to one that is more naturally occurring and manageable.

Differential Reinforcement of Other Behavior (DRO) Another way to treat attention-maintained problem behavior is to provide attention to other behaviors. In other words, reinforcement can be provided for any and all behaviors *other* than the problem behavior (Cooper et al., 2020). Sometimes DRO procedures can be difficult to maintain due to the sheer magnitude of other behaviors you would be reinforcing, so behavior analysts must determine whether they are going to set an interval or momentary DRO schedule. In an interval schedule, the target behavior must not occur for a set amount of time before reinforcement is delivered. This requires the behavior change agent to be actively monitoring the client through the entire interval. Alternatively, in a momentary schedule, the behavior must not occur at a specific moment in time. While interval DRO may be more effective at reducing the problem behavior, momentary DRO may be a more manageable way to reinforce other behaviors (Cooper et al., 2020). Similar to NCR, in an interval DRO you would select an amount of time, usually less than the current inter-response time (IRT) (i.e., time between instances of problem behavior), and once the time had elapsed, you would reinforce the first instance of *other* behavior that occurred. In setting the time less than the current IRT, the behavior analyst is ensuring that the other behavior is reinforced at a rate higher than the problem behavior, thus making it more effective for gaining attention than the problem behavior. For example, let's go back to Maria, who engages in whining behavior while her mom is on the phone. Her current IRT is averaging 6 min. So, you set your interval at 5 min. The first behavior that occurs after the 5 min elapse is any behavior other than whining would get attention. The key difference with DRO (compared to NCR) is that if problem behavior occurs, you do not provide reinforcement. The reinforcement is contingent on the absence of the problem behavior.

Treatment Selection

It may sometimes be difficult to identify the best treatment option for any given situation given the number of different function-based interventions available to behavior analysts. However, the BACB's Ethics Code for Behavior Analysts (ECBA; BACB, 2020) gives behavior analysts recommendations for doing so. Specifically Code 2.14 states, "Behavior analysts also consider relevant factors (e.g., risks, benefits, and side effects; client and stakeholder preference; implementation efficiency; cost effectiveness) and design and implement behavior-change interventions to produce outcomes likely to maintain under naturalistic conditions." Grow et al. (2009) provide behavior analysts with a simple decision tree to aid in treatment selection for attention-maintained problem behavior. In addition, there is a host of research on evidence-based practices, which means to "integrate the best available evidence with client values/context and clinical expertise in order to provide services for their clients" (Slocum et al., 2014, p. 41). Earlier, we outlined specific contextual variables such as culture, values, setting, resources, age, and family preferences when selecting treatments. In order for function-based interventions to be effective and generalized, it is imperative that they are selected and designed specifically for the context of the individual we are serving.

Problem Behavior Maintained by Automatic Reinforcement

When individuals engage in behaviors to get access to the stimulation created by that very same behavior, those behaviors are said to be maintained by automatic reinforcement. In the review by Beavers et al. (2013), 16.9% of cases resulted in an automatic function. Behaviors maintained by automatic reinforcement present many challenges for behavior analysts (Vollmer et al., 1994). Specifically, because the behaviors produce their own reinforcers, it is often difficult to manipulate and separate the reinforcer from the behavior without using intrusive interventions, such as blocking. For example, if an individual engages in skin picking that is automatically maintained, without blocking the behavior itself, the individual will continue to access the reinforcer each time they engage in skin picking. Another challenge with behavior maintained by automatic reinforcement is that it is often difficult to identify the specific reinforcer for the behavior. For instance, when self-injurious behavior, such as biting, is found to be maintained by automatic reinforcement, it is unclear during the functional analysis if the specific reinforcer is the stimulation created on the skin from the bite or if the reinforcer is the stimulation felt in the individual's teeth. Given these difficulties, identifying functional antecedents to better predict and prevent the behavior and creating function-based interventions can be challenging.

Functional Antecedents

As mentioned before, the reinforcers that maintain automatically reinforced behaviors are difficult to identify. As a result, identifying the specific antecedents that evoke these behaviors is extremely challenging. However, behavior analysts can make predictions about the specific antecedents that may trigger problem behavior through the manipulation of different types of stimulation. Typically, there are five types of stimulation that a behavior produces: (a) tactile, (b) visual, (c) olfactory, (d) auditory, and (e) thermal. As a result, any event that either removes or presents any of these types of stimulation can evoke the problem behavior. In a study by Patel et al. (2000), researchers conducted antecedent assessments to identify the specific sensory stimulation that triggered problem behavior for two participants. During the assessments, the researchers presented and removed various types of stimulation during different conditions and measured the rate of problem behavior. The researchers successfully identified common triggers to the problem behaviors and were able to create function-based interventions for each participant.

Treatment for Behaviors Maintained by Automatic Reinforcement

Similar to other types of problem behavior, automatically maintained problem behavior can be approached through either antecedent-based or consequence-based interventions. However, given the difficulties with identifying specific reinforcers, interventions for behaviors maintained by automatic reinforcement more often involve antecedent manipulations rather than consequence-based interventions.

Antecedent-Based Interventions

The most common treatment for problem behavior maintained by automatic reinforcement is noncontingent reinforcement (NCR). During NCR, the client is given access to known reinforcers on a fixed or variable time schedule independent of behavior (Cooper et al., 2020). A common form of NCR used for automatically maintained problem behavior is environmental enrichment (Gover et al., 2019). During environmental enrichment, clients are given access to tangible items and/or activities on a fixed or variable time schedule. The goal of this intervention is to abolish the motivating operation for the reinforcers that maintain the problem behavior in order to decrease the probability that the behavior will occur. Research has shown that in order for environmental enrichment to be effective, the stimuli provided should successfully compete with the behavior (Berg et al., 2016; Piazza et al., 1998). Stimuli are said to successfully compete with the behavior if there are low levels of the behavior when the client manipulates the stimulus. For example, if an individual's levels of hand flapping decrease while playing with blocks, the blocks successfully compete with the behavior. These data are typically collected during a preference assessment. During the preference assessment, the behavior analyst presents the client with a number of stimuli and allows them to manipulate each one. The behavior analyst then records the levels of the automatically maintained behavior across all items and/or activities. Preferred stimuli that produce the lowest levels of problem behavior during the assessment are then used in the environmental enrichment intervention. The effects of this intervention are enhanced when the sensory stimulation produced by the preferred stimuli matches the sensory stimulation produced by the behavior (Piazza et al., 1998, 2000). For example, if a client engages in pica in order to get access to oral stimulation, behavior analysts could use edible items during environmental enrichment. Behavior analysts can identify these stimuli by conducting a matched stimulus assessment (Love et al., 2012; Piazza et al., 1998, 2000). During a matched stimulus assessment, behavior analysts present the client with various stimuli that are both preferred and match the sensory stimulation produced by the problem behavior. Additionally, stimuli from all other sensory categories are included and presented to the client during the assessment. For example, if behavior analysts believe that the hypothesized reinforcer for the behavior is a result of some sort of oral stimulation, during the matched stimulus assessment, the behavior analyst presents stimuli that produce oral stimulation and stimuli that produce other types of stimulation, such as tactile, auditory, visual, and thermal stimulation.

Consequence-Based Interventions

Another strategy that enhances the effectiveness of environmental enrichment is the use of reinforcement-based strategies. For example, behavior analysts can reinforce appropriate manipulation of objects and appropriate engagement in activities during environmental enrichment by delivering socially mediated reinforcers. Clients can earn tokens, praise, and other tangible or edible reinforcers for appropriate manipulation. For example, during environmental enrichment, the behavior analyst could deliver praise contingent on the individual playing appropriately with the items provided. However, sometimes individuals may not have the necessary skills to effectively manipulate the various objects in the room. The behavior analyst may sometimes have to implement a skill acquisition program that focuses on increasing play skills. Using this intervention, behavior analysts could prompt and reinforce appropriate manipulation of the items during environmental enrichment.

Occasionally, reinforcement-based strategies in combination with environmental enrichment are not effective at decreasing problem behavior maintained by automatic reinforcement. The reinforcer resulting from engagement in the problem behavior is much too strong and may not compete with other stimulation. When this occurs, behavior analysts may need to implement consequence-based interventions that are specifically targeting the problem behavior. The most intrusive approach is to use punishment-based interventions, such as the use of reprimands, response cost, overcorrection, physical or mechanical restraint, response blocking, and response interruption and redirection. Overcorrection can be used during environment enrichment as a consequence-based intervention. Specifically, contingent on problem behavior, the client is asked to engage in effortful behavior that is related or similar to the problem behavior (Cooper et al., 2020). Delivering verbal reprimands during environmental enrichment includes the behavior analyst making statements such as “Stop that!”, “No,” and “Don’t do that” contingent on problem behavior. Response cost can be used during environmental enrichment by removing access to the preferred objects and/or activities contingent on problem behavior. The use of physical or mechanical restraint during environmental enrichment can involve many things. For example, if the automatically maintained problem behavior involves the client engaging in skin picking, the behavior analyst can hold the client’s hands down contingency on the occurrence of the behavior. However, another option would be to use a mechanical restraint contingency on problem behavior, such as belts, to keep the client’s hands down for a specified duration of time. For example, contingency on the occurrence of skin picking, the behavior analyst could place the client’s hands into the mechanical restraint for 1 min during environmental enrichment. Response blocking involves the behavior analyst physically blocking the client from engaging in the problem behavior as soon as the behavior occurs throughout the duration of environmental enrichment. For example, if the behavior is hand-mouthing, behavior analysts can block the client by putting their hands over the client’s mouth as soon as the client engages in the problem behavior. Finally, response interruption and redirection is a variation of response blocking where behavior analysts interrupt an instance of problem behavior and redirect the client to engage in a more appropriate response. For example, if a client engages in hand-mouthing, behavior analysts can block the client from engaging in the behavior as soon as the behavior occurs and immediately redirect the client to clap their hands.

Treatment Selection

According to a recent review by Gover et al. (2019), a combination of both antecedent and consequence-based treatment is the most effective approach for decreasing behaviors maintained by automatic reinforcement. Specifically, environmental enrichment is most effective when a combination of both reinforcement and punishment-based interventions is used. However, using punishment-based interventions poses several issues for clients who are receiving treatment. For instance, treatments based on punishment are aversive and can often evoke emotional responding on the part of the client. These procedures would not be accepted well by both clients and their families. Given that our ethical compliance code requires us to ensure client and caregiver acceptability of our treatments, it would be difficult to reach acceptability with aversive interventions. Even more, using aversive interventions will make it less likely that caregivers or teachers will continue the treatment with fidelity outside of the treatment sessions. As a result, behavior analysts should go through the evidence-based practices that are based on reinforcement, such as using matched stimuli preference assessment and skill acquisition interventions, to avoid punishment-based strategies unless absolutely necessary.

Problem Behavior Maintained by Access to Tangibles

When clients engage in problem behavior in order to get access to goods, leisure items, or activities, they are said to be maintained by access to tangibles. In the review by Beavers et al. (2013), 17.2% of cases resulted in a tangible function. Similar to behaviors maintained by attention, when behaviors are found to have multiple functions, it is very likely that access to tangibles is one of those maintaining variables. For example, when individuals engage in escape-maintained behaviors, they usually do not escape to nothing. Typically, when individuals are given a break from work, they also gain access to preferred items and/or activities. As a result, it is very common for behaviors to be maintained by both escape and access to tangibles. Behavior analysts must ensure that they take into account all antecedent- and consequence-based variables when identifying function-based interventions for behaviors maintained by access to tangibles.

Functional Antecedents

The most common antecedent for behaviors maintained by access to tangibles is the removal of a preferred item or activity. For example, an individual may engage in problem behavior anytime their preferred items (such as food or their iPad) are removed. However, other antecedents that may trigger problem behaviors maintained by access to tangibles include denied access to the tangible items in the first place. For example, an individual may engage in problem behavior anytime their caregivers deny them access to preferred items, such as toys and/or activities. While both antecedent events are functionally similar, the treatment approach will vary depending on which antecedent event triggers the most problem behavior. For example, if an individual engages in more problem behavior when denied access to items than when the items are removed, the behavior analyst may need to focus treatment on teaching that individual to accept "No" rather than teaching them to ask for items appropriately. On the other hand, if an individual engages in more problem behavior when items are removed than when they are denied access to those items, the behavior analyst will need to focus treatment on teaching the individual to ask for the item back in a more appropriate way, such as "Can I have more time?" or "Can I have it back?"

Treatment for Behaviors Maintained by Access to Tangibles

Function-based treatments for behaviors maintained by access to tangibles generally involve reinforcing a more appropriate response for accessing the tangible items. However, as mentioned before, the type of response taught will depend on the specific antecedents evoking the problem behavior. Either way, like many other types of problem behavior, the most effective treatment approach for behaviors maintained by access to tangibles involves a combination of both antecedent and consequence-based interventions. Specifically, treatment should involve creating an environment that decreases the establishing operation for the problem behavior while also disrupting the relationship between the problem behavior and the tangible reinforcers. Below, we will talk about how to address each approach.

Antecedent-Based Interventions

A common approach to the treatment of many problem behaviors is functional communication training (FCT). This procedure involves teaching an appropriate communicative response in order to access the specific tangible item. FCT is often used when the individual cannot mand for items or activities. The first step in FCT is to identify the form of the communicative response. The behavior analyst will include the family and client in deciding whether they will teach a vocal response, a picture card, an augmentative device, a microswitch, or any other form of language. Once a form is identified, the behavior analyst will then begin the process of teaching the communicative response.

The behavior analyst will base the specific communicative response to teach during FCT on the specific antecedent event that evokes problem behavior. Sometimes, the communicative response is a specific item, food, and/or activity, such as "Skittles" or "Go outside." Other times, the behavior analyst may choose to teach a more general communicative response, such as "I want my way," in order to capture multiple items and/or activities. Finally, as mentioned above, sometimes the communicative response that is targeted during FCT is a tolerance response such as "Ok" in response to a caregiver saying "No" or denying access to item.

Although FCT is an effective intervention used to decrease problem behaviors maintained by access to tangibles, there are a few things that behavior analysts should consider. First, during FCT for access to tangibles, individuals may become obsessed with the tangible item and/or activity. As a result, the frequency of the communicative response may increase to levels that may interfere with learning. This can be alleviated by doing a variety of things. For example, the behavior analyst could schedule noncontingent access to the tangible item in order to decrease the motivating operation for the item Another option would be to provide other preferred stimulus based on a preference assessment. Finally, behavior analysts could use what is called a "safety spot" where the individual loses access to the item or activity but can still see it in the room. With this procedure, behavior analysts identify a "safety spot" in the room where the individual can place the item when their time with it is up. A second barrier that may come up during FCT for access to tangibles is that learners may have a restricted range of actions they perform with the item. For example, an individual may learn to ask for their iPad appropriately; however, when they get access to their iPad, they watch short segments of videos over and over again. Behavior analysts could address this by scheduling specific times where the individual could engage in this restrictive behavior and times where they must do other things on their iPad. A final barrier that may come up during FCT for access to tangibles is the availability of the tangible item or activity. Specifically, an individual's preferred item or activity may only be available during restricted times. For example, if an individual's preferred activity is playing outside, access to playing outside is restricted to days where it is safe to go outside. If there is any inclement weather that prevents the individual from going outside (i.e., too cold, raining, etc.), access to that preferred activity is no longer an option and the behavior analyst can no longer use it as a reinforcer. A way to address this issue is to identify multiple items and/or activities that the individual can access contingent on appropriate requests. For example, instead of teaching an individual to appropriately request one specific item, the behavior analyst could teach them to request multiple items. This can be done by either teaching a general request such as "I want Max time" or by teaching the individual to ask for multiple items (Reichle & Wacker, 2017).

Consequence-Based Interventions

Once an individual can successfully ask for a tangible item, behavior analysts switch from FCT to differential reinforcement of alternative behaviors (DRA). During a typical DRA procedure, behavior analysts reinforce an appropriate request for a tangible item and put the problem behavior on extinction (Cooper et al., 2020). That is, they no longer deliver the tangible item contingent on problem behavior and instead only deliver the tangible item contingent on an appropriate request such as "Can I have skittles?" or "I want skittles." For example, if a client engages in physical aggression that results in access to an iPad during a DRA procedure, behavior analysts will no longer deliver the iPad contingent on physical aggression and instead only deliver the iPad if the client says, "Can I have my iPad?"

Despite its effectiveness in decreasing problem behaviors, barriers can arise when implementing extinction during DRA. For example, there are some behaviors that are too dangerous to withhold reinforcement. Specifically, in order to keep the client and others safe, it is necessary to continue to reinforce the behavior. For example, if a client engages in aggression that is maintained by access to tangibles, it would be dangerous to withhold the reinforcer while allowing them to continue to aggress toward others. Another example is when the behavior involves self-injurious behaviors. If an individual engages in head hitting in order to get access to tangible items, it would be extremely dangerous to allow the behavior to occur without delivering a reinforcer. Additionally, complete extinction of a problem behavior can be extremely difficult for both behavior analysts and caregivers. Extinction bursts commonly follow the onset of extinction interventions. Extinction bursts occur when the behavior increases in magnitude or intensity as a result of withholding a reinforcer. This increase in magnitude and/or intensity can become extremely aversive for the caregivers and/or behavior analysts who are implementing the intervention. As a result, treatment fidelity may decrease if the caregiver and/or partitioner can no longer tolerate the behavior.

Recent reviews on DRA suggest that using extinction is not always necessary to decrease problem behavior. Given the many barriers that arise from using extinction during DRA, an alternative approach is to use DRA without extinction (Peck et al., 1996). Specifically, behavior analysts could continue to reinforce the problem behavior but at a lower rate or with a thinner schedule of reinforcement. This procedure can be delivered in many different ways. For example, one approach would involve delivering the highest quality reinforcer contingent on appropriate requests for tangible items and delivering a low-quality and/or less preferred tangible item contingent on problem behavior. For instance, if an individual engages in tantrums in order to gain access to their computer (i.e., high preferred item), behavior analysts can allow access to the computer contingent on the client saying, "Can I play on my computer?" At the same time, the behavior analyst can deliver blocks (i.e., low preferred item) contingent on tantrums. Another approach would be to change the schedule of reinforcement based on appropriate and inappropriate behaviors. For example, if an individual engages in physical aggression in order to gain access to food, the behavior analyst could allow access to food for each response of "I want food" (i.e., FR1). However, if the individual engages in physical aggression, the behavior analyst will only deliver food after five instances of physical aggression (i.e., FR5). Finally, behavior analysts can also change the magnitude of the reinforcer for both appropriate and inappropriate behaviors. Specifically, if the individual above were to engage in physical aggression, the behavior analyst might deliver a small portion of a food item while delivering large portions for appropriate requests.

Treatment Selection

Combinations of DRA, like the ones mentioned above, are frequently used in the literature to address behaviors maintained by access to tangibles. Some considerations for effective implementation of the procedures above include ensuring that you have conducted frequent preference assessments and ensuring that you identify an array of multiple tangible items. Regardless of what moderation of the DRA procedure you use, the ultimate goal is to teach the individual a more appropriate way to access the tangible items and activities they need.

Behaviors Maintained by Negative Reinforcement (Escape)

When negative reinforcement (escape) is identified as the function of problem behavior, the consequences for problem behavior are either the removal or delay of an aversive task or activity. Behavior maintained by negative reinforcement can involve either an escape or avoidance contingency. When the removal or termination of an aversive task or activity maintains problem behavior, we refer to that contingency as escape, and the behavior as escape maintained. For example, a student who swipes materials off their desk after beginning a math worksheet will almost certainly have work terminated for a short time (e.g., while the teacher gathers the materials off the floor). If the student continues to swipe materials off the desk more often moving forward, this is conceptualized as an escape contingency; in other words, the student swipes materials because it results in a temporary removal of the math work. On the other hand, if a behavior is either preventing a task from being presented all together or delaying it, we refer to this as avoidance. For example, a student who hits a peer after recess (right before math instruction begins) and is sent to the office or resource room, avoided contact with instruction altogether. In this scenario, because the behavior resulted in the prevention of the aversive task presentation, we may conceptualize this behavior as avoidance (if behavior occurs more often in the future). Both escape and avoidance (i.e., negative reinforcement) are the most common functions of problem behavior among individuals with intellectual and developmental disabilities (IDD), including those with autism spectrum disorder (ASD; Beavers et al., 2013), and the percentage observed is even higher in classroom settings (Llyod et al., 2016). Problem behavior that occurs during instruction is especially disruptive to learning as it interferes with the ability to acquire academic and other important skills. Given the importance of skill building for individuals with ASD, effective treatments for escape-maintained problem behavior are critical for successful long-term outcomes.

Functional Antecedents

Whether an individual is behaving to escape or avoid an aversive situation, what constitutes what is aversive will be idiosyncratic across individuals (Langthorne et al., 2014). This is an important consideration when deciding and designing treatments. We commonly think of individuals escaping from academic work; however, research has demonstrated escape or avoidance may occur with a variety of other stimuli including aversive aspects of the environment (e.g., noise; Kettering et al., 2018; Dupuis et al., 2015), attention or physical proximity (e.g., Hagopian et al., 2001; Oliver et al., 2001), as well as nonacademic tasks (e.g., daily living routines). Correspondingly, very specific stimuli associated with an aversive task or activity may evoke escape or avoidance behavior while others may not. Consider that particular academic work topics (e.g., math), or types of work (e.g., word problems), may evoke escape or avoidance when others (e.g., reading or numeral problems) may not. Identifying the specific stimulus conditions evoking escape may be important for designing the most effective and least restrictive intervention (Call et al., 2004) and can be evaluated using treatment analyses (e.g., Cooper et al., 1992) or structural analyses (e.g., Hagan-Burke et al., 2015).

To illustrate, imagine a child in a special education classroom who engages in aggression during instruction, we'll call her Luna. A functional analysis demonstrated negative reinforcement is the function of Luna's aggression, and the descriptive assessments suggest it's most likely to occur during math instruction. This may sound like a straightforward case of escape-maintained problem behavior that most function-based interventions could resolve. But as it turns out, math work itself is not what Luna is actually seeking to escape; she's seeking to escape the physical prompts involved during number block lessons (e.g., graduated guidance) that are not present in other academic tasks. Although a less individualized intervention may reduce aggression, if we know that Luna is actually engaging in aggression to remove physical prompts, a simple antecedent change in the type of prompting could reduce behavior without the need for a more restrictive intervention. Further, if that type of prompting during instruction will be temporary, the aggression is tolerable, and she's showing mastery, we may decide not to intervene at all. Although this level of analysis may not always be necessary or feasible to implement, the more fine-grained analysis should be prioritized when an FBA evaluating standard escape conditions is inconclusive, or when problem behavior occurs during control conditions (Langthorne et al., 2014). As behavior analysts, we are ethically bound to provide the most effective and least intrusive intervention, so careful consideration of context in this manner should not be dismissed (BACB, 2020).

Treatment for Behaviors Maintained by Negative Reinforcement (Escape)

A variety of function-based interventions have been established as effective for reducing negatively reinforced problem behavior. These treatments can be divided into two broad categories: those that intervene on variables present prior to the problem behavior (antecedent-based interventions) and those that occur after (consequence-based interventions). As noted above, contextual factors related to the individual need to be considered when selecting an intervention. It is crucial that our interventions match not only the problem behavior function but also match the intervention context, requiring thorough consideration of all relevant variables described previously (e.g., cultural factors, preference, setting, etc.). The sections that follow describe an overview of intervention procedures and considerations for choosing function-based interventions for escape-maintained problem behavior. Given that escape-maintained problem behavior often occurs in instructional contexts (Llyod et al., 2016), the examples presented will be specific to behavior to escape or avoid instructional tasks.

Antecedent-Based Interventions

Instructional Modifications Similar to attention-maintained behavior, the first thing to consider when deciding a treatment for escape-maintained behavior is the context in which the behavior is occurring. After reading that last sentence, you might be saying "Well of course it is! Evaluating and changing the context is what we do!". You'd be right, of course, but there are contextual variables we often overlook, particularly when we're acting as consultants who are not typically part of the natural environment. The contextual variable most relevant to escape-maintained problem behavior during instruction is the current instructional situation. In particular, assessing the instructional level of tasks, the way instructions are being delivered, the availability of support for the student while completing tasks, and whether or not the student has the skills to recruit any needed support. The purpose of assessing instructional level is to ensure the skills of the student match the instructional materials they're expected to engage with. A mismatch in instructional level can include both tasks that are too difficult or tasks that are too easy, and in both cases can result in decreased academic engagement and problem behavior (Sanford & Horner, 2012). The most straight forward way to assess instructional level is to evaluate student accuracy on the task. Literature suggests an accuracy level between 70% and 80% is ideal during the acquisition of new material (Archer & Hughes, 2011; Engelmann, 1999; Kestner et al., 2019). If learner accuracy is too low, instructional modifications should be considered. These might include providing the student supplemental materials to increase accuracy that can be faded over time (e.g., a number line or calculator to assist with math; McComas et al., 2000), support during the task (e.g., prompting), or adjusting the instructional target (e.g., reducing task difficulty or teaching required prerequisite skills). If making support available during instruction is used as an intervention, it's important to evaluate the learner's ability to recruit that support. Recruiting assistance during instruction will be discussed more in depth in the section on functional communication training (FCT). Other changes to instruction that may reduce challenging behavior include decreasing the number of problems on worksheets (Ellis & Magee, 1999), changing the modality tasks are presented (e.g., paper vs. iPad; Neely et al., 2013), and adjusting how instructions are provided (e.g., 1-step instead of multistep directives; Richman et al., 2001; Boelter et al., 2007).

Activity Choice Incorporating learner choice within the instructional context is a simple evidence-based antecedent intervention. A variety of choice situations have been evaluated and shown to be effective including choice of the task itself (e.g., Rispoli et al., 2013), choice of the sequence of tasks (e.g., Kautz et al., 2018; Stayer Smeltzer et al., 2009), and choice of task materials (e.g., choice of two types of matching materials; Ulke-Kurkcuoglu & Kircaali-Iftar, 2010). For activity choice, learners are typically provided a choice between all available instructional activities. After a choice is made, the learner is required to complete the activity and then a choice between the remaining activities is provided (e.g., Romaniuk et al., 2002; Rispoli et al., 2013). For example, if a learner's choices were math, spelling, and reading, and they first choose to complete reading, the next choice would be between spelling and math. This process continues until all activities have been completed. Providing individuals choices in the sequence of tasks is very similar, but instead of choices being presented after each task is completed, the learner chooses the order of all tasks up front and is then required to complete tasks in that order (e.g., Kautz et al., 2018; Stayer Smeltzer et al., 2009). Although an antecedent intervention, choice of activity or sequence of activities is considered a function-based intervention for escape-maintained problem behavior because the learner has the ability to delay an aversive task by choosing to complete less aversive tasks first. Choice of activity materials has also demonstrated improvement in problem behavior (e.g., Koegel et al., 2010), but less research has evaluated its effectiveness compared with other activity choice approaches.

Noncontingent Escape (NCE) A final antecedent intervention considered evidence-based practice is noncontingent reinforcement (NCR; Ritter et al., 2018). As mentioned earlier in this chapter, NCR involves presenting the functional reinforcer on a time-based schedule independent of behavior (e.g., Waller & Higbee, 2010). For negatively reinforced problem behavior procedurally, this involves providing escape (i.e., noncontingent escape [NCE]) from the task (e.g., breaks) after a specific time interval (i.e., fixed-time schedule), or after an average number of minutes (i.e., variable-time schedule). For example, during math instruction, a student may get a break every 1-min regardless of what work has been done during that time. Because NCE doesn't require the learner to engage in a specific behavior to obtain the reinforcer, it's considered an antecedent intervention. Conceptually, NCE is likely effective because frequent access to the reinforcer acts as an abolishing operation that reduces motivation to engage in the problem behavior. Noncontingent reinforcement is often used in conjunction with other interventions (e.g., DNRA or DNRO; Fritz et al., 2017; Kodak et al., 2003). Advantages of NCE include that it's easy to implement, is effective on its own, and problem behavior is likely to be reduced quickly because the functional reinforcer is provided as part of the procedure. Disadvantages include the disruption it can cause to the natural environment as dense reinforcement schedules are typically used initially, that BCBA oversight may be required to successfully fade the intervention, and the potential to accidentally reinforce problem behavior (Waller & Higbee, 2010). Simple adjustments in procedures, such as increasing the interval if undesirable behavior is occurring, can avoid inadvertently reinforcing the target behavior.

Consequence-Based Interventions

Escape Extinction (EE) When behavior is under extinction conditions, reinforcers that had been previously provided contingent on problem behavior are withheld. Extinction procedures result in a decrease in future behavior because the response–reinforcer relationship that previously maintained the behavior is broken. Procedurally extinction is different depending on the function of the behavior; for negative reinforcement, the aversive stimuli are continuously presented without allowing escape until the relevant demand is completed (e.g., escape extinction). In other words, to implement escape extinction you would not allowing the learner to escape or avoid the aversive situation. For example, if a learner swipes instructional material off the table when a demand to complete work is presented, escape extinction might involve immediately representing the instructional materials every time materials were swiped until the learner completes the demand. While escape extinction can be used alone (Tereshko & Sottolano, 2014), it is most often combined with other interventions (e.g., instructional fading; Pace et al., 1993). Despite its effectiveness, escape extinction is not appropriate for all problem behaviors or settings, given the procedures can be labor intensive and involve adverse side effects that make it less likely to be implemented with high levels of treatment fidelity (Geiger et al., 2010; Lerman et al., 1999). When treatment fidelity of escape extinction is low, problem behavior can be inadvertently strengthened or intensified in magnitude. Escape extinction is best implemented with mild problem behaviors or in settings with high levels of control over the environmental setup and sufficient staffing. Further, implementing escape-extinction alone is not preferable given an appropriate behavior is not taught as part of the intervention. If escape-extinction is being used, ensuring programming for strengthening other behaviors in place is best practice. Given the potential constraints for the implementation of escape extinction, exploring treatment options that combine extinction with other procedures or remove it entirely is important for effectively matching the evidence-based treatment to both the individual and context.

Differential Reinforcement One treatment that often involves extinction as one component is differential reinforcement. When differential reinforcement is implemented as function-based intervention for negatively reinforced behavior, the reinforcer provided is escape (i.e., Differential Negative Reinforcement of Alternative Behavior [DNRA]). DNRA and variations of it are one of the most common interventions utilized for escape-maintained behavior. A standard DNRA procedure involves providing reinforcement (i.e., escape) for an alternative behavior while problem behavior is placed on extinction. For example, if a learner (let's call him Mateo) screams when instructions are provided, you may implement procedures so reinforcement (e.g., escape) is provided when Mateo says "not now" or "I want to do something else" after a task demand and withheld (e.g., instruction continues) when he screams. DNRA with extinction may be preferable to escape extinction alone because it involves teaching an alternative response in addition to the suppression of the problem behavior.

DNRA has been successfully implemented without the use of extinction (Briggs et al., 2019) but requires manipulating dimensions of reinforcement in favor of the alternative response (e.g., quality and/or duration; Trump et al., 2020) or other treatments added (e.g., NCR) to be successful (MacNaul & Neely, 2018). Vollmer et al. (2020) have recently made a call to redefine differential reinforcement procedures as increasing reinforcement along some dimension for one behavior and minimizing it along some dimension for another behavior. For the purpose of this chapter, interventions that manipulate dimensions of reinforcement across concurrent operants to reduce problem behavior are described in the section on choice-making treatments.

Another differential reinforcement procedure successful in reducing escape-maintained problem behavior is Differential Reinforcement of Other Behavior (DNRO; Kodak et al., 2003). In DNRO, escape is provided when a specified amount of time elapses without the occurrence of the problem behavior. Similar to using EE alone, DNRO may be a less preferred intervention because it doesn't include increasing an adaptive response. DNRO may be more appropriately considered when the stimuli individuals are escaping are not related to instruction (e.g., wearing a medical bracelet; Cook et al., 2015), are difficult to manipulate (e.g., automatic reinforcement), or when they cannot be feasible identified (e.g., due to setting constraints; Jessel & Ingvarsson, 2016).

Function Communication Training (FCT) As mentioned previously, FCT is a variation of a DRA procedure that involves teaching an alternative communicative response to obtain the reinforcer that's maintaining problem behavior. FCT is the most commonly implemented treatment for problem behavior and has a vast literature base to support its use (Falcomata & Wacker, 2013; Tiger et al., 2008). Similar to DRA procedures, FCT is most often implemented with extinction (Hagopian et al., 1998) and is often combined with other intervention procedures (e.g., noncontingent reinforcement; Doughty & Anderson, 2006; Rooker et al., 2013). If possible, implementation with extinction is recommended as it is most effective with extinction added (Hagopian et al., 1998; Tiger et al., 2008), and in some cases, punishment has been required to obtain clinically significant behavior reduction (Fisher et al., 1993; Hanley et al., 2005). However, in situations where extinction is not feasible, recent research suggests that when combined with other interventions, FCT may be successful without extinction (e.g., instructional fading; Davis et al., 2018).

For escape-maintained problem behavior, there are two main communicative responses taught: request for a break and request for assistance. Requests for assistance should be taught when an activity is too difficult or cannot be completed independently by the learner. Alternatively, requests for break should be taught when the learner can successfully complete the activity but is either habituated or satiated with the activity (Reichle & Wacker, 2017). For example, if a student, Hiroshi, reliably starts and completes part of a writing lesson but then engages in property destruction, teaching him to request a break would be more appropriate than teaching him to request assistance because he is able to complete the task without assistance. Diya on the other hand, is a learner who is just learning to write and requires prompts to complete the lesson. Diya swipes her materials when the teacher is not immediately available to assist her. In Diya's case, teaching a request for assistance would be more appropriate. Whichever communicative response is necessary, it should be established in the learner's repertoire before implementing FCT in the instructional context. Main benefits of FCT include that it teaches an appropriate communicative response to obtain the functional reinforcer, is low cost and easy to implement and client focused. Drawbacks include that fading reinforcement for the communicative response may require careful BCBA oversight and that extinction is often included as a component and may not be feasible in some contexts.

Choice-Making Interventions Choice-making interventions for problem behavior maintained by negative reinforcement involve presenting two or more concurrently available options (i.e., operants), each with separate schedules and/or dimensions of reinforcement altered. Some authors have proposed using "differential reinforcement with asymmetrical choice options" to describe these interventions. This type of intervention is used to reduce target behavior similar to DRA but doesn't fit current definitions of DRA because they don't always include an extinction component and may involve more than two concurrently available operants

(Kestner et al., in press). A growing body of literature supports these interventions as successful to reduce escape-maintained problem behavior with extinction as one of the operants (e.g., McComas et al., 2002; Peck Peterson et al., 2005) and also without extinction when dimensions of reinforcement are altered to favor alternative responses (e.g., Piazza et al., 1997; Davis et al., 2012). Dimensions of reinforcement including duration of the break, quality of the break (e.g., positive reinforcement added), or a combination of both have been successful in shifting responding from problem behavior to more adaptive behavior. Recent research evaluating the magnitude of escape required for interventions to be successful suggests that large differential magnitudes are preferred (Rogalski et al., 2020).

To illustrate what this intervention may look like let's imagine a teenager named Bandile who engages in severe aggression during instruction in his special education classroom. Given Bandile's size and severity of behavior, escape extinction would not be appropriate in a school setting with limited staff and other students present. This makes differential reinforcement with asymmetrical choice options a good match for both the client and the setting. Dimensions of reinforcement like the duration and quality of the break could be varied to favor either work completion or appropriately requesting a break while continuing to provide comparably minimized reinforcement for the problem behavior. During instructional tasks, Bandile could be provided two options with cards associated with each: He could take a short break (choose the break card) or work and have a longer break with access to his iPad (choose the work then break card). Bandile can also engage in problem behavior, a third available operant. These cards would be presented to Bandile at the start of every work session, and he'd be given the opportunity to choose. If he chooses to work, after completing the task he'd receive the long high-quality break (e.g., 5 min with iPad). If he chooses to request a break, work materials would be removed immediately and he'd receive a short break (e.g., 1–2 min), and if he aggressed toward the teacher, a very short break (e.g., 15–30 s) would be provided before work was again presented.

Demand/Instructional Fading In the previous example, given problem behavior is severe and the individual is older, the school setting may not be able to tolerate even low levels of the behavior. As such, combining the concurrent operant DRA intervention with an intervention that reduces the likelihood inferring behavior will occur may be needed. One evidence-based intervention likely to result in the reduction of problem behavior when combined with other interventions is demand/instructional fading (also called stimulus fading but henceforth referred to as instructional fading). In instructional fading, demand requirements are initially reduced significantly or to zero levels and then increased slowly over time based on learner success (Zarcone et al., 1994; Piazza et al., 1996). Ideally, instruction is increased (faded in) gradually enough that problem behavior is avoided altogether or significantly minimized. Instructional fading has almost exclusively been evaluated in combination with other interventions (e.g., FCT; Davis et al., 2018), but larger decreases in problem behavior are observed when it's added. Instructional fading is simple intervention to implement and combine with other approaches. In addition, it offers the benefit of reducing the likelihood undesired behavior will occur at all but may require very small increases in demand requirements to do so. This may limit the acceptability of this intervention in some instructional settings where delays to engagement with instruction cannot be tolerated.

Inclusion Positive Reinforcement Some studies have demonstrated that the addition of positive reinforcement to the instructional context can effectively compete with negative reinforcement. The addition of both attention (e.g., Cooper et al., 1992) and edibles (e.g., Carter, 2010; Lomas et al., 2010; Slocum & Vollmer, 2015) has shown a reduction in problem behavior even when it continues to result in escape. Given the relatively few studies demonstrating these effects in isolation without other interventions, and some that suggest a combination of both positive and negative reinforcement may be most effective (Bouxsein et al., 2011), the inclusion of positive reinforcement may be best as an addition to other evidence-based interventions.

Treatment Selection

The literature on treatment of negatively reinforced problem behavior resoundingly supports the use of function-based interventions whenever possible, and treatment packages that combine multiple interventions may be most effective. Given there are many evidence-based interventions available to choose from and combine, deciding on a specific intervention can be daunting. Geiger et al. (2010) developed a decision-making tool to assist practitioners in selecting interventions for escape-maintained problem behavior that may be of use. Although this tool can be helpful as a starting place and provides a helpful overview of interventions, caution is advised when using the tool in isolation. Validation studies on the Geiger et al. (2010) decision-making tool have been mixed (Hoffmann et al., 2022; Saini et al., 2017), and further research is needed to identify conditions under which it will result in the effective identification of a successful intervention. Although some considerations have been outlined in this section, the importance of individualized intervention cannot be overstated. We are bound by our ethics code as BCBAs to match our interventions to the individual and context they behave in, and doing so will ensure we implement the most effective and least restrictive intervention. Often we may have multiple matched evidence-based options available, and under these circumstances, it's crucial that we consider the individual receiving treatment and their care providers' preference.

Practical Considerations for Treatment

As demonstrated in this chapter, there is no shortage of evidence-based interventions at the behavior analyst's disposal when selecting function-based treatments for problem behaviors. Our hope is that following this chapter, the savvy practitioner will have added a few more tools to their toolbox. Remember that there are a handful of cardinal rules when selecting function-based treatments for your clients. First, determine your client's priorities. As a behavior analyst, it can be easy to get bogged down in the multitude of interventions you'd like to implement to increase the skills and quality of life of your clients. The reality is that we are most effective when we prioritize and focus on tackling those priorities systematically. Create a list of questions you might ask yourself as you begin treatment planning (e.g., "How will this improve my client's life?", "Is this goal aligned with their values and culture?", "Will this intervention increase independence?", "Is this goal aligned with the client's goals?"). Consider drafting questions relevant to your scope of clinical practice and client population.

Next, remember that context matters. Clients and their families bring a lifelong history of experiences, triumphs, disappointments, skills, and deficits to the table when we meet them. To thoughtfully and aptly serve them, we must consider all of the cultural variables and contextual factors that have shaped their behaviors and influenced their lives before they met us. Their environmental context and culture will impact all aspects of their treatment and its subsequent success. Brainstorm ways to keep context at the forefront of treatment selection. Consider your client's experience and history, and seek support as needed. We can only hope to educate others through our own awareness and education.

Finally, make it feasible. Be thoughtful about who might be implementing the treatments you select and the environment in which they will be trained. Think about the reading level of your behavior plans—are they accessible to all of the staff, teachers, caregivers, or other individuals who might be implementing treatment? Consider the barriers and resources that are presented to your clients. Are there ways to advocate, empower, or remediate barriers for our clients? As mentioned earlier in the chapter, don't be afraid to get creative or ask for advice from colleagues. From the literature (and experience), we know that a feasible treatment is a successful treatment. No matter what, as long as you keep your client's success as the focus of every treatment plan, you will undoubtedly demonstrate the safe, effective, and ethical practice of applied behavior analysis.

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Part V

Treatment Methods

31 Token Economies

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Most behavior–analytic interventions rely on the careful, systematic arrangement of reinforcement contingencies—a given consequence is delivered contingent upon a desirable response under conditions in which that response would be appropriate and the consequence would be valuable to the individual. That response is "strengthened" insofar as it becomes more probable under future similar circumstances. A token economy is a specific kind of flexible arrangement of reinforcement contingencies, used frequently in therapeutic and instructional contexts, in which the delivered consequence is a conditioned reinforcer, a token, that is later exchangeable for other reinforcers. The reference to "economies" derives from its resemblance to how we all learn to exchange earned arbitrary symbolic units (e.g., coins and paper money) for goods and services. That is, earned tokens are exchanged for backup reinforcers in much the same way that money is exchanged for goods and services in conventional economic systems.

Token economies offer several advantages over other reinforcement systems that rely on the direct delivery of the backup reinforcers (discussed below). For example, tokens are easy to administer and provide learners with a salient marker that represents their progress. As such, they have become common across many settings. In a survey of 406 professionals who serve people with developmental disabilities, Graff and Karsten (2012) found that tokens were the second most delivered programmed reinforcer, following only verbal praise. Token economies can be implemented in the same structured format for multiple individuals in a given setting. They can also be individualized for each client, as there are essential components that can be adjusted to suit each individual's needs and circumstances. In what follows, we provide a detailed description of these components of a token economy. We follow with an elaborated description of the advantages afforded by these systems over other reinforcement arrangements, advantages that resulted in their widespread adoption. We further describe the history and use of token economies, touching upon the multiple contexts in which token economies have been used. We end with a variety of additional considerations, including embedding punitive outcomes within a token system and concerns that have been expressed about the use of token systems.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_31

Components of a Token Economy

Although descriptions vary, most agree that token economies consist of seven essential components (e.g., Miltenberger, 2012; Hine et al., 2017; Ivy et al., 2017) that can be individualized for each participant or setting and can be adjusted based on performance. These components include (1) identification of the target behaviors, (2) identification of the stimuli used as tokens, (3) identification of backup reinforcers, (4) arranging the token-production schedule, (5) arranging the exchange-production schedule, (6) arranging the token-exchange schedule, and (7) token-training procedures. Below, we address each component by providing a description of the process and product, supplemented by research on best practices when available.

Identifying Target Behaviors

Prior to implementing a token economy, one must identify and operationally define the target behavior(s) that will result in token delivery. Target behaviors should be socially significant (Miltenberger, 2012) and appropriate for the client's repertoire and treatment goals. Examples of potential target behaviors include communication responses (e.g., Mason et al., 2015), daily living activities (e.g., Paul & Lentz, 1977), alternatives to problem behavior (e.g., Christensen et al., 2004), and health-related behaviors (e.g., DeLuca & Holborn, 1992; Patel et al., 2019). Tokens have also been delivered contingent on the absence of problem behavior, for example, by arranging token delivery on a differential reinforcement of other behavior (DRO) schedule (e.g., Didden et al., 1997; Donaldson et al., 2014). Problem behaviors may also be directly targeted when response cost is incorporated into a token system, as discussed in greater detail below.

As in all behavioral interventions, a critical issue is careful specification of the operational definitions of the target behavior(s). Loose descriptions of the behavioral criteria that result in token delivery (or token removal) can result in suboptimal performance within the token economy. For example, Moore et al. (2001) conducted an informal component analysis of an ineffective token economy in an inpatient psychiatric facility and identified two critical problems. One involved the delay in exchanging the tokens. Another was that the target behaviors had not been operationally defined. The latter was addressed by more clearly specifying the behavior(s) that would result in token delivery. Prior to the modification, the criteria were loosely defined as "follow directions," "be nice," and "be where you are supposed to be." These definitions were clarified for both staff and children. For example, "be nice" was transformed into "remaining at least two feet away from another child" because the key issue seemed to be participants invading each other's personal space. Although the other modification (altering the delay to token exchange) ultimately had a greater impact, simply modifying the operational definitions had a clear and consistent influence on the number of tokens earned collectively by the participants.

Identifying Stimuli Used as Tokens

In most cases, the tokens themselves are initially behaviorally neutral stimuli. That is, they have little pre-experimental or pre-therapeutic value or stimulus function but acquire value or stimulus functions through token training. The tokens themselves can vary along several dimensions, and common examples include poker chips, laminated images, plastic coins, and check marks. Token system developers must consider several factors when selecting stimuli to use as tokens. First, tokens should be safe to manipulate and should not pose a choking hazard, particularly when working with children and individuals with neurodevelopmental disorders. In addition, tokens should be items that clinicians can easily transport and deliver quickly, such that they immediately follow the occurrence or nonoccurrence of the target behavior. Relatedly, tokens should be stimuli that clients can easily carry, accumulate, and exchange. Tokens should also be durable because they will likely be used throughout the course of an intervention. Clinicians should also avoid using items that are readily available in the environment to prevent learners from bootlegging or counterfeiting tokens. For example, star stickers may be placed on a chore chart in a school-based token economy, but the stickers should not be available elsewhere in the classroom and some marking might be added to differentiate them from stickers that are available in stores or at home.

Clinicians should also consider whether tokens should be manipulable or nonmanipulable. A manipulable token is an item that is physically handled by the learner during token production and exchange (e.g., a poker chip), whereas a nonmanipulable token is a stimulus whose delivery and exchange are mediated by the practitioner (e.g., a check mark on a board or virtual tokens on an iPad). Physical token manipulation may increase the saliency of the response–reinforcer contingency (Leaf et al., 2012). On the other hand, manipulable tokens may occasion token-directed behavior (e.g., playing with the tokens, tapping tokens on a table) that can interfere with learning by increasing the time between learning trials and decreasing overall instructional time. Sleiman et al. (2020) compared relative rates of responding when manipulable or nonmanipulable tokens were provided for academic task completion in three children with autism spectrum disorder (ASD). One participant engaged in higher rates of responding in the nonmanipulable token condition, while the remaining participants engaged in similar rates across both conditions. All three participants demonstrated a preference for manipulable tokens in a preference assessment. In the absence of functional differences, clinicians should consider the client's preference. However, if the learner engages in token-directed behavior that interferes with learning, nonmanipulable tokens should be considered. Nonmanipulable tokens may also be beneficial when an exchange response cannot be trained (Hine et al., 2017) or if the client is likely to engage in problem behavior related to token exchange. This may be particularly relevant in a response-cost system if learners are asked to relinquish tokens contingent upon undesirable behavior.

When selecting stimuli to use as tokens, clinicians must also decide whether to use novel or preferred stimuli (i.e., interest-based tokens). An example of an interest-based token is using laminated images of Mickey Mouse as tokens for a client known to be particularly fond of Mickey Mouse. The advantage of novel stimuli is that the clinician controls the learner's history with tokens via token training. However, token training can be time-consuming. Alternatively, stimuli that are already preferred by the learner might already function as conditioned reinforcers and, thus, might require less training time. Fernandez (2021) recently completed an internet survey of token economy practices among clinicians involved in early intervention for learners with autism spectrum disorder and found that roughly 70% of clinicians reported using interest-based tokens in clinical practice. Charlop-Christy and Haymes (1998) found that using stimuli with which children were often preoccupied (i.e., an object of obsession) as tokens resulted in more correct responding and less problem behavior than novel tokens. However, it is unknown whether participants engaged in token-directed behavior outside the definition of problem behavior that might have produced longer intertrial intervals. Nonetheless, when using interest-based tokens over extended periods of time, preference for the stimulus being used as a token may diminish and reduce the tokens' effectiveness. However, this is unlikely to occur if the interest-based token is exchangeable for valuable backup reinforcers. Thus, clinicians should regularly evaluate the effectiveness of backup reinforcers and not rely solely on the previously existing conditioned reinforcing properties of an interest-based token.

Identifying Backup Reinforcers

Backup reinforcers are the stimuli or activities for which clients exchange their tokens (Hackenberg, 2018). The nature of viable backup reinforcers will vary, of course, depending on the population and what is readily available in the setting. Examples of backup reinforcers often used in token economies for children with neurodevelopmental disorders include edible reinforcers, leisure items (e.g., access to a tablet, toy cars), outdoor playtime, and escape (i.e., break from demands). Notably, one can also include reinforcers that are "free" and readily available, such as opportunities for social interactions with caregivers. By contrast, several studies have used token economies to support desirable behavior in workplace settings with typically developing adults (e.g., Camden et al., 2011; Vergason & Gravina, 2020), where the sorts of reinforcers listed above would clearly be less relevant. Simonian et al. (2020) conducted a systematic review of methods used to identify effective reinforcers for employees in organizational settings. Common candidate back-up reinforcers included items such as gift cards (themselves, characterizable as tokens), coupons, opportunities to leave work early, opportunities to choose work assignments, and preferred parking.

Independent of the population or setting, when selecting backup reinforcers, clinicians should select preferred items, activities, or privileges identified via a preference assessment and demonstrated to support appropriate behavior. Ideally, one should conduct direct preference assessments, which involve the systematic presentation of stimuli and observation of the learners' approach, selection, and/or consumption responses. Researchers have developed and evaluated several methods of conducting systematic preference assessments. Options include single-stimulus presentation methods (DeLeon et al., 1999; Pace et al., 1985), paired-stimulus presentations methods (Fisher et al., 1992), and multiple-stimulus presentation methods (DeLeon & Iwata, 1996; Hanley et al., 2003; Roane et al., 1998). A detailed description of these methods is beyond the scope of the current chapter, but the reader is directed to Virues-Ortega et al. (2014), who describe each of these methods and provide guidance on selecting the most appropriate preference assessment method under varying circumstances.

For time-based backup reinforcers (e.g., playtime, tablet, and escape), the duration of access should be directly related to the number of tokens exchanged for that activity. For example, if each token is exchangeable for 30 s of tablet access, the client should receive 5 min of tablet time in exchange for 10 tokens. Therefore, clinicians should consider whether they can easily control access to backup reinforcers (i.e., remove when access time expires). Clinicians should also consider selecting backup reinforcers that can be restricted to the token economy, such that the learner can only access the item by exchanging tokens (i.e., a closed economy). Several authors have observed that free access to reinforcers outside of the context in which they must be earned (i.e., an "open economy") can reduce levels of responding within the earning context (e.g., Kodak et al., 2007; Roane et al., 2005). Thus, access to backup reinforcers outside of the context of the token economy might suppress motivation and responding, limiting the system's effectiveness.

Setting the Token-Production Schedule

The token-production schedule specifies how and when target behaviors will produce tokens, or in other words, "the rule that describes the specific response requirements and environmental conditions that must be satisfied for token delivery" (Ivy et al., 2017, p. 723). Token-production schedules can theoretically mirror any arrangement that has been studied in behavior–analytic research (see DeLeon et al. (2013), for a description of schedule variations in applied settings) and vary necessarily depending on the clinical target. However, in practice, most clinical researchers adopt a fixed-ratio (FR) or variable-ratio (VR) schedule of reinforcer delivery (Fernandez, 2021). In a FR schedule arrangement, the token is delivered following the emission of a fixed (unvarying) number of target responses, whereas a VR schedule implies that the number of required responses can vary but is anchored to a mean (e.g., a VR 3 schedule implies that a token would be delivered after a mean of 3 responses, but delivery of any single token might occur following a number of responses that ranges between 1 and 5). That said, Ivy et al.

(2017) reported finding examples of FR schedules, VR schedules, differential reinforcement of alternative behavior (DRA) schedules, differential reinforcement of incompatible behavior (DRI) schedules, and DRO schedules as token-production schedules in their review of token research.

Token-production schedules seem to result in response rates and patterns typical of schedules of direct reinforcement (Hackenberg, 2018). For example, DeLuca and Holborn (1992) found that successively increasing a variable-ratio (VR) token-production schedule produced response rate increases as would be expected based on what is known about the relation between schedule values and performance on VR schedules in basic research. When setting token-production schedules, one should therefore consider the goals of the intervention. Still, during initial training, clinicians and researchers generally begin by delivering tokens on a very dense schedule (e.g., FR 1) to establish a consistent relation between the response and delivery of the token. Once the target response meets a mastery criterion, the schedule for that response may be thinned to an intermittent schedule for practical purposes. When selecting an intermittent schedule, clinicians should consider the natural schedule under which the target response will be maintained as well as optimal response rates. In some instances, different intermittent schedules may be similarly effective (e.g., Repp & Dietz, 1975). In such cases, one should consider the client's preferences when selecting the token-production schedule. One should directly train, or verbally describe, the response requirements to produce tokens (Ivy et al., 2017).

However, one should approach increasing the token-production schedule with caution. In token systems in which the amount or duration of backup reinforcers is directly tied to the number of tokens earned, increasing the token-production schedule necessarily increases the ratio of responses to reinforcers (i.e., the unit price), such that more responses are required for each reinforcer delivery. For example, Hackenberg (2018) describes that doubling the token-production schedule doubles the ratio of responses required to produce one reinforcer. As such, clients might demonstrate decreased responding indicative of ratio strain, a situation in which the targeted performance ceases to occur because the behavioral cost of each token has become too high. Thus, Hackenberg (2018) recommends holding the token-production constant and increasing the exchange-production schedule instead. However, if the token-production schedule will be changed, one should consider gradually thinning the schedule to prevent ratio strain (e.g., Ackerman et al., 2020).

A further important consideration about token-production schedules is the immediacy of token delivery. Tokens should be delivered immediately after the target behavior, as delays in token delivery tend to decrease task compliance (Boerke & Reitman, 2011) and response rates and increase latency to responding (Leon et al., 2016). Leon et al. (2016) found that delays to token deliveries as brief as 3- to 6-s produced decrements in responding relative to immediate delivery. Moreover, clinicians should consider and evaluate unprogrammed delays in token delivery (i.e., failures in treatment integrity) as a possible explanation for decrements in responding that may emerge throughout the course of the intervention and for initially low levels of responding that cannot be explained otherwise.

Setting the Exchange-Production Schedule

The exchange-production schedule specifies how and when the client will exchange earned tokens for backup reinforcers. Calling this a "schedule" in the same sense as the token-production schedule, seemingly implies that a specific number of tokens must be earned before an exchange opportunity is arranged. This is accurate in some cases, but in actual practice, exchange-production schedules can take numerous other forms. For example, in an instructional context for learners with ASD, the clinician might arrange an exchange opportunity (1) after a certain number of tokens have been earned, (2) at the end of the instructional session independent of how many tokens have been earned, or (3) at the end of the day (or even at the end of the week) during a convenient time for exchange. The last exemplifies a time-based exchange-production schedule rather than a response-based exchange-production schedule. Ivy et al. (2017) reported that 60% of the studies they reviewed employed time-based exchange production schedules; they seemingly have become the norm. The timing of opportunities to exchange can have a significant impact on the effectiveness of a token economy. Field et al. (2004) reported meaningful improvements in token economy effects in initially "nonresponsive youth" by changing the frequency and immediacy of access to back reinforcers. By increasing exchange opportunities from once a day to twice a day and by halving the number of tokens (or points in their case) that a child needed to earn access to preferred consequences, the authors observed clear increases in the frequency of earning backup reinforcers and corresponding decreases in "intensive behavioral episodes."

Backup reinforcers may be displayed in a "token store," for example, by using either a menu format or in a room in which individuals can make their purchases. In time-based schedules, individuals should only have access to the token store at designated times, which may include predetermined store hours (e.g., from 1:00 pm to 4:00 pm). Of course, the time and place where token exchange will occur must be decided in advance. When first establishing a token economy, the token store should be available frequently, but exchange-production schedules could be thinned across time and become available more intermittently for practical purposes (Cooper et al., 2020). McLaughlin and Malaby (1976) assessed the effects of fixed-time (FT) and variable-time (VT) exchange-production schedules on assignment completion of a fifth- and sixth-grade class. Both schedules were equal to 5 days, with token exchange occurring between 3, 5, 7, and 9 days under the VT schedule. Although the FT schedule produced between 88% and 100% assignment completion, the VT schedule produced less variable responding (i.e., 100% assignment completion). Thus, variable exchange-production schedules may produce more consistent responding during token production.

Arranging response-based exchange-production schedules may require careful consideration owing to second-order effects. That is, responding in the token-production schedule may be affected by the exchange-production schedule. Nonhuman research has shown that FR exchange-production schedules can produce decreased response rates and longer postreinforcement pauses (PRP) on the token-production schedule than equivalent VR exchange-production schedules (Bullock & Hackenberg, 2006; Foster et al., 2001). However, Argueta et al. (2019) found that FR and VR exchange-production schedules did not significantly affect responding on an arbitrary task in a child with ASD. Both schedules also produced similar pause-reinforcement pause (PRP) durations, with the exception of the VR2 schedule, which produced slightly longer PRPs and decreased relative to FR2. The differences observed in PRP may be an artifact of the backup reinforcer used in the study (i.e., videogames on an iPad). Given that each token was exchangeable for 15 s of access to the iPad, exchanges occurring following the accumulation of one token may have produced an aversive context in which access to the backup reinforcer was brief and distributed. Distributed reinforcement arrangements have been shown to produce decreased levels of responding and to be less preferred (see DeLeon et al., 2014). Therefore, it is also important to consider whether the reinforcer potency of the backup reinforcer is enhanced by accumulated access when determining the exchange-production schedule.

Regardless of whether the exchange-production schedule is time- or response-based, the schedule should be dense initially to maximize contact with backup reinforcers. Over time, the scheduled can be thinned. If the client stops responding during schedule thinning, the clinician may consider returning to a previous, denser schedule as decreased responding may be indicative of a different kind of ratio strain—a situation in which the targeted performance ceases to occur because the opportunities to exchange have become too few and far between.

Setting the Token-Exchange Schedule

The third schedule to consider is the token-exchange schedule, which specifies how many tokens must be exchanged for a given backup reinforcer or the "price" of each backup reinforcer. For example, each token could be exchanged on a one-to-one ratio for a preferred edible reinforcer or 30-s access to an iPad. There are no explicit rules on how to set the prices of backup reinforcers, and researchers have adopted several strategies. One method is to set the price of all backup reinforcers at the same number of tokens (Akin-Little & Little, 2004). For example, all high, moderate, and low preferred backup reinforcers cost five tokens. Alternatively, the price of each backup reinforcer may vary based on the learner's preferences or reinforcer availability. For example, the learner's highest preferred item is set at 10 tokens, while a moderately preferred and low-preferred items are set at 5 and 1 tokens, respectively. Leaners may then accumulate tokens to access higher priced backup reinforcers (Ackerman et al., 2020). Fernandez (2021) reported that 48% of clinicians determined the price of backup reinforcers based on learner's preferences. In this case, presumably, more preferred items are set at higher prices as a means of promoting motivation to earn tokens, but no research is available to our knowledge to endorse this practice.

The learner's level of functioning may also be an important consideration when selecting a strategy to set the price of backup reinforcers. While higher functioning learners may be able to effectively accumulate and distribute tokens among a variety of differently priced backup reinforcers, lower functioning learners may benefit from a token store in which all the backup reinforcers have the same price. Clinicians must also consider how many tokens the learner can produce and accumulate before exchange, or lose if a response cost is implemented, to ensure that the learner can access reinforcers. Like with the other schedules, the price of backup reinforcers should initially be low before systematically thinning the schedules. For example, initially, each token could be exchanged for one unit of the selected backup reinforcer, after which the token exchange schedules could be adjusted for practical purposes. Once again, the token system developer may need to be cautious about setting the prices too high. Backup reinforcers that are functionally unobtainable because of a high token-exchange value may cease to motivate targeted responding.

Token Training: Common and Best Practices

Token training refers to procedures used to establish tokens as conditioned reinforcers. Although this step necessarily precedes the execution of other token economy components, sequentially, we describe it last because the description requires an understanding of the other components. Recommendations for token training vary depending on the learner's repertoire. For clients with intact verbal abilities, it may suffice to provide verbal instructions (e.g., vocal, written) that explain the token-production and exchange contingencies (Cooper et al., 2020; Kazdin, 1977). Ivy et al. (2017) reported that when token conditioning procedures were reported at all, 76% of studies provided a verbal description of the token economy contingencies. For clients who are less responsive to instructions, recommendations typically suggest some sort of pairing procedure to establish a relationship between tokens and backup reinforcers, thus "imparting value" upon the tokens (Doll et al., 2013; Hackenberg, 2018; Hine et al., 2017).

There are multiple pairing procedures from which to choose, the simplest of which is stimulus–stimulus (S–S) or direct pairing, in which tokens are delivered noncontingently and are immediately followed by a backup reinforcer (Doll et al., 2013). The most common pairing procedure reported by practitioners is response–stimulus (R–S) pairing (Fernandez, 2021), in which, contingent on a target response, a token is delivered and immediately followed by an established reinforcer. Kazdin (1977) suggested another procedure, hereinafter referred to as stimulus–exchange–stimulus (S–E–S) pairing, which involves noncontingently delivering tokens and then prompting an exchange response, contingent on which backup reinforcers are delivered. Last, another alternative is to combine R–S and S–E–S pairings by delivering tokens contingent on responding and delivering backup reinforcers contingent on exchanging delivered tokens (e.g., Argueta et al., 2019; DeLeon et al., 2014). However, applied researchers have not directly evaluated the general and relative effectiveness of these procedures for pairing tokens. To the extent that findings with other stimuli and species generalize to tokens, clinicians should use pairing procedures that require an exchange response (e.g., S–E–S training) and, more generally, those that require response–contingent pairings (e.g., R–S pairing; Hackenberg, 2018).

In addition to pairing, token system managers must often also teach token exchange and production responses, the topography of which should be carefully considered. Exchange responses refer to handing in tokens for backup reinforcers. Examples of exchange responses include handing a completed token board (e.g., Leaf et al., 2012) or individual tokens (e.g., Argueta et al., 2019) to a therapist, depositing tokens into a slot (e.g., Smith, 1972), or verbally indicating which backup reinforcer is desired. When selecting an exchange response, one should be mindful that some exchange responses might not be physically possible or might be too effortful for some clients (Hine et al., 2017). If an appropriate exchange response is not identified, clinicians should consider exchanging tokens for the client (Hine et al., 2017) until a suitable response is available. However, clinicians should be mindful that exchange responses are indispensable if one plans to teach learners to accumulate and exchange tokens at their discretion (Hine et al., 2017).

Production responses are those which result in token delivery (i.e., the target behaviors). The topography of production responses can vary widely and can include acquisition or mastered targets. However, to minimize demand- and delay-related problem behavior, mastered and low-effort responses are preferable during initial training. To the extent that unmastered tasks are aversive, their use during training might compromise the reinforcing value of tokens. Production and exchange responses may be trained using a variety of procedures, including but not limited to verbal instructions (Doll et al., 2013; Kazdin, 1977), errorless learning (e.g., Leaf et al., 2012), prompting (e.g., Argueta et al., 2019; DeLeon et al., 2014), and chaining (Hackenberg, 2018). Practitioners' most common default strategy for training production responses is akin to forward chaining, in which learners earn the first token in the terminal token-production schedule and subsequent tokens are added gradually (Fernandez, 2021). The second most common default strategy for practitioners training production responses is akin to backward chaining (Fernandez, 2021). Note that prior to training production responses, exchange responses should be trained to establish the relationship between tokens and backup reinforcers (Hackenberg, 2018).

After exchange and production response training, clinicians may include accumulation training to teach clients to compile and save tokens. Accumulation allows individuals to access more (Hine et al., 2017) or higher cost and more preferred backup reinforcers at each exchange. However, the increased availability of reinforcers via accumulated tokens can weaken clients' motivation to engage in token-earning behavior (Hackenberg, 2018). Thus, the decision to allow for token accumulation must be carefully weighed. If clients can accumulate tokens, clinicians should consider restricting accumulation, such as by limiting how many tokens clients can accumulate (e.g., Yankelevitz et al., 2008) or setting expiration dates for tokens. Clinicians can also restrict the quantity of tokens that learners can or must exchange at each exchange opportunity. Accumulation training can employ procedures like those for training exchange and production responses. However, additional training might be required to establish discriminative stimuli that signal when accumulation is available. Prior to training, one must also decide where and how clients will store accumulated tokens.

History and Use of Token Systems

Hackenberg (2009, 2018) provided a detailed history of the development of token economies, beginning with its roots in nonhuman experimentation. In what follows, we cover some of the highlights of that history. Wolfe (1936) and Cowles (1937) were among the first to systematically evaluate tokens in the laboratory. Both researchers used poker chips as tokens and chimpanzees as subjects to investigate response patterns across various token arrangements and to compare the reinforcing effectiveness of tokens to primary reinforcers. In a series of experiments, both Wolfe and Cowles demonstrated that establishing a token–reinforcer relationship (i.e., pairing) is central to tokens' effectiveness. Specifically, Wolfe (1936) found that chimpanzees preferred tokens that were paired with food over those that were not paired with food. Cowles (1937) found similar results, including that paired tokens supported the acquisition of matching-to-sample discriminations with levels of accuracy comparable to but lower than those supported by food. Following Wolfe's and Cowles's experiments, token research lagged until a series of experiments conducted by Kelleher (1956, 1957, 1958). Investigating reinforcement schedules, Kelleher (1956) found that responding for tokens under various simple schedules of reinforcement generally conformed to the typical patterns of responding observed when the reinforcers delivered were food. However, Kelleher (1958) found that higher FR token-production schedules produced longer pauses in responding early on in sessions than those typical of food production schedules.

A spike in applied token research was spurred by Ayllon and Azrin's (1965) seminal study evaluating the effects of a token economy on the self-help and vocational behaviors of adults with psychosis hospitalized in an inpatient facility. Across six experiments, Ayllon and Azrin demonstrated that participants' performance improved as a function of the token economy, an effect that was lost when the token system was disrupted. The value of Ayllon and Azrin's study was in the social significance of the behaviors and population included (Hackenberg, 2018). Kazdin and Bootzin (1972) and Kazdin (1982) addressed the increase in applied token research and identified practical areas (e.g., staff training, generalization, procedural fidelity) warranting further analysis. In the ensuing years, researchers also began applying token economies across a broad range of settings and circumstances. Matson and Boisjoli (2009) suggested that tokens system have been used most often in inpatient psychiatric settings and school-based programs, the descriptions below exemplify the variety of contexts in which token economies have been successfully implemented.

Preschools Token economy research has been conducted in preschool settings to proactively address behavior management in young children. Filcheck et al. (2004) implemented a class-wide levels system managed by the teacher, in which, in lieu of dispensing tokens, children's names were moved up and down seven levels contingent on meeting the specified criteria associated with each level. This type of economy removed the effort of the teacher to dispense tokens and did not require the students to count, track, or exchange tokens. It also allowed all students to participate and earn reinforcers without "singling out" the children with behavior management issues.

Elementary Schools In elementary schools, token economies may be used to identify and diagnose the children with behavior problems and learning disabilities while cultivating peer relationships and social skills. Anhalt et al. (1998) evaluated the ADHD Classroom Kit to increase prosocial behavior and decrease disruptive behavior in classrooms. The Kit was designed for kindergarten through sixth-grade classrooms and involved splitting the class into groups so as not to single out children with ADHD or other behavior management issues. Groups and individuals earned tokens for desirable behavior and received an opportunity to correct disruptive behavior following verbal warnings. The Kit required students to rely on each other, increased accountability within groups, and allowed for peer modeling of prosocial and on-task behaviors. Additionally, the Kit has been shown to increase appropriate behavior in children with problematic behavior or disabled learning and has been used in numerous case studies (Anhalt et al., 1998).

Middle and High School Token economies have been evaluated with adolescents in middle schools to improve the accuracy and variety of academic skills. For example, Swain and McLaughlin (1998) used a point system in a classroom of adolescents diagnosed with behavioral disorders to improve their math accuracy. Truchlicka et al. (1998) successfully used a token economy with a response cost component to improve the performance of adolescents in a special education classroom on spelling tests. Token research in high schools is sparse and often takes place in special education classrooms. One consideration for the lack of use in high schools may be that teachers do not find token economies socially valid at this level. They may also not be feasible in classrooms where students attend one class a day before moving to the next.

University/College Token research in university and college settings may be more common than in high schools. Boniecki and Moore (2003) successfully used tokens to increase college students' participation during class by distributing tokens for answering questions correctly during lecture, and they were exchangeable for extra credit points. Nelson (2010) conducted a similar study, but instead, students earned tokens by asking questions in class. These studies used tokens to increase participation during class toward the aim of improving students' performances during evaluations. This expands the literature on token use to large, diverse groups and beyond the use to address disordered behavior and psychiatric conditions.

Residential/Community Facilities Token economies have been successfully implemented in residential and community facilities. For example, Phillips (1968) implemented a token economy at a residential rehabilitation center for predelinquent boys. The adolescents earned points (i.e., tokens) for appropriate behaviors (e.g., self-care, prosocial behavior, academic achievement) and lost points for inappropriate behaviors (e.g., aggressive speech, failing schoolwork, arguing). Phillips reported significant improvement with all the participants. Similarly, Adams et al. (2002) described the implementation of a camp-wide token economy to increase prosocial behaviors at a pediatric burn summer camp. Nastasi et al. (2020) used a token economy to increase physical activity in a residential home for adults with IDD.

Organizational Settings There have also been applications of token economies within a variety of organizations to reinforce employees' desired behaviors. Fox et al. (1987) used stamps as tokens to reinforce miners behaving safely in an open-pit mine. They reduced the time and money lost by the company due to injury. Camden et al. (2011) decreased employee absenteeism and rescheduling by almost half through a credit reward system. Vergason and Gravina (2020) successfully had guests and confederates provide tokens to employees at a zoo for appropriate greeting behavior. These applications show the versatility of token economies across several contexts.

Therapy Settings Token economies have also been implemented in therapy settings. For example, Ingham (1982) evaluated the effects of a token system for reducing the stuttering of adults. However, the results were inconclusive but provided initial evidence that token programs might be an effective intervention for this behavior and population. In general, token economies implemented with patients with schizophrenia have been effective (Dickerson et al., 2005). However, research with this population published since

1994 has not been reviewed and evaluated. Thus, the current effectiveness of recent studies is unknown and cannot be compared to previous research. After all, it is possible that the level of care provided in older research differs from that provided in contemporary studies. Although behavior analysts report using token economies often and although tokens are the second-most common consequence delivered by staff working with people with IDDs, research elucidating the efficacy of tokens with other populations is lacking. As such, studies with populations and in therapy settings with which we do not typically evaluate token economies are needed to better understand the efficacy of token economies in differing therapies.

Several authors have noted a marked decline in the quantity and change in the nature of token economy research. Hackenberg (2018) observed that most recent applied research has generally focused on practical and clinical concerns rather than elucidating the processes underlying token systems' effectiveness. Thus, recent applied token research has generally not been informed by basic research and has declined significantly since the 1970s. In fact, in applied publications including token economies, token systems are usually a component of treatment packages rather than the focus of the interventions or the research themselves.

Matson and Boisjoli (2009) discuss several reasons why applied token economy research might have declined. At the height of applied token research in the 1970s and 1980s, much of the research involved psychiatric inpatients. However, once the deinstitutionalization movement began, the demand for token economies in institutions declined, and thus related research also declined (Liberman, 2000). Additionally, Hackenberg (2018) posits that the successful widespread application of token economies might have contributed to their decline in applied research. Both as a primary intervention and as a component of treatment packages, token economies have been successfully implemented to change behavior across a variety of settings, subjects, responses, and procedural modifications. Consequently, researchers may have had little motivation and reason to evaluate token economies in their own right or to investigate variables that impact their effectiveness.

Mechanisms Underlying Token Effects

Tokens increase responses upon which they are contingent, but the mechanisms by which they do so are not well understood. One account is that tokens function as conditioned reinforcers that strengthen responses due to their relationship to backup reinforcers (Hackenberg, 2009, 2018). For example, Smith (1972) and Moher et al. (2008) demonstrated that contingent tokens differentially increase children's responding when the tokens are paired with backup reinforcers compared to when they are not. Moher et al. (2008) further observed that paired tokens maintained levels of responding similar to those maintained by the backup reinforcers themselves, suggesting that the acquired value of tokens is commensurate to that of the backup reinforcers for which they are exchangeable. Wolfe's (1936) and Cowles's (1937) findings that tokens maintained similar levels of responding to food also supported the conceptualization of tokens as conditioned reinforcers. Relatedly, tokens are typically conceptualized as generalized conditioned reinforcers when they are paired with more than one backup reinforcer. Supporting the conceptualization of such tokens as generalized conditioned reinforcers, Moher (2008) found levels of responding are less susceptible to fluctuations due to changes in motivating operations (MOs) when tokens are paired with multiple vs. one backup reinforcer.

Another account posits that tokens do not increase responding because they function as conditioned reinforcers that directly strengthen the responses they follow, but that they increase responding much like discriminative stimuli in that they signal that reinforcement is forthcoming and, thus, guide responding much like signs on roadways direct drivers to their destination (Shahan, 2010). For example, Bullock and

Hackenberg (2015) compared pigeons' rates of responding to identical tandem and token schedules for food (i.e., FR 200) in which the token schedule also produced tokens on a FR 50. If tokens were conditioned reinforcers, rates of responding should have been greater during the token schedule because it produced more reinforcers. However, rates of responding were lower during the token schedule, suggesting that tokens have a discriminative or signaling function and, thus, resulted in more efficient responding. In addition, rates of responding toward the end of the token requirement approximated rates at the end of the tandem requirement, indicating that early token delivery signaled a delay to the terminal reinforcer (i.e., food) and, thus, suppressed responding. Bullock and Hackenberg's results indicated that tokens have discriminative functions when token schedules produced lower rates of responding relative to identical tandem schedules for food, even though the token schedule resulted in four times as many reinforcers (i.e., tokens) for every food delivery on the tandem schedule.

To our knowledge, researchers have not conclusively evaluated the mechanisms responsible for token effects with applied populations, and therefore, it is unclear which mechanisms account for their effects on human behavior. Regardless, tokens' exchangeability for backup reinforcers appears to be critical to their effects (Hackenberg, 2009, 2018; Shahan, 2010).

Benefits/Advantages of Token Reinforcement

Token economies have many advantages relative to other reinforcement systems. First, tokens are typically discrete and easy to store (Ivy et al., 2017) and transport across environments (Ayllon & Azrin, 1968). Additionally, token systems allow for immediate reinforcement without interrupting ongoing responses or activities in the way that directly delivering other reinforcers (e.g., toys) can (Kazdin & Bootzin, 1972). The ability to reinforce responding immediately is an especially important benefit given findings that delays to reinforcers as brief as 6- to 10-s can negatively impact skill acquisition by reducing instructional efficiency and effectiveness (Carroll et al., 2016; Majdalany et al., 2016). Relatedly, token accumulation facilitates continuous, uninterrupted access to backup reinforcers (e.g., 10 min access after 10 tokens are exchanged), which researchers have found supports more responding and is preferred by learners than distributed (e.g., 1 min access after one token is exchanged) access (DeLeon et al., 2014).

Another benefit is that tokens can be established as generalized conditioned reinforcers and, thus, can be less susceptible to satiation effects. When tokens are paired with multiple backup reinforcers, they can continue to support similar levels of responding even when the client is satiated on one of the backup reinforcers (Moher et al., 2008). By contrast, satiation inevitably renders actual reinforcers delivered as direct consequences less effective. To maximize resistance to satiation, tokens should be paired with at least two to three reinforcers (Moher et al., 2008), and the classes (e.g., edible vs. leisure items) of those reinforcers should vary (Becraft & Rolider, 2015).

Further, each component of token systems can be individualized and tailored to a range of circumstances and treatment objectives (Ivy et al., 2017). For example, differential reinforcement can be easily embedded into a token system by arranging for different target responses to produce different quantities of tokens (Miltenberger, 2012). Similarly, response cost can be incorporated into a token system. Contingent removal of earned tokens can reduce problem behavior when appropriate (see later section on "Response Cost"). Moreover, each schedule in a token system can be readily adjusted to promote optimal responding for each client as the environment and their repertoire change.

Additionally, token economies have large-scale applicability; they can be used to change the behavior of group members (e.g., Fox et al., 1987). A good example is money, which functions as a token reinforcer because it can be exchanged for goods and services and is typically earned (and lost) by engaging in specific behaviors. Money functions as a token reinforcer for most individuals in a society and, therefore, influences the behaviors of many. Relatedly, because token economies mirror societies' monetary systems, they can be used to teach saving and spending behaviors.

Additional Considerations

Response Cost in Token Economies

Response cost is a negative punishment procedure whereby the tokens one already possesses are removed contingent upon undesirable behavior. Response cost is essentially a modification of the token-production schedule (Hine et al., 2017). It is incorporated into token economies when one of the aims of the token economy is to decrease undesirable behavior, and simply reinforcing appropriate behavior has not achieved this aim (Miltenberger, 2012). Therefore, in practice, token economies do not typically begin with response cost, but they may be added when other attempts to decrease undesirable behavior through positive reinforcement have been thoroughly exhausted. Response cost can be implemented in varying ways. For example, individuals might be given some number of tokens at the beginning of an intervention period (noncontingent token delivery). By contrast, the individual may have to earn the tokens that are later removed contingent upon inappropriate behavior (Conyers et al., 2004).

Results of studies that compared token economies with and without response cost in decreasing problem behavior have found mixed results (Conyers et al., 2004; DeJaeger et al., 2020; Phillips et al., 1971), although some evidence indicates that response cost is just as effective, if not slightly more than symmetrical reinforcement-based procedures for reducing undesirable behavior. Interestingly, when given a choice between the procedures, many study participants have expressed a preference for response cost over the reinforcement-based alternative (Donaldson et al., 2014; Jowett Hirst et al., 2016).

Insofar as response cost is a punitive procedure, several considerations are important in deciding whether to incorporate it into a token economy. Punishment can be associated with undesirable side effects (e.g., emotional responding, punishment-induced aggression), so care must be taken to ensure that implementing response cost does not, in fact, occasion more undesirable behavior than it decreases. Although some studies suggest that token response cost may be relatively benign in this respect relative to other punitive procedures (see Iwata & Bailey, 1974; McGoey & Dupaul, 2000), we know of no direct comparisons between response cost and other kinds of positive or negative punishment procedures.

Another important consideration in the use of response cost is whether it would be difficult to remove tokens from an individual that does not particularly want to relinquish them. Removing tokens under some circumstances may result in a struggle, and under other circumstances may result in a sort of delay to the punitive operation. Delayed punishment has been shown in some cases to have diminished effects relative to more immediate punishment (e.g., Abramowitz & O'Leary, 1990).

Other important considerations involve questions regarding how many tokens should be removed contingent on an undesirable response. On the one hand, the amount lost must be sufficient to offset what is gained from engaging in the target response. That is, the relative value of the loss incurred through response cost must outweigh the gain achieved by engaging in the undesirable behavior. On the other hand, it is important that the individual not lose access to all tokens through response cost, thereby establishing a condition in which no further penalty could be imposed for additional instances of undesirable behavior. In other words, losing all of one's tokens "might produce a segment of time in which contingencies for appropriate behavior are vague, perhaps creating an establishing operation for problem behavior." (Hine et al., 2017; see also Miltenberger, 2012).

Fading a Token Economy

Fading a token economy refers to the methods employed to transfer control of target behaviors from the token system to natural contingencies in a manner that promotes response maintenance. In most cases, fading token systems will be necessary to facilitate clients' transitions from treatment to natural environments. As such, prior to implementing a token economy, one should ensure that fading the token program will be feasible. Otherwise, one should consider alternative interventions to prevent possible decrements in responding resulting from removing the token economy without fading. Additionally, one should establish criteria for initiating fading while developing the token system, and one should also develop fading procedures well before the client meets said criteria.

There are two general approaches to fading a token system: (a) changing the contingencies and schedules of the token system while it remains in effect and (b) gradually eliminating the token economy in its entirety. Paul and Lentz (1977) utilized the former method to fade a type of token economy known as a level system that targeted psychiatric patients' daily living skills (e.g., bed making). Participants began at Level 1 and moved on to other levels by meeting predetermined criteria. As participants accessed higher levels, the schedules were faded such that the contingencies more closely resembled those in the natural environment outside of the hospital. For example, when participants moved to Level 2, token delivery was delayed such that they received large quantities of earned tokens at once, much like a "pay day" (Boerke & Reitman, 2011). Participants at Level 4 could purchase backup reinforcers without restrictions if they continued to meet applicable response requirements and purchased a card that unlocked this privilege. In this manner, Paul and Lentz faded the token economy and promoted self-management skills (e.g., planning, self-monitoring) required in the natural environment.

The other method of fading involves gradually eliminating the token program and transferring control solely to the natural environment. For example, Petursdottir and Ragnarsdottir (2019) completely faded a token reinforcement system that had successfully changed the disruptive behavior and academic engagement of elementary school students. The researchers faded the token program by systematically (a) pairing token delivery with social reinforcement, (b) increasing delays to token and backup reinforcer delivery (i.e., token-production and exchange-production schedules), (c) raising performance criteria (i.e., increasing the token-production schedule), and (d) increasing the token-exchange schedule (i.e., higher prices for backup reinforcers). Ultimately, participants had to engage in target behaviors for progressively longer intervals to earn tokens, earn a greater proportion of all possible tokens to access the same backup reinforcers, and wait long periods for opportunities to exchange tokens. Eventually, the researchers were able to thin these schedules such that they were able to eliminate the token system entirely while maintaining responding at desirable levels.

Evidence suggests that the treatment effects of a token economy may persist for several years after the system is removed (Kazdin, 1982; e.g., Paul & Lentz, 1977). Variables associated with such maintenance include individualized instruction, smaller classroom sizes, parental involvement, and home-based reinforcement (Kazdin, 1982). However, sometimes the treatment effects of faded token systems are not maintained, and this loss may be the result of individuals operating in environments that do not support the behaviors targeted in the token economy. Alternatively, the environment might support the behaviors, but if the token system was not appropriately faded, individuals might experience ratio strain resulting in response decrements. To promote response maintenance once a token program is removed, Kazdin (1982) recommends incorporating the procedures described by Stokes and Baer (1977) for facilitating generalization. More specifically, Kazdin (1982) suggests fading in reinforcers (e.g., praise) that occur naturally in the environment, increasing delays to and schedules of reinforcement, involving peers and caregivers in delivering reinforcers, and conducting training across environments and stimulus conditions to encourage generalization.

Potential Limitations of Token Economies

Token economies harness much of what we know about arranging effective instructional and therapeutic contingencies, as verified by hundreds of studies. Still, in relation to other behavior change systems, they do incur some costs, which warrants a consideration of their relative benefits and costs in relation to other contingency arrangements.

Unlike the simple provision of immediate tangible reinforcers, token economies require one to train the recipients of intervention to use the token system. This added time detracts from instructional time during which the client might otherwise be acquiring skills via direct tangible reinforcement. Thus, training might result in a delay in the onset of intervention for some behaviors, especially those the token economy will target. However, time spent in training might reduce time that could potentially be spent managing problem behavior related to the use of nontoken reinforcers (e.g., unprogrammed delays to reinforcement, immediate unavailability of reinforcers).

Also, when used to their greatest potential, token systems require continuous monitoring and frequent adjustment of many moving parts (e.g., schedules, backup reinforcers). One generally starts a token system with a dense schedule of contrived reinforcement that bears little resemblance to the circumstances under which that performance is expected to persist in the future. To eventually approximate the target natural contingencies, one is required to change the system based on performance and the changing needs of the client's repertoire and environment. Additionally, if responding in a token economy begins to degrade, there are many potential components to evaluate and manipulate to restore responding. Among the possible issues are whether one or more of the backup reinforcers are no longer potent, whether one of the three schedules has been thinned too rapidly, and whether treatment integrity has been compromised.

Matson and Boisjoli (2009) outlined several criticisms launched against the use of token economies. One involves potential ethical concerns surrounding the use of response cost within a token system, which carries the same risks as any other punishment procedure. As such, it is possible that the individuals managing the token economy (e.g., teachers, therapists) might find implementing response cost negatively reinforcing, which might result in an overuse of response cost and similar punishment procedures. Thus, a response cost embedded within a token economy can result in the same negative side effects as any other punishment procedure, including aggression, emotional responding, and discriminated avoidance of individuals and stimulus conditions associated with the procedure. However, Matson and Boisjoli point out that few token economies include a response cost component.

Another criticism is that ethical and clinical standards of care for psychiatric patients have changed, and there is a possibility that tokens are not considered appropriate for this population. They may also be difficult to maintain by staff and thus are not feasible. As such, Glynn (1990) posed that the efficacy of token economies in these settings was not properly disseminated, but also that the ethical and feasibility barriers may have been too great to implement in these settings.

Others have expressed concerns that token systems, like all other contrived reinforcement systems, might reduce internal motivation to engage in the targeted activity (i.e., overjustification effect; Deci, 1971; Kohn, 1993). However, researchers using single-subject designs have repeatedly demonstrated that there is little evidence that external reinforcement systems like token economies, as used in applied behavior analytic research, produce a systematic decline in targeted behavior (Levy et al., 2017; Peters & Vollmer, 2014). Even so, teachers and parents who are unaware of such research may be unlikely to collaborate on or consent to token research, respectively. As such, these and other such reservations about token economies might have further contributed to the decline in applied token research.

Such concerns and limitations are genuine and require attention. Despite the above-noted decline in token-oriented research, a variety of questions clearly remain to be addressed. Nonetheless, token economies have been found to be effective across numerous settings and circumstances. The rich literature on their use has shown that they can be successful in diverse applications that can be tailored to suit individual therapeutic and educational needs. As summarized by Matson and Boisjoli (2009), "the technology is powerful, efficient, and largely has been able to deal with critical comments. Thus, we see no substantial clinical justification for the decreased use of token economies."

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32 Discrete Trial Instruction

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Discrete trial instruction (DTI), also called discrete trial training (DTT; e.g., Tarbox & Najdowski, 2008), is an instructional paradigm rooted in behavior analysis first proposed as a method for teaching verbal language to individuals with autism spectrum disorder (Lovaas, 1977; Lovaas & Smith, 1989). It has since been expanded to promote the acquisition of a wide variety of skills, including verbal and nonverbal communicative behaviors (e.g., Koegel et al., 1988), academic skills (e.g., Carroll et al., 2016), and adaptive behaviors (e.g., Downs et al., 2007). DTI is built upon the foundation of operant conditioning (Cooper et al., 2020), which posits that the consequences following our behaviors shape their future likelihood and those behaviors that contact pleasurable consequences (i.e., reinforcement) are more likely to be exhibited again. Whereas more traditional instructional paradigms rely on naturalistic contingencies of reinforcement for their success, DTI takes a more intentional approach by providing learners with many more opportunities to respond (OTRs; e.g., Haydon et al., 2012) and ensuring each opportunity ends with the learner contacting reinforcement for accurate responding.

In DTI, each OTR is labeled a trial, which represents the smallest unit of learning within the instructional paradigm. Sessions of DTI involve the delivery of many consecutive learning trials and it has sometimes been referred to as "massed-trial instruction" for this reason (e.g., Majdalany et al., 2014). There is evidence to support the notion that higher rates of OTRs are linked to increased academic engagement and student learning (e.g., Common et al., 2020). As we will describe later, instructional pacing and inter-trial intervals are important variables within effective DTI programs. Although it is typical to deliver blocks of massed trials targeting a single skill or behavior in order to create behavioral momentum (Nevin et al., 1983), it is not uncommon to rotate through several target skills within a single treatment session by devoting each new block of trials to a different skill. Selecting which skills to target within a DTI paradigm is also very important and involves a combination of indirect assessments (e.g., interviews, rating scales) and direct assessment (e.g., observations, skill probes). A learner's current target skills and future planned targets comprise their instructional program, which can be likened to an individualized curriculum. Goals and objectives can be set based on this curriculum, allowing instructors and stakeholders to make data-based decisions about learners' progress through their program. In sum,

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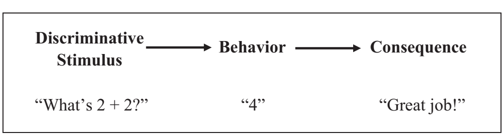
J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_32

DTI represents a data-based instructional paradigm through which instructors can model small changes in learner behavior to inform instructional modifications and drive socially desirable change.

The remainder of this chapter will expand on the preceding two paragraphs to provide readers with a deep understanding of DTI and the literature supporting it as an instructional strategy. We begin with a brief overview of the behavior analytic principles underlying the effectiveness of learning in a discrete trial format. Next, we review several critical considerations for effective DTI related to the structure and process of treatment sessions, data collection, and program evaluation. Third, we provide a broad review of the literature supporting DTI across a variety of environmental and learning characteristics, such as setting, population, and behavioral target as well as potential barriers to effectiveness (e.g., training requirements, generalization). We conclude with an example of DTI program development and implementation.

Behavior Analytic Principles

As mentioned previously, DTI is built upon the principles of operant conditioning and behavior analysis. Specifically, each trial within DTI is comprised of three distinct components: (1) an antecedent prompt (i.e., discriminative stimuli) signaling to the learner that a specific response is requested; (2) the response exhibited by the learner; and (3) positive reinforcement contingent upon the response. These three components make up the three-term contingency (e.g., Albers & Greer, 1991) and we have provided a visualization of how this is conceptualized within an instructional environment. Each of these components is described in more detail below.



Discriminative Stimuli

Discriminative stimuli (abbreviated S^D) are antecedent stimuli that signal to an organism that a specific behavior is likely to be reinforced (e.g., Cooper, Heron, & Heward, 2020). In the example above, "What's 2 + 2" serves as the S^D for the response of "4." One non-academic example is an "OPEN" sign in the window of a storefront, signaling that your attempted entry into said store will be reinforced. In naturalistic settings, S^Ds are not perfect indicators that reinforcement is available. For example, the "OPEN" sign may have accidentally been left facing the street when in fact, the store is closed and the door is locked. Similarly, answering the question "What's 2 + 2?" with "4" may not always result in a reinforcing consequence (i.e., "Great job!"). Instead, there may be no apparent consequence at all, or a punitive one (e.g., "Duh, everyone knows that"). It is also important to note that specific stimuli do not universally function as S^Ds for all organisms. Instead, they are shaped into S^Ds through repeated pairings with a consistent consequence or shared through the specification of verbal contingencies (e.g., "If the sign says 'OPEN' the door should be unlocked"). Thus, it is our unique learning histories that form three-term contingencies and the stimuli that signal their availability.

This is important to keep in mind when considering DTI as an instructional paradigm. Each skill or behavior targeted within DTI will be associated with a specific antecedent prompt. The purpose of DTI is to establish new three-term contingencies through repeated pairings (i.e., massed trials) of the prompt, the response, and a reinforcing consequence. The goal is to shape the antecedent prompt from a neutral stimulus into an S^D that signals to the learner that engaging in the skill or behavior will result in reinforcement. Furthermore, because the aim of DTI is to promote skill acquisition across a variety of settings, it is important to choose an antecedent prompt that learners are likely to encounter outside of the teaching environment. For example, consider the social skill of greeting others (e.g., making brief eye contact and saying "Hello"). It would not be appropriate to select "Show me how to say hello" as an antecedent prompt for this behavior. Even though it may appear appropriate within the context of learning and is likely to evoke greeting behavior from most individuals, it is not contextualized within a social interaction and does not represent the likely S^D for this behavior in naturalistic settings. In other words, a learner is unlikely to hear "Show me how to say hello" outside of the instructional setting and would likely not respond to a more naturalistic greeting (e.g., "Hi, [NAME]") because it was not introduced during the learning process. Instead, selecting something like "Hi, [NAME]." as an antecedent prompt for greeting behavior is likely to result in opportunities to exhibit the behavior in naturalistic settings.

There is some debate about whether to use a range of antecedent prompts (e.g., "What's your name?" and "Who are you?") or one prompt for a single skill. The single prompt proponents suggest that too much variability in the form of antecedent prompts may prohibit learning by slowing the establishment of clear three-term contingencies (e.g., Grow & LeBlanc, 2013). Other suggest that while variability in prompt form may impede initial acquisition, it is critical if learners are expected to exhibit the skills learned in DTI across the wide variety of settings and naturalistic stimuli, they are likely to encounter once instruction concludes (Leaf et al., 2016). The most practical recommendation is to begin instruction of a new skill with a single prompt and allow the learner to demonstrate mastery with that prompt before introducing variability using multiple exemplars (Stokes & Baer, 1977).

Response

Because DTI is used primarily to promote skill acquisition, the behaviors targeted within an instructional program are unlikely to be within a learner's repertoire and a response to a target skill's antecedent stimulus, if one occurs at all, is likely to be incorrect. A response that does not occur cannot be reinforced, leaving DTI instructors repeating the antecedent prompt over and over again waiting endlessly for an opportunity to reinforce the learner's correct responding. Fortunately, the antecedent prompt is only the first in a hierarchy of prompts provided to learners, allowing instructors to implement a DTI program with more fluidity than otherwise would be possible.

Prompting hierarchies establish a progression of additional prompts exhibited by the instructor should the learner fail to exhibit a correct response following the initial antecedent prompt. Prompts can be classified into topographical categories, the most common of which are verbal, gestural, model, and physical. Within DTI, verbal prompts include any verbal stimulus provided subsequent to the initial antecedent prompt. For example, given the antecedent prompt "What's the capital of Florida?", a subsequent verbal prompt might be "T-," "Tal," or "Tallahassee." Gestural prompts include any gesture (e.g., pointing, facial orientation, nodding) by the instructor to indicate to the learner the correct response. For example, when presented with an array of two colored cards, one red, one green, and the antecedent prompt of "Touch green." A subsequent gestural prompt might involve the instructor pointing toward the green card. A model prompt involves the instructor exhibiting the correct response for the learner to observe. For example, given the antecedent prompt "Clap your hands," a subsequent model prompt would see the instructor clapping their hands to show the learner what the expected behavior looks like. Finally, physical prompts involve the instructor using hand-over-hand guidance to assist the learner in exhibiting the correct response. For example, given the antecedent prompt "Clap your hands," a subsequent physical prompt would have the instructor gently taking the hands of the learner and clapping them together. Physical prompts can be partial or full, meaning that the instructor provides some physical guidance (e.g., brings learners hands up and ready to clap) or complete physical guidance (e.g., the learners hands are clapped for them).

Within DTI, prompts are typically arranged in hierarchies (e.g., most-to-least or least-to-most) by their level of intrusiveness. For example, a least-to-most hierarchy might arrange prompts in this order: (1) gestural prompt, (2) model prompt, (3) partial physical prompt, and (4) full physical prompt, whereas a most-to-least might have them reversed. Learners who do not respond correctly to the initial antecedent prompt would receive the next prompt in the hierarchy, continuing through each prompt type until they responded correctly. Learners requiring a full physical prompt to exhibit a behavior are still considered to have provided a correct response, just with a very intense level of prompting required. As we will discuss later, it is important to record which prompt type was necessary to evoke a correct response from the learner as progress within DTI programs is often exhibited by demonstrating increases in the percentage of trials in which a learner responded correctly and independently (i.e., no prompts required in addition to the initial antecedent prompt); however, progress may also be exhibited by demonstrating that a learner who previously required full physical prompts to respond correctly now only requires a model or gestural prompt.

Research investigating the relative effectiveness of the different prompt types and prompting hierarchies within DTI suggests that any differences are idiosyncratic (e.g., Seaver & Bourrret, 2014). For all prompt types, it is very common for the initial antecedent prompt to be repeated with whichever prompt is being used. In this way, the initial antecedent prompt is still paired with the correct response and subsequent reinforcement. In addition, instructors can build a fixed or progressive time delay into their prompting procedures, meaning that learners are given a brief period of time (e.g., 3 s) to exhibit the correct response before a subsequent prompt is provided. This time period is meant to reduce learner dependence on prompts and allow them to contact reinforcement more quickly should they exhibit the response independently compared to waiting for the next prompt (e.g., Soluaga et al., 2008).

Consequence

The final component of the DTI trial is the reinforcing consequence. When a learner exhibits a correct response following a prompt from the instructor, their response is reinforced to strengthen the three-term contingency. Often, and especially when a new skill is introduced, the schedule of reinforcement is very thick or continuous (e.g., FR1), meaning that each correct response by the learner contacts' reinforcement. As a learner acquires a skill and begins to exhibit it more reliably and with less intrusive prompts, an instructor may consider thinning the schedule of reinforcement (e.g., FR2, FR5) and switching to a variable schedule that approximates naturalistic conditions. When considering the stimuli that will be used for reinforcement, instructors have several options.

First, it is often recommended that DTI instructors attempt to condition their presence and attention as a reinforcer. This process is known as pairing and Lugo et al. (2017) describe a systematic pairing process that includes close physical proximity, frequent verbal praise, reflections of the learner's verbalizations, imitation of the learner, description of the learner's play behavior, and initiation and creation of play with the learner. Pairing allows the instructor to use differential delivery of praise and other attention to the learner as reinforcement instead of tangible or edible stimuli that may not be feasible or appropriate. With that being said, preference assessments and reinforcer assessments (e.g., Cannella et al., 2005) of tangible and edible stimuli can provide insight into what stimuli may be used within a DTI program to reinforce correct responding. Finally, token economies (Matson & Boisjoli, 2009), in which arbitrary stimuli (i.e., tokens) acquire reinforcing properties because they can be exchanged for primary reinforcers (i.e., edible or tangible stimuli), have been used frequently to establish and maintain DTI programs (Haq et al., 2015).

Considerations for Implementation

Successful DTI implementation depends on first clearly defining the learning objective. Skills and behaviors that are appropriate for DTI typically display a clear beginning, middle, and ending. An example of a suitable behavior for DTI intervention might be writing at least five words on a sheet of paper with a pen or pencil when asked to start writing. Notice that we can identify a clear antecedent to the target behavior for this example—in this case, the verbal prompt to begin writing. As mentioned previously, antecedent prompts are typically explicit, succinct verbal instructions. Once the target behavior and its antecedent(s) are clearly identified and operationally defined, a specific criterion for mastery must be established as well (Bogin et al., 2010). We might stipulate mastery of the writing skill to be complete when the individual writes at least five words, at three out of four (75%) opportunities in a single week, across two or more teachers.

What distinguishes the DTI framework from other instructional methods is its emphasis on "chunking," or breaking down complex skills and behaviors into small steps that can each be taught independently. Progress in a DTI intervention resembles ascent on a stairwell with each step progressing from a simpler task toward a more advanced skill set. A task analysis is typically performed to determine what steps a task should be divided into (Cohen et al., 2006; Eikeseth et al., 2002). To return to our previous example, we might break the target behavior (writing five words when prompted) down into the steps outlined below. Note that the same criterion for mastery (e.g., *learner performs task at 75% of opportunities in a single week across two or more teachers*) should be implemented at each step before progressing to the next level:

1. Learner puts pencil to paper when provided multiple prompts.
2. Learner puts pencil to paper when verbally prompted once.
3. Learner writes 1 or more words when provided multiple prompts.
4. Learner writes 1 or more words when verbally prompted once.
5. Learner writes 3 or more words when verbally prompted once.
6. Learner writes 5 or more words when verbally prompted once.

DTI is typically administered by a single teacher who works one-on-one with a learner. Discrete trials are usually kept short and follow the same pattern: teacher cues for target behavior, prompts if necessary, and immediately reinforces the learner's response (Smith, 2001). After a short pause (i.e., inter-trial interval; e.g., 3–5 s), the instructor provides another antecedent prompt for the response again. Each trial has a definitive beginning (i.e., initial prompt) and end (i.e., delivery of reinforcement), and is typically followed by a brief break before beginning an additional trial or set of trials. The inter-trial interval between the end of one trial and the beginning of the next trial should be kept relatively short to maintain a steady pace of instruction. It is recommended to deliver trials in a rapid manner, with about 2–3 s between each trial (Koegel et al., 1980). In this way, the learner is given frequent OTRs, repeated reinforcement for correct responding, and behavior momentum is built. Longer pauses between trial deliveries (i.e., breaks) can be given after entire blocks of trials are completed.

DTI interventions' time- and content-intensive nature makes organizing materials a key priority in successfully carrying out teaching sessions. There should be very little time elapsed between a learner's correct response to a previous prompt and a teacher's prompt for the following response. Moreover, data must be collected trial by trial by the teacher or, if possible, by an independent observer. For each trial, instructors should note whether a correct response was produced by the learner as well as the level of prompt necessary to produce a correct response. These data are then converted to the percentage of trials in which an independent correct response was produced. It is recommended that data collection sheets be tailored to the specific set of behaviors being taught and specific prompting method and hierarchy employed (Bogin et al., 2010). DTI's intensive format provides for many learning opportunities for the learner, up to 10 or 12 per minute. The pattern of continuous, repetitive reinforcement of correct responding is theorized to strengthen target behaviors through operant conditioning. In addition, since instructors and learners typically work one-on-one, DTI interventions can be constructed explicitly by tailoring prompts and reinforcers to meet individual students' needs. These characteristics make DTI a particularly effective way to teach students new behavioral repertoires in an accelerated fashion (Smith, 2001).

Evaluating Progress and Determining Mastery

As with any instructional method, it is of interest to the DTI instructor to determine how effective they have been in promoting skill acquisition within a learner. Fortunately, DTI's objective instructional procedures are conducive to data collection and allow instructors to examine even small changes in learner behavior over time. To evaluate acquisition and mastery of a skill, it is important to have a data collection tool and method to evaluate the learners' progress. Data collection sheets should include information on the target skill, date of target introduction, date of each probe, date of mastery, and level of prompting for target response (see Fig. 32.1 for an example). Data collection should take place following each probe of a target skill for the session. For example, if the learner independently emits the correct response with no prompting within 3 s following the S^D, the instructor would record that trial as a correct independent response. If the learner does not emit the correct response within 3 s following the S^D and requires further prompting, the level of prompt needed for the learner to exhibit a response would be recorded. An incorrect response can include any response other than the target response, the target response chained with another response, a self-corrected response, no response at all, or the target response with a latency longer than 3 s. Defining what constitutes a correct and incorrect response requires the instructor to consider what variations in responses, if any, would be functional outside of the learning environment.

As mentioned previously, data collection during DTI may be as simple as recording the level of prompt necessary for a learner to exhibit a correct response for each trial. Acquisition goals will often be set on this indicator of performance and progress toward these goals can be reflected through a linear graph with the percentage of trials with correct independent responding on the *Y*-axis and sessions on the *X*-axis. Figure 32.2 provides an example of what these data would look like for a single skill probed ten trials each session. For this method, a minimum of five or ten trials should be run for each skill per session. Because DTI sessions typically involve conducting many more than five trials per skill per session, it is common to use the first few trials (e.g., five or ten) of the session as the evaluation probes. These are known as "cold probes" and are thought to best represent the learner's performance outside of the learning environment and before they have been given the opportunity to "warm up" to the session. After all evaluation probes for the skill have been conducted, the percentage of correct responses should be calculated. A common acquisition mastery goal is 90% or more trials with correct independent responding across two or three sessions. Of course, these goals can be changed to accommodate the idiosyncrasies that each learner will bring to DTI session; however, it is important to set goals stringent enough to ensure that the learner has in fact acquired the skill. All data on skill acquisition should be graphed to represent at least weekly progress in order to evaluate the number of skills acquired and consider the need for modifications in the programming. Learners should be making reasonable progress based on their developmental level and number of service hours being provided.

Beyond mastery, target skills should be probed periodically for maintenance over time. Maintenance probes can occur on a less frequent schedule (e.g., once per week, once per month). If the data indicate a decrease in accuracy, the target should be added back into the learner's

DTI - Data Collection Sheet

Learner:________________ **Date**:__________ **Session**:____________

Skill: Color Discrimination

Stimuli: Four identical blocks varying only in color arranged in a line on the table in front of the learner

Verbal Prompt: "Point to the [COLOR] block."

For each of the first ten trials, circle whether learner exhibited correct independent response [Y] or not [N]. If [N], place a check mark under the most intrusive prompt required for that trial.

Trial	Independent Correct	Gestural	Model	Physical
1	Y N			
2	Y N			
3	Y N			
4	Y N			
5	Y N			
6	Y N			
7	Y N			
8	Y N			
9	Y N			
10	Y N			

Fig. 32.1 Sample skill acquisition data collection sheet

instructional programming. It is also important for mastered target skills to be probed for generalization. The target should be probed in various settings (e.g., classroom, playroom, outside), with different individuals (e.g., teacher, parent, other adult), using multiple exemplars (e.g., different pictures, physical objects, different materials), and with various instructions (e.g., point to yellow, show me yellow, which one is yellow). If the data suggest that a skill is exhibited by a learner accurately in one setting but not others, more intentional generalization strategies can be employed (see section "Limitations" below).

Empirical Support

There is a large body of literature supporting DTI as a generally effective instructional strategy; however, it is almost exclusively used with individuals with autism spectrum disorder, intellectual disabilities, and other developmental disabilities. Several meta-analytic studies have

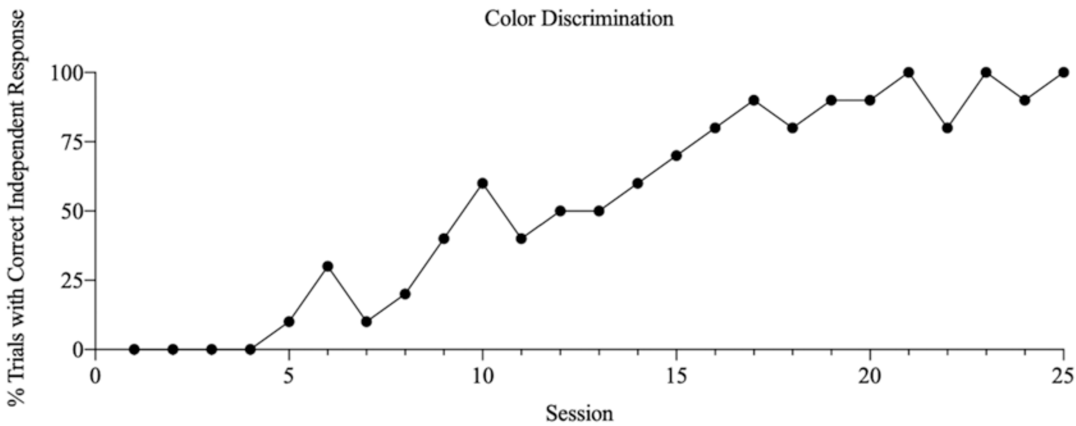


Fig. 32.2 Sample linear graph of a learner's progress toward accurate color discrimination

investigated the effectiveness of DTI and reported positive outcomes in these populations. For example, Kane et al. (2010) evaluated the effectiveness of spoken language interventions developed for children on the autism spectrum. The meta-analysis compared 22 different studies composed of either contrived teaching approaches (e.g., DTT) or naturalistic approaches in terms of their effects on the generalization and maintenance of learned skills. The meta-analysis results indicated that both methods were considered effective, but that DTI-like approaches demonstrated greater generalization effects in the children with ASD, suggesting a preference for teaching style in this population to generalize learned skills (Kane et al., 2010).

Virués-Ortega (2010) examined the effectiveness of long-term, comprehensive ABA interventions in populations of children with autism or pervasive developmental disability not otherwise specified. In this meta-analysis of 22 studies, the researchers synthesized the literature supporting intensive behavior analytic treatment programs based on DTI (e.g., one-to-one format, individualized intensive intervention). They found medium-to-large positive treatment effects for DTI interventions "in terms of intellectual functioning, language development, acquisition of daily living skills and social functioning in children with autism" (Virués-Ortega, 2010, p. 387). Another meta-analysis by Peters-Scheffer et al. (2011) evaluated the effectiveness of early intensive behavioral intervention (EIBI) in children with ASD. EIB is based on ABA methods and includes DTI practices. The researchers found that, across 11 studies, experimental groups that received EIBI "outperformed the control groups on IQ, non-verbal IQ, expressive and receptive language, and adaptive behavior" (Peters-Scheffer et al., 2011, p. 60). In sum, it is clear that DTI is an effective instructional method to promote skill acquisition and intellectual functioning within these populations.

Regarding the types of skills targeted by DTI, it is often used to promote "fine and gross motor skills, recreation, self-care, cognitive, and academic skills" (Bogin et al., 2010, p. 1). One of the most common targets of DTI is communication, either verbal or nonverbal, reflecting one of the primary deficits and diagnostic features of ASD. Paul et al. (2013) compared the effectiveness of a DTI approach to a more naturalistic approach for spoken language acquisition in preschoolers with ASD. They found that although both treatments performed similarly in terms of overall effectiveness, the DTI method resulted in larger treatment effects for those children with poorer receptive language. In addition to language and communication, DTI has been used to promote learners' social behavior (e.g., Jennett et al., 2008), academic skills (e.g., Carroll et al., 2016), and adaptive behaviors (e.g., Downs et al., 2007).

DTI has also shown to be effective across various settings, such as in-home, school, and community settings (e.g., Devlin & Harber, 2004). Moreover, researchers demonstrate the utility of DTI in both individual and small group settings. For example, Devlin and Harber (2004) incorporated DTI in one-to-one settings. The researchers first implemented structured DTI sessions in the students' home and school settings. Upon mastery of the targeted skills, the DTI sessions were carried over into the student's natural environment in the greater community. Students who received this intervention showed improvement in various skills related to attention, imitation, receptive and expressive language, pre-academic, and self-help (Devlin & Harber, 2004). Similarly, Taubman and colleagues' (2001) study incorporated DTI in small group settings. This study was conducted in a preschool classroom of eight developmentally disabled children and extended one-on-one discrete trial teaching to an environment with group instructions. The findings showed that the group DTI method was useful in establishing various educational skills, such as language and pre-mathematics skills (Taubman et al., 2001).

Finally, because of the relative simplicity of DTI's core procedures compared to other therapeutic or instructional methods, individuals require only basic training to become effective DTI instructors. Sarokoff and Sturmey (2004) demonstrated that a behavioral skills training (BST) package consisting of instruction, modeling, roleplay, and feedback was sufficient to improve the fidelity of three teachers' implementation of DTI to an average of 98%. Similarly, Radley et al. (2015) used behavioral skills training to teach high school seniors how to implement a DTI program with their peers to teach functional skills and adaptive behaviors. Leaf et al. (2019) conducted a systematic review of 51 studies examining techniques to train DTI instructors and found that students, therapists, paraprofessionals, parents, and individuals with ASD were all capable of becoming proficient instructors within a DTI framework (Leaf et al., 2019). Therefore, although long-term implementation of DTI may appear complex and intensive, the literature supports it as a feasible strategy due to the relatively low training demands compared to more complex psychological treatments.

Limitations

Despite its widespread implementation and effectiveness, there are several limitations of DTI that warrant consideration. First is the lack of authenticity within the learning setting. The environment in which DTI is conducted is in itself unnatural, or contrived, and highly controlled (Smith, 2001). This could make it difficult for the behaviors learned through DTI to transfer into natural situations (i.e., generalization). Generalization of the skills learned in DTI is important to ensure the skill will be used in a variety of settings to increase student functioning in areas other than a controlled setting. Making DTI sessions more like the natural conditions the learner will experience will help increase student practice of the skills, and hopefully utilize the skill taught in DTI in more than just one specific prompt (Cowan & Allen, 2007). An emphasis on the generalization of skills is also one aspect that is representative of an effective intervention with children who have ASD (Steege et al., 2007). In DTI, generalization has to be explicitly taught or the student will only respond to the prompts they have been working on in the previous sessions. Naturalistic approaches use natural consequences, diversity in training, and the incorporation of mediators of training to help increase generalization of the skill taught in DTI (Cowan & Allen, 2007). Using naturalistic modifications to DTI can help increase the generalizability of skills taught within sessions (Cowan & Allen, 2007; Steege et al., 2007). Some naturalistic approaches that have been used alongside DTI are incidental teaching, pivotal response training, and script-fading (Cowan & Allen, 2007).

Implementing DTI also requires a significant amount of resources from staff members. According to Smith (2001), it is not uncommon for DTI programs to be implemented for up to 35–40 h per week. DTI is a core component of early intensive behavioral intervention (EIBI) for children with ASD (e.g., Reichow et al., 2012), which, true to its name, is very time intensive, often being implemented for 20 or more hours each week. DTI allows instructors to provide a large amount of material to most accurately meet a learner's needs, but this individualization takes a large amount of the student's time. Staff members are also limited to the resources available, including availability of time, space, and materials. Although the core concepts of DTI are not complex, instructors may be required to undergo more intensive training to increase their understanding of the more nuanced aspects of DTI, including how to chunk trials appropriately and how to provide appropriate reinforcement. For these reasons, it is most common to see DTI programs implemented in a clinical setting, as opposed to a school and instructor burnout becoming a more frequent topic of study (e.g., Griffith et al., 2014).

Example of DTI Program Development

We conclude this chapter with an example of how DTI can be implemented programmatically and have intentionally selected verbal behavior as a point of example due to its popularity within the DTI community. Verbal behavior DTI programs are frequently developed to address the broad domains of functional language, or verbal operants. Specifically, individuals rely on both receptive and expressive language objectives as they expand their ability to communicate with others. Practitioners are tasked with examining the presence and absence of skills across receptive and expressive verbal operants as they design verbal behavior programs, which begins with conducting skill assessments. Data collected from comprehensive verbal behavior evaluations can allow the development of a curriculum tailored to the needs of the individual learner. Verbal behavior assessments provide stakeholders insight into skills that need to be taught or targeted and areas of proficiency for the learner.

Verbal behavior skill assessments evaluate linguistic milestones of an individual. By determining if an individual has reached a specific developmental benchmark, practitioners can assess if the individual is primed for advancing forward. A practical approach to understand more about an individual's language skills is to systematically examine their abilities across the verbal operants. An individual's ability to make requests, or manding repertoire, can provide insight into the potency of reinforcement and personal motivation for emitting verbal behavior. Armed with knowledge of how establishing operations impact language, gathering knowledge regarding the ability to imitate sounds can influence subsequent assessments (e.g., Speech Sound Assessments; Articulation Assessments). Sundberg and Michael (2001) highlight a learner's demonstration of tacts as being related to "the nature and extent of nonverbal stimulus control over verbal responses, and a systematic examination of the receptive and intraverbal repertoires will show the control by verbal stimuli" (p.706). Practitioners can further define areas of concern by discovering the presence of "splinter skills." Specifically, individuals presenting high functionality in one area may be masking deficits in another area, which can potentially have long-term impacts on overall language competency.

An iconic example is Sundberg's (2007) Verbal Behavior Milestones and Placement Program (VB-MAPP). Purposed to evaluate children from 0 to 48 months, practitioners can identify gaps in a child's functional language development. This criterion-referenced assessment can provide instructors with insight into the skills of their learner and the skills of a learner acquiring language typically in their natural environment. This comprehensive evaluation tool consists of three individual assessments investigating a child's current verbal repertoire, barriers that may be impeding progress for the child, and areas that may impact meaningful progress. In addition, practitioners can consult numerous task analyses to guide skill tracking for programming targets. Stakeholders can also obtain guidance for recommending individualized educational program (IEP) goals. Progress monitoring is built into this tool through quarterly administrations, making program evaluation an essentially embedded component.

Although individuals exposed to verbal behavior programming demonstrate promise and perhaps even progress with each correct response during DTI, these are not synonymous with mastery of a skill. An individual can demonstrate skill mastery through fluency and generalization of the skill outside of the learning environment. In addition, proficiency is measured as an individual continues to reliably demonstrate the skill over time. Establishing regular data collection procedures explicit to determining mastery of target skills being taught and skills recently acquired is considered best practice. On a weekly basis, reviewing the current targets across single trials, often called probes, prior to provide any teaching can inform an individual's level of mastery. More specifically, practitioners can analyze responding during weekly probes, across time to guide decisions regarding introducing new targets, and the need for teaching modification when targets are resistant to mastery.

Identifying barriers impending with skill acquisition is vital to continued progress throughout verbal behavior programs. Practitioners could conduct formal assessments to determine which behaviors or individual deficits may be contributing to a lack of growth. Recognizing specific obstacles can directly inform individual interventions or strategies necessary for skill acquisition. For example, if an individual is overly dependent on prompts for correct responding when presented a target, the stakeholder can examine prompt fading to move closer to skill acquisition.

Teaching procedures of DTI follow a highly structured format that allows for complex skills to be broken down into sub-skills that can then be targeted and mastered (Tarbox & Najdowski, 2008). Sub-skills are categorized by student responses which allow for intensive support to be provided based on individual need paired with repeated practice for effective teaching. For example, a student would be presented with a given stimulus and then has an opportunity to respond to that stimulus. The student's response is then paired with the appropriate consequence. A correct response would receive immediate reinforcement that can come in multiple different forms based on student preference (praise, tangible items, etc.). Incorrect responses or failures to respond are paired with the absence of a reinforcer and this can look like inattention to their response, offering feedback on their response, or just simply not giving them a reinforcer at all (Tarbox & Najdowski, 2008). DTI is considered unique in its ability to use direct, explicit instruction that focuses on skill development within a process and targets individual needs at the most basic level to then attain the complexity of the skill.

To effectively use DTI, it is crucial to acknowledge the environment in which the teaching will take place and refrain from any aversive factors that may occur. As an explicit instructional paradigm that is informed through student responses, the environment should maximize student engagement while isolating the specific consequence that is paired with the response. It is also critical that those who engage with DTI are proactive when pairing a student with a teacher and environment and provide careful consideration for external factors that may impact the outcomes of the student (Haydon et al., 2012).

Mands are responses dictated by the desired reinforcement (Skinner, 1957). Specific reinforcement is the response consequence, while the establishing operation serves as the controlling variable when learners emit a mand. Despite being commonly described as a request for an item, mands can also demand information or the removal of nonpreferred stimuli. A learner that can effectively request stimuli demonstrates a level of control over their own environment; as such, this operant is often addressed first. Skinner (1957) suggests that by demonstrating the utility of verbal behavior to the learner through mand training, the value of emitting verbal language increases for the learner. Another reason to begin programming around mands pertains to the ease with which motivation can build using preferred items (e.g., toys, candy, snacks).

Verbal stimulus without point-to-point correspondence or formal similarity is considered an intraverbal. Following this type of response, the learner is provided nonspecific reinforcement, or a generalized conditioned reinforcer (e.g., tangible item, adult attention, break from demand). Finishing a verse of a nursery rhyme, providing remaining elements of a sequence (e.g., "Ready, Set, ___"), and XXX are all examples of intraverbal responses.

The controlling variable for the echoic verbal operant is verbal stimulus with point-to-point correspondence and formal similarity. More simply, when an individual imitates a sound, word, or phrase, they have emitted an echoic response. This verbal operant is met with a nonspecific reinforcement during teaching trials.

When using DTI, teachers should also mix prompts or tasks given to the student. In behavioral momentum theory, there is an emphasis on "building momentum" of a behavior by asking students to do tasks that often come before the more complex task (Podlesnik & Shahan, 2010). In this theory, students tend to comply with difficult and low-probability instructions by building momentum through easy and high-probability instructions that the student has already mastered. Using tasks the student has already mastered will help scaffold as well as reduce frustration of starting an entirely new task. When using these previously mastered tasks, it is also important to continue reinforcement to reduce the ratio strain. When there are large gaps of time without reinforcement, the student may not have any response. To avoid this, teachers using DTI should be prompting and reinforcing at a regular rate that is developmentally appropriate for the student they are working with.

Conclusion

DTI is a popular and effective instructional paradigm, particularly for teaching verbal behavior and other communicative skills to individuals with ASD and other developmental disabilities; however, because it is rooted in basic behavior analytic principles, DTI's effectiveness transcends the population and target skills for which it is typically used. With the primary goal of establishing and maintaining functional three-term contingencies between naturally occurring antecedent stimuli, adaptive behaviors and skills, and reinforcing consequences, DTI is clear in its purported mechanism of change. Due to this, DTI has been incorporated into large-scale programmatic treatment efforts to address developmental delays in young children (e.g., EIBI, UCLA model) and has proven successful in doing so. Although efforts to promote generalization of learned skills outside of the instructional environment have been effective, it remains one of the primary concerns of the long-term viability of DTI.

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33 Group-Based Instruction

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Introduction

In 1948, B.F. Skinner published his utopian novel, *Walden Two*. It describes a commune in the rural American East developed and sustained entirely through behavioral engineering. Through the first-person account of Professor Burris, we learn about Walden Two from Frazier, the founder of Walden Two. Over the course of the story, Frazier describes how experimental behavior analysis was used to create a community that encourages "people to view every habit and custom with an eye to possible improvement. A constantly experimental attitude toward everything" (p. 82). As a result, Walden Two is a community of intelligent, caring, artistic, and content individuals living very happy and healthy lives together. As Frazier notes, "the potency of behavioral engineering can scarcely be overestimated. It makes one wonder why the techniques haven't been put to better use long before this" (p. 399).

Although fictional and, without a doubt, utopian, Skinner used *Walden Two* to describe the potential value, behavior analysis can have on large groups of individuals; how the principles of behavior, with a commitment to experimental analysis, can meaningfully improve collective outcomes for all. Setting aside Skinner's radical behaviorism and any desire to reimagine society, there is an important lesson to be gleaned from *Walden Two*: the principles of behavior can be successfully used with groups of individuals to meet desired outcomes. It is the overly simple summation that we shall explore in this chapter, namely, how the principles of behavior, as enacted through applied behavior analysis, have been used to change the behavior of groups of individuals. Below, we will provide a brief rationale for working with groups and the benefits of doing so. We will then describe research in a variety of applied areas, with a focus on school settings and children. Overall, our goal is to highlight how applied behavior analysis has been applied to groups and the subsequent resulting benefits.

Rationale

There is overwhelming evidence that socially important behaviors can be changed (e.g., Hanley et al., 2003). In fact, Baer et al. (1968) note in the first sentence of their seminal paper that "the analysis of *individual behavior* [emphasis added] is a problem of scientific demonstration… reasonably well understood" (p. 91). As such, the unit of analysis in most applications of ABA is the individual and their behavior. For example, Lang et al. (2010) used functional analysis to develop a treatment to reduce elopement behaviors demonstrated by a 4-year-old boy with high

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_33

functioning autism. The authors, experimentally manipulated attention, access to a tangible reinforcer, and free play in two settings. Based on functional assessment, the authors found that an attention-based intervention was most salient in a resource-room setting, while a tangible-based intervention was most salient in a classroom setting. The functional analysis was conducted one-on-one with the boy and a therapist, while the interventions based on the functional assessment results were implemented by a teacher. Collectively, the assessment and intervention required extensive staff time and attention.

Elopement is a behavior that may require an individualized intervention, given the dangers the behavior poses and the unique contingencies triggering and maintaining its occurrence. Yet, many other behaviors may not require the same level of intensity and/or specificity. These behaviors can likely be addressed through group-based assessments and interventions. For example, Rasmussen and O'Neal (2006) used a fixed-interval schedule of positive reinforcement by a teacher to reduce verbal classroom disruptions of three students with emotional and behavioral disorders (EBD) in an alternative school. The authors conducted individualized functional analyses and determined that the function of the verbal disruptions for all three students was teacher social attention and developed individualized interventions for each student. Alternatively, Groves and Austin (2017) use interdependent and independent group contingencies class wide to reduce verbal disruptions of four students with EBD in an alternative school. The authors did not evaluate each students' function, but instead evaluated the effect of the group intervention on individual student behaviors. Both studies established a functional relation between the intervention and verbal disruptions. However, one was more efficient, as it was applied class wide.

Group-based applications of ABA are distinct from individualized interventions in that the unit of analysis of the independent variable is a group. We define group broadly to include two or more individuals, and group-based as assessment or intervention focused on a group. For example, a teacher implementing an interdependent group contingency, such as the Good Behavior Game (GBG) (Barrish et al., 1969), conducts the intervention with all of the students in her class. She may be using the intervention to reduce problem behaviors class wide or the problem behavior of an individual student. Regardless, the independent variable is applied to the whole group.

Application of an assessment or intervention to a collective group has a number of advantages. First, group-based ABA can be resource efficient. Well-trained staff, such as Board Certified Behavior Analysts (BCBA), can impact a collective group, increasing the number of individuals and their behaviors impacted by a single staff member. Group-based ABA can also save time. There is no doubt that identifying and experimentally manipulating the function of an individual's behavior will increase the likelihood of behavior change. Yet, when applying practices to a group, conducting individualized functional analyses may not be necessary for all group members. Returning again to the interdependent group contingencies example, the teacher does not know the function of all her students' behaviors and may not have them under stimulus control. Yet, the application of the interdependent group contingency may decrease student behaviors, particularly low intensity problem behaviors, by capitalizing on the natural reinforcers in the classroom (Barrish et al., 1969). Furthermore, applications of more low-intensity group-based interventions by fewer well-trained staff can be used to rule out potential environmental confounds on the intractability of a target behavior and screen individuals within the group in-need of more intensive support. For example, two students in a class exhibit very aggressive physical and verbal aggression toward peers during large group instruction. The teacher then implements a group-based intervention, this time a class wide token economy. One of the students significantly reduces their aggressive behaviors, while the other does not. By first conducting the group-based intervention, the teacher found that for one student, increasing access to reinforcement during large group instruction changed the target behaviors, meaning that the teachers' classroom management may have been the reason for the aggressive behaviors. However, for the other student, access to the class-wide reinforcement was not salient and indicates that the student may need more individualized assessment and intervention. Thus, the token economy was able to identify one student, not two, in need of more intensive supports, thereby saving time and resources. This process is, in fact, the central premise and motivation for school-wide positive behavior interventions and supports (SWPBIS; Sugai & Horner, 2020), a multitiered prevention and intervention framework grounded in ABA and designed to be efficient and effective.

Group-based applications of ABA can also reduce costs. When services are delivered at the group level, the costs of individual behavior change are spread across all involved. For example, Greenberg and Martinez (2008) examined the cost-effectiveness of an ABA-based early intervention model in preschools across 1 year of implementation. The author implemented a group-based discrete trial training using learning units and natural environment teaching (NET) to increase preschool children's correct learning units. The authors found reduced costs per learning unit by delivering the intervention in groups instead of individually. Intuitively, this should be the case for most group-based applications. By reducing resources, saving time, and spreading the individual benefit across the group, significant money saving can be attained.

There are many examples of group-based ABA assessment and intervention procedures. For our purposes, we categorize these procedures by the characteristics of the group. Specifically, research has demonstrated group-based behavior change for large groups, such as whole schools or facilities, and smaller groups, such as classrooms or social skills groups of three to five individuals. Further, group-based ABA procedures have been used with young children in preschool settings and school-aged students in public, private, and alternative schools. Given the myriad applications, we provide a brief overview and review of research in each of these contexts below. Our goal is to simply survey different applications of group-based ABA procedures and suggest that research has demonstrated socially important behavior change.

Example Group-Based ABA Procedures

School-Wide Positive Behavior Interventions and Supports (SWPBIS)

SWPBIS is a three-tiered framework for implementing positive behavior support (PBS) school-wide. PBS is a technology with four core features: (a) application of research-validated behavioral science; (b) integration of multiple intervention elements to provide ecologically valid support; (c) commitment to substantive, durable outcomes; and (d) implementation of support within organizational systems that facilitate sustained effects (Carr et al., 2002; Dunlap et al., 2009). SWPBIS uses an MTSS approach for improving social and academic student outcomes school-wide by integrating school data, systems, and practices. SWPBIS is not a packaged program, but rather a framework of data driven and research-based practices which support all students across the school. The framework consists of core features which allow a school leadership team to use data to create a personalized plan for their school with consideration for the school's organizational structure, resources, and cultural needs (Horner & Sugai, 2015; Sugai & Simonsen, 2012). Core features include a team-driven approach to sustainable systems' change throughout the school, universal screening for all students, ongoing progress monitoring, school-wide expectations, a continuum of procedures to reinforce those expectations, a continuum of strategies to address problem behaviors, implementation fidelity, and continuous professional development for all staff (Anderson & Kincaid, 2005; Sugai & Simonsen, 2012). Research, including meta-analyses, suggests that SWPBIS has a positive and meaningful impact on all student behavior (Gage et al., 2018) and the behavior of under-represented students (McDaniel et al., 2020).

As noted, there are three SWPBIS tiers. Tier 1, or universal, provides proactive, preventative support to all students. Critical features of Tier 1 include establishing, teaching, and reinforcing school-wide behavioral expectations. Reinforcement is often, but not always, delivered through a school-wide token economy system. An additional component is implementation of evidence-based classroom management practices in the classroom, as well as throughout the school. School-wide data, such as office discipline referrals, are used for identifying students non-responsive to Tier 1 prevention, and in need of more intensive, Tier 2 supports. Tier 2 is often provided in small groups of students and includes self-management, self-regulation, social skills, and/or academic support. Intervention decisions should be informed by hypothesized functions of behaviors. Tier 2 supports are monitored through on-going data collection. Students non-responsive to Tier 2 support receive Tier 3 individualized interventions based on a functional behavior assessment (FBA). The goal across all three tiers is to efficiently deliver evidence-based behavior supports, grounded in PBS and ABA, to all students and increase the intensity of those supports for students in need. Below, we highlight a few specific group-based components of SWPBIS.

Behavioral Expectations A core primary prevention practice in SWPBIS is establishing, teaching, and reinforcing school-wide expectations. Teaching rule-governed behaviors increases the likelihood students will respond effectively to specific environmental triggers without having a history of contacting the contingencies (Skinner, 1969). School teams establish three-to-five broad behavioral expectations and then define those expectations across all school settings and routines, typically using a behavioral matrix. For example, a school may define their school expectations as be safe, be respectful, and be responsible. Then, specific expected behaviors are defined by setting for each of the school-wide expectations and, most importantly, directly taught to all students. Rules are developed for all settings of school (e.g., walking through the hall, standing in the cafeteria, entering, sitting in, and exiting a bus, areas of the playground, and a variety of classroom settings). Once students are taught the expectations and rules, pre-corrections are used to verbally and gesturally prompt students to demonstrate the expected behaviors throughout the school.

Consequences of Behavior Consequence-based interventions can include any interventions intended to respond to a behavior either through reinforcement to increase its future occurrence or punishment to decrease its future occurrence. By pairing these contingencies to their function, school teams are able to consider appropriate school-wide consequences (Skinner, 1969). Once students have learned the expectations, school staff create two systematic and consistent continuums to provide consequences for student behavior. First is a continuum of positive procedures to encourage and acknowledge students for following the expectations. This continuum is linked to the school-wide expectations, used across all school settings, and accessible to all students. School teams chose the research-based components of this continuum based on the student need and school resources. Some evidence-based reinforcement procedures frequently implemented include behavior specific praise, group contingencies, behavioral contracting, and token economies (Simonsen et al., 2008). The token economy is a system in which students earn tokens, ideally paired with behavior specific praise, contingent upon the display of expected behaviors. Students trade in the tokens for backup reinforcers, including edibles (e.g., candy, chips), tangible items, (e.g., small toy, stickers) social reinforcers (e.g., attention from a teacher, playtime with a friend), and special privileges (e.g., extra recess, time on the computer). The tokens can be provided to students and exchanged for back up reinforcers on a variety of schedules in order to meet the different developmental needs of the students (Maggin et al., 2011). For example, access to reinforcement latency may be shorter in elementary schools or early elementary school grade levels and longer in secondary school settings.

Strengths and Weaknesses There is a large evidence base supporting the effectiveness of SWPBIS reducing student disciplinary actions and improving organizational health. Lee and Gage (2020) conducted a systematic review and meta-analysis of the SWPBIS literature and included studies that (a) focused on the school as the unit of analysis, given that SWPBIS is a group-based approach aimed at improving the behavior of all students in a school and (b) used an experimental group design (i.e., a treatment group and a comparison group). The authors identified 32 studies that included almost 9000 schools and estimated that schools implementing SWPBIS significantly reduced disciplinary exclusions, including suspensions, increased academic achievement, and increased organizational health. Although the evidence is positive, it is unclear which features of SWPBIS implementation are critical for actualizing positive student behavioral outcomes. Most studies include a measure of fidelity of implementation, quantitatively documenting that SWPBIS was implemented as designed. Unfortunately, those measures are global and do not provide insight beyond a total score. Therefore, to date, it is unclear which components and interventions are the most salient. Such information would increase understanding of the PBS technology and allow for more targeted professional development.

Classroom Management

All behaviors are functionally related to the teaching environment, and therefore, teachers can alter the occurrence of desirable and undesirable behaviors by changing the teaching environment. Research suggests that teachers using ABA-based classroom management strategies, defined as function-based (Hershfeldt et al., 2010), have better control of their classrooms and prevent and effectively respond to student behavior (Conroy et al., 2014). Classroom management focuses on how teachers establish and maintain school and classroom expectations rules, and routines, as well as how teachers respond to and restore desired behavior patterns when they are disrupted (Brophy, 20). The goal of classroom management is to ensure students are on-task and engaged in the curriculum and instruction and equip students with desired learning outcomes. Below, we describe some of the evidence-based classroom management strategies teachers use.

Antecedent Strategies Antecedent strategies are directed at changing the teaching environment before behavior occurs. Thus, these strategies are considered preventative in nature. Antecedent strategies applied to a group of students (i.e., classroom management) include as previously mentioned classroom expectations and routines, as well as providing choice and implementing visual schedules (Conroy et al., 2014; Dunlap et al., 2001). Teachers clearly communicate what is expected (i.e., follow teacher directions the first time, stay in your learning area, have all needed materials), and then, students role-play examples and appropriate non-examples and practice modeling each expectation. Teachers regularly provide precorrections and prompts for the expectations throughout the day. Expectations are retaught if regular problem behaviors occur. In order to ensure that students have exposure to explicit modeling and multiple opportunities to practice each of the classroom expectations, teachers use the I do, we do, you do teaching sequence.

Instructional choices can be offered to select the order of academic tasks, choice of reinforcer when task is completed, and within task choices (i.e., materials to use, location to work, partners). Providing choices has been found to increase academic engagement, student self-esteem and self-determination (Royer et al., 2017). Establishing predictable routines and providing visual schedules can help all students, but particularly students with autism spectrum disorders, transition between daily activities and tasks (Sevin et al., 2015). A visual support system uses images or photographs in a sequence for the activities of the day and allows all students to see the order of events. An icon can be used to indicate when a change in routine is expected to happen (i.e., assembly, picture day, field trip). Language like “first we will independently read, then we earn a movement break” can be used to break down multi-step instructions and reminds students of earned reinforcers.

Consequence Strategies A number of consequence-based classroom management strategies are used to reinforce appropriate behaviors. As noted above, these include, behavior specific praise, group contingencies, behavior contracts, and token economies (Simonsen et al., 2008). Group contingencies are often used to provide group rewards when the group or individual student meets a pre-determined goal. Data toward the goal can be tracked using a compliment chart or token jar. Teachers can be creative by tailoring these data collection systems to match students' interests. For example, if the student with more frequent problem behaviors really likes unicorns, a teacher might design the data collection system using a unicorn theme. While explicitly stating how the group earned a step toward their goal, teachers can visually add a flower to the garden, piece to Captain America, or a marble in a jar. Teachers can make the goal more attainable or more challenging by changing the number of required items to earn the reward. "Secret student" can be played by the teacher predetermining a student for the chosen time block. The teacher will remind the class that the secret student needs to follow a specific rule(s) for the class to earn the reward. When the time block is over, the teacher announces if the secret student met or did not meet the goal. It is important to know which students like to be praised publicly and which prefer to not have attention on them. To minimize peer pressure and retaliation, it is critical that the secret student is not named prior to the time period ending, or if the student did not meet the goal. If the student does not make the goal, a teacher might say "our secret student did not earn a prize because they did not stay in their area. Remember we stay in our area by sitting at our table. We will try again next time."

A positive version of the Good Behavior Game can also be played. Teachers select a short block of time to play and students are divided into teams. The teacher explicitly states how students can earn a point (i.e., raising a quiet hand, staying in area, focusing on assigned work). When students from a team demonstrate one of these expectations, their team is given a point. At the end of the time block, the team with the most points wins. To connect the game to already established group contingencies, the whole class can earn a marble if both teams earn a predetermined number of points. Rewards that students earn can be cost effective or free. Teachers can determine students' preference in reinforcers by observation, interview, or using a preference assessment. Teachers can facilitate building relationships with trusted adults in a variety of ways, like hosting mystery guest parties with the principal, school counselor, or specials teachers. Teachers can mail post cards home or send an electronic version through email or text recognizing appropriate student behavior. Reinforcement is a group-based intervention that if implemented effectively can decrease student problem behavior in the classroom.

Strengths and Weaknesses A number of systematic reviews and meta-analyses have examined the evidence base of classroom management generally, as well as evidence of specific interventions. Oliver et al. (2011) completed a meta-analysis on the impact of classroom management on disruptive and aggressive behavior, findings that classroom management has an average effect of 0.80 ($p < 0.05$) standard deviation units. Put differently, classroom management significantly and meaningfully reduces disruptive and aggressive behaviors in a classroom. Marzano et al. (2003) found similarly large effect sizes ($d = 0.90$, $p < 0.05$) but also found a significant and positive effect size of 0.52 ($p < 0.05$) for academic achievement. With regard to specific classroom management strategies, reviews have found similar outcomes. Royer et al. (2019) reviewed research focused on behavior specific praise, MacSuga-Gage and Simonsen (2015) reviewed research on teacher-directed opportunities to respond, and Gage et al. (2020) reviewed active supervision research, to name a few. All found positive and significant improvements in student behavior when each practice was implemented. That being said, there are some weaknesses. First, the literature does not always clearly distinguish specific, discrete classroom management strategies, such as behavior specific praise, from classroom management interventions, such as group contingencies or token economies. Second, studies have not determined which specific discrete behaviors are most salient and what combination of discrete teacher behaviors and classroom interventions are most effective for increasing student engagement and reducing problem behaviors.

Direct Instruction Curricula

Research consistently demonstrates that explicit and systematic instruction, based on ABA principles, has a direct and meaningful impact on student academic achievement. One such approach, Direct Instruction curricula (DI; Engelmann & Colvin, 2006), has an extensive evidence base with demonstrations of positive impacts on learning for more than 50 years. DI is based on the assumption that students learn with well-designed instruction that is contingent on students mastering prerequisite knowledge and skills. Students receiving DI begin with assessment to determine current academic skills levels to identify what skills have been mastered and what skills need to be mastered. Students are then grouped by skill level and the curriculum is enacted. The target skills are then introduced slowly, ensuring that students achieve mastery through repeated practice. All details of the instruction are controlled to ensure accuracy of delivery and effect of instruction. The instructors also provide regular positive reinforcement of demonstrated mastery behaviors, celebrating student successes at regular intervals (Engelmann, 2014).

A recent systematic review and meta-analysis evaluated 50 years of DI research (Stockard et al., 2018). The authors included 328 research studies evaluating the impact of DI on student achievement in reading, math, language, and spelling, as well as impacts on affect and perceived ability. Across almost 4000 effect sizes from the total corpus of studies, the authors found large effect sizes for all academic areas ($d > 0.50$) and moderate effect sizes for affect and ability ($d > 0.30$), with all effects favoring DI. DI, an ABA- and group-based approach, has a significant, positive, and meaningful impact on student academic achievement and other outcomes.

Strengths and Weaknesses Strengths of the DI literature base are both shear volume and consistent positive impact. Yet, a number of criticisms have been levied against DI, particularly the rigidity of the curriculum and the exclusive focus on skill mastery and not higher order concepts, such as reading comprehension. There has also been concerns that DI is only effective for young children or children with extensive needs. These concerns do not align with the meta-analysis results, which indicate that DI is effective for all students. Nonetheless, even in the face of clear and consistent evidence, DI is not broadly implemented across the nation. Therefore, more work is needed to increase the social acceptability of DI as an accessible instructional model.

Preschool/Early Childhood Settings

Although similar to K-12 school settings, preschools and early childhood settings, including in-home day care and center-based care, have unique needs and developed its own literature-base separate from school-based research. The size of groups in these settings varies. The American Academy of Pediatrics recommends an adult-to-child ratio of no more than 1:8; however, the laws are left up to each state in which the maximum ratio reaches upward of 1:20 for 4-year-old children, and as of 2011, 11 states did not have any required regulation for preschool group sizes. Some of the most widely used and least intensive group strategies in preschool and early childhood settings include antecedent interventions, natural environment teaching, and the use of group contingencies.

Antecedent Interventions As noted above, antecedent interventions are defined as a manipulation of the environment or events that occur prior to a behavior's occurrence (Smith, 2011). Antecedent strategies serve as a proactive approach to ensure a safe and positive environment that is structured to promote desired behaviors and limit the opportunity for problem behaviors. Antecedent strategies can be broadly classified into two different categories of intervention: default interventions (in which the teacher/caregiver is manipulating the environment in which problem behavior may occur) and function-based interventions (in which the teacher/caregiver is manipulating a previously identified contingency which maintains the problem behavior) (Smith, 2011). These could include well-defined classroom centers, visual schedules, and opportunities for movement and choice. One popular antecedent intervention is antecedent exercise. Research shows that antecedent exercise decreases disruptive behavior (Allison et al., 1995). Specifically, with preschool children, Webster et al. (2015) found that following a classroom physical activity break, students on task behavior increased and the most off task preschool children's behavior increased by an even greater margin following exercise. The creation of an enriched environment is an additional default antecedent strategy in which noncontingent access to reinforcement is available (Cooper et al., 2020). In a preschool classroom, this could include whole class or small group access to toys and games or opportunities for socialization.

Two function-based antecedent interventions that have been effective in preschool and early childhood settings are noncontingent reinforcement (NCR) and high probability instruction (high-p) (Cooper et al., 2020). Though these interventions are typically used in individualized instruction, they can be used in group settings. Following the recommended steps from Coy and Kostewicz (2018) for implementation of NCR, teachers collect data to establish context, identify reinforcers, deliver reinforcers continuously, create a formal plan, and then implement and evaluate the effectiveness of their plan. While this is designed for individual use, the steps could be adapted to evaluate whole class adherence to expectations and rules and reinforced on a fixed or variable schedule via class wide work breaks, access to edible reinforcers, or teacher attention. High-p or behavior momentum has been studied specifically in the preschool context. Austin and Agar (2005) found that the use of high probability command sequences was effective in increasing compliance in pre-kindergarten and kindergarten classrooms with typically developing children. Jung et al. (2008) used high-p in combination with peer-modeling to increase social interactions in 5- and 6-year-old children with autism.

Natural Environment Teaching Natural environment teaching (NET) in preschool settings is implemented to teach children in natural settings, allowing for more interaction with their peers, less one-on-one instruction, and greater generalization of skills. Two variations of NET typically used in preschool settings include incidental teaching and milieu teaching. Milieu teaching incorporates incidental teaching, as well as modeling, mand-prompting, and time-delay (What Works Clearinghouse, 2012). Both incidental teaching and milieu teaching are methods designed to increase functional language of young children building upon the processes outline by Hart and Risley (1975). There are mixed reviews of the effectiveness of these interventions. A 2009 review on milieu teaching reported increases in children's communication, while a U.S. Department of Education, What Works Clearinghouse has reported no evidence for milieu teaching due to a lack of research meeting their standards of rigor (Mancil, 2009; What Works Clearinghouse, 2012).

Group Contingencies Group contingencies are one of the least intensive strategies for acknowledging appropriate behavior in the preschool and early childhood settings. The three types of group contingencies include independent ("to each his or her own"), interdependent ("all for one"), and dependent ("one for all") (Simonsen et al., 2008). A review of group contingencies with preschool-aged children found positive effects for all three types of group contingency interventions, though the majority of studies evaluated interdependent contingencies in which all members of the group must meet the required expectation, so that all children receive the agreed upon consequence (Pokorski et al., 2017). The Good Behavior Game (GBG) is an example of a widely used interdependent group contingency, including in preschool and early childhood settings. An evaluation of the GBG in preschools found that the use of visual and vocal feedback during the GBG resulted in significant decreases in the level of disruptive behaviors displayed by young children (Wiskow et al., 2019).

Strengths and Weaknesses The literature describing group-based interventions grounded in ABA implemented in preschool and early childhood settings include many practices used with older students but adapted for the unique context. Many of these adaptations are clear. For example, milieu teaching does not necessarily have to be an early childhood intervention, but much of the research has focused on early childhood settings. Yet, although many ABA- and group-based interventions are implemented in preschool and early childhood settings, more rigorous research is needed. Returning again to milieu teaching, many studies have been conducted, but most do not meet rigorous evidence standards.

Juvenile Justice and Detention Centers

Incarceration is a form of punishment. However, it is only a true consequence if it reduces the probability of the future occurrence of behavior. If incarceration acts as an operant punishment, then we would expect the rate of recidivism and amount of criminal behavior in the United States to be low; however, that is not the case (Apel & Diller, 2016). Research shows that the effectiveness of punishment-based interventions varies based on the intensity, the probability of contacting punishment, the immediacy of the punishment, the strength of the reinforcement contingency that sustains the behavior, and any competing reinforcers. Incarceration may be more effective when paired with intervention, including group-based interventions.

The state of Oregon used an approach based on behavior analysis in their "Supermax" detention center. Specific behaviors were targeted in a behavior action plan, based on systematic assessment. In order to be released from the unit, the individuals had to finish the program assigned to them and were not allowed to display any rule violating behavior. Data were regularly collected on both appropriate and inappropriate behaviors of all inmates, and the inmates earned positive reinforcement for displaying appropriate behavior, including access to visitors and tangible reinforcers. As a result, the program found overall decreases in problem behavior displayed across the prison (Webb, 2003).

Contingency management programs have also resulted in positive outcomes in detention settings. Based on operant conditioning, these programs provide reinforcement to individuals immediately contingent upon the appropriately exhibited behavior and are associated with prisoner's behavior gains in a variety of areas. These programs can include token economies, response cost, behavior contracts, time out, and overcorrection. The token economy is the most common contingency management program in detention center, and it is also notable because it is a positive reinforcement. A token economy allows individuals to earn tokens or points when they display appropriate behavior, then later exchange those tokens for backup reinforcers (Gendreau et al., 2014).

A growing evidence-base is combining many of these practices and organizing them into a multitiered system of support framework for juvenile justice and detention centers. The approach, known as facility-wide positive behavior interventions and supports (FW-PBIS; Sprague et al., 2020), adapts SWPBIS for juvenile justice settings, leveraging PBS practices, and, importantly, defining behavioral expectations and positively reinforcing demonstrations of those expectations. A recent review by Grasley-Boy and colleagues (2021) identified 19 studies of FW-PBIS conducted in juvenile justice and alternative school settings. Overall, the review found that FW-PBIS reduced restraints and seclusions of incarcerated youth, and, for some youth, improved behavior and academic achievement.

Strengths and Weaknesses Juvenile justice and detention centers are difficult contexts. Yet, there is a growing evidence-base that ABA-based interventions, delivered facility-wide, can be used to improve problem behavior and, importantly, reduce the need for restraints and seclusions. That being said, it is important to acknowledge that the literature is still developing and more experimental studies are needed. The Grasley-Boy et al.'s review could not include a meta-analysis because of a number of design limitations. Thus, more studies establishing experimental control, either through single-case experimental designs or group-based designs with a control group, are necessary to establish these ABA- and group-based practices as evidence-based in juvenile justice and detention centers.

Concluding Thoughts

Our goal was to briefly describe research areas evaluating the implementation of group-based instruction. Across all of the settings, interventions, and strategies, accumulated evidence demonstrates that socially important behavior can be successfully changed. The examples focused exclusively on children and youth, yet there are other examples that could be described. For example, one area left out is organizational behavior management, which is the application of behavior analysis to organizational settings, such as health care, sports, and manufacturing. Thus, it is clear that group-based interventions grounded in ABA are widely implemented, effective, and efficient.

It is worth noting that across all of the group-based contexts, a few specific themes emerged. First, most research on ABA- and group-based strategies focuses on prevention, creating high structured environments to teach behavioral expectations and reinforce displays of those expectations. Reinforcement was often structured through a token economy, but also included contingent praise when expected behaviors were displayed. The second theme was the broad use of group contingencies, particularly the Good Behavior Game. Finally, the application of multi-tiered systems of support, leveraging PBS, is expanding beyond the K-12 setting. SWPBIS and FW-PBIS are, in essence, frameworks for delivering prevention and intervention practices using a tiered approach. Thus, the framework could continue to expand, potentially into the organizational behavior management context. Regardless, the growing evidence-base situates SPWBIS as an evidence-based group implemented framework for improving behavior.

The utopian vision Skinner described in *Walden Two* provides a fictional exemplar for how ABA could improve society. Practically, the myriad group-based interventions and strategies described here may not actualize any utopian dreams, but, when implemented as designed, can have real and meaningful impacts on the lives of children, youth, and adults. We believe that expanding the use of these strategies can save time, resources, and money while simultaneously meaningfully improving outcomes, including socially important behaviors of groups and individuals.

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34 Caregiver Training

Rebecca K. Dogan

According to National Alliance for Caregiving and AARP (2015), in the United States, approximately 43.5 million informal caregivers provide support each year, not including parents or caregivers of non-biologically related children. Fifteen percent of those caregivers provide services for more than one individual. In addition, these caregivers are estimated to have an increasing economic value of $470 billion in 2013, compared to $375 billion in 2007, with close to 50% coming from caregivers of individuals with Alzheimer's disease or dementia. For some caregivers, such as parents or guardians, this role is a full-time and long-term job, while other caregivers may only care for an individual a few hours a week in a private home or care facility, such as a senior who requires minimal assistance or an adult with a physical, medical, or mental disability. On average, caregivers spend 19 days a month providing basic necessities, such as shopping, meal preparation, transportation, housekeeping, monitoring medication, and self-care support (e.g., grooming, bathing, assistance with toileting, dressing, etc.) (National Alliance for Caregiving & AARP, 2015).

The roles of a caregiver vary enormously based on the needs of the care receiver, the care-related tasks that are required, and the skills of the caregiver (e.g., experience, training, education) (Kavanaugh et al., 2019). In general, caregivers are expected to not only provide basic necessities (food, shelter, medical needs, etc.) but also encourage and support socially appropriate behaviors that allow individuals to be as independent as they are capable of being. This is no small feat and a role that can be complicated even more by the thousands of books and resources available, many of which are conflicting and change with new popular psychology theories. Some parents, for example, may be struggling with a child who has severe behavioral issues. The role of caregivers who have children or adolescents with these conditions often needs more focus on caregiver training/education that teaches skills not only to improve prosocial behaviors (e.g., compliance) but also to learn strategies to manage and reduce undesirable behaviors (e.g., defiance, aggression). Caregivers responsible for individuals with developmental challenges may have far more complex roles requiring caregiver training/education in addition to more specific skills training in areas such as social and communication skills. Other caregivers who provide support for individuals with physical, neurocognitive, or medical diagnoses, such as traumatic brain injury, dementia, stroke, or cancer, require more advanced, specific skill development in several key areas such as communication skills, treatment of behavioral issues (e.g., aggression, wandering), in addition to broader, long-term self-care skills (e.g., ambulating independently).

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_34

For caregivers who provide support for those individuals with complex chronic care issues, that caregiver may provide roughly 96% of assistance with activities of daily living (ADLs), such as dressing, shopping, transportation, and managing hygiene (National Alliance for Caregiving & AARP, 2015). Each diagnosis presents with its own confronts, all of which alter and complicate the role of the caregiver who is ultimately responsible for helping the care receiver develop the skills necessary to lead productive, inclusionary lives. Caregivers face many challenges in several common areas including teaching novel skills to address deficits (e.g., behaviors that occur too infrequently) and managing behavioral excesses (i.e., behaviors occurring too often). Caregiver training attempts to assuage these issues by providing guidance to managing both.

Behavioral Parent Training

In caregiving training literature, the preponderance of empirically based studies is in the areas of behavioral parent training for children with specific diagnoses. According to the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), the category disruptive, impulse-control, and conduct disorder (CD) includes oppositional defiant disorder (ODD) and CD, formally referred to as part of the disruptive behavior disorders category in the DSM-IV-TR (American Psychiatric Association [APA], 2000). Neurodevelopmental disorders are a category that encompasses conditions with onset occurring in the developmental period such as attention–deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD). Behavioral parent training has long been recognized as an evidence-based treatment for children diagnosed with ADHD, ODD, and CD (Danforth, 2016; Carr, 2014; Bearss et al., 2015). With well over 100 studies expanding over several decades, behavioral parent training has emerged as one of the most successful interventions and has well-established its effectiveness (Booth et al., 2018; Cohen et al., 2010; Kaehler et al., 2016) and even its efficacious impact over other forms of treatment (Carr, 2014). For example, 60–70% of children whose parents participated in parent training showed improvements in child behavior and gains were maintained at reassessment during a 1-year follow-up (Carr, 2014).

According to the Center for Disease Control and Prevention (CDC), approximately 1 in 6 children meet criteria for a mental health disorder (CDC, n.d.-a). The more common childhood disorders include ADHD (9.4%), behavior disorders (7.4%), anxiety (7.1%), and depression (3.2%) (CDC, n.d.-a). Children with ASD represent about 1 in 54 children in the United States (CDC, n.d.-b). Forms of child mental illness are ubiquitous across the globe, but prevalence rates vary due to under-reporting, especially in countries with limited diagnostic and treatment resources (Our World in Data, n.d.). In many US states and across countries worldwide, services for individuals with special, explicit needs and their caregivers are still not available, accessible, or affordable (Lord & Jones, 2013) and as many as 75% of children and adolescents will not receive evidence-based treatment services (Kaehler et al., 2016). Access to treatment services for children with disruptive behaviors is often impacted by ethnicity and socioeconomic status (Lesch, 2015). When considering the global restriction of services and barriers to treatment in addition to the efficacious results and wealth of research supporting parent training, additional work still needs to be done to make this intervention more accessible, affordable, and sustainable to those who can benefit.

Most parent training programs (PTPs), commonly referred to as PTPs, are designed and studied for children with a specific mental health disorder (e.g., ADHD, ODD, CD, ASD) and are delivered as a group treatment package that is highly structured, such as parent–child interaction therapy (PCIT), the incredible years (IY), and Triple P programs. The primary goal of these PTPs is to reduce childhood problem behaviors by enhancing parent behavior management skills (Zwi et al., 2011; Young & Myanthi Amarasinghe, 2010; Booth et al., 2018; Lessard et al., 2016). However, the term "parent training" goes by many names and is referred to throughout the literature as in-home training, parent-assisted training (Booth et al., 2018), parent education, parent-implemented, parent-mediated, and caregiver-mediated training (Bearss et al., 2015). In most cases, the term "mediated" is used when the caregiver is the agent of change, meaning the individual responsible for delivering treatment to their child. Mediated can be further defined as either primary or complementary, where the parent is part of a therapist led program (Bearss et al., 2015). Literature has also demonstrated benefits for caregivers who have participated in parent training such as experiencing a reduction of parental stress and improvement in parenting skills capability (Schultz et al., 2011). Over the years, variations of these training programs have been modified and adapted to address a wider range of psychiatric diagnoses (e.g., ASD, CD) as well as caregiver barriers, such as parental mental health issues (Charles et al., 2013; Gardner et al., 2010) and economic stressors (Carr, 2014; Danforth, 2016).

Over time, there has been a shift from working solely with the child to modify his or her behavior to incorporating the use of nonprofessionals (e.g., peers, parents) into caregiver training programs. Parents play a vital role in the development, generalization, and maintenance of their child's behaviors (Booth et al., 2018; Hsieh et al., 2011). Caregiver training allows parents to act as the agent of change and to be properly supervised during the practice of newly learned skills. In addition, trained parents can also be taught how to train other caregivers, such as a sibling or relative, which can boost generalization (Loughrey et al., 2014) and enhance maintenance of skills. Parents have a greater number of opportunities in the natural setting to have a substantial effect on learning since they spend the most time with their children. They also have more opportunities to have their child practice newly learned skills in novel settings and with an array of individuals. Parental involvement as an intervention agent is by no means a novel idea and was incorporated into Lovaas' work in the 1970s (Lovaas et al., 1973). Parental participation is a key component of PTPs and, more recently, a wider range of caregiver skills training programs that target specific skills sets such as discrete trail teaching (DTT; Eid, Aljaser, et al., 2017b; Subramaniam et al., 2017), manding (Loughrey et al., 2014; Suberman & Cividini-Motta, 2020), and arranging safe sleep environments (Carrow et al., 2020).

Attention-Deficit/Hyperactivity Disorder

Parent training is seen as an integral part of behavioral interventions for children and adolescents with ADHD (Daley et al., 2018; Danforth, 2016). ADHD is a chronic and pervasive neurodevelopmental disorder characterized by symptoms associated with inattention or hyperactivity/impulsivity, or a combination of both affecting roughly twice as many males as females (APA, 2013; Wolraich et al., 2019). It has been one of the most well-researched and studied disorders of childhood (Young & Myanthi Amarasinghe, 2010).

Common evidence-based treatment strategies for younger individuals with ADHD include contingency management, behavior therapy, and social skills training, all of which require multiple sessions, and in most cases, a caregiver is involved (Daley et al., 2018). For preschool children, the focus of parent training is education on ADHD (e.g., written materials, internet sources), addressing caregiver risk factors, and teaching parents how to improve their parenting skills. Specific skills targeted include identifying and learning to modify antecedents and consequences that impact their child's desirable and undesirable behaviors; in addition to learning to track and monitor behaviors (e.g., behavioral diaries), as well as enhancing caregiver ability to correctly reward appropriate behavior (e.g., compliance, good listening) while properly decreasing challenging behaviors (Young & Myanthi Amarasinghe, 2010). With very young children, most reward systems include praise and tangible rewards such as stickers and access to preferred items or activities. Antecedent-based strategies may include providing effective instructions or removing distractions prior to a demand, whereas consequence-based strategies can include the use of time-out, limiting parental attention (i.e., planned ignoring for attention maintained behaviors), temporary removal of preferred items or activities, or rewards for demonstrating desirable behaviors. Researchers and physicians are in agreement that for young children, the first line of treatment should be on caregiver education and training rather than pharmacological interventions (Young & Myanthi Amarasinghe, 2010).

For school-age children, very similar strategies are used but modified to be developmentally appropriate. For instance, the use of monetary allowance would be chosen rather than parent play time; likewise, grounding would be more appropriate than time-out. The training program also concentrates more on generalization of skills learned at home that should now be transferred to the school setting or the program may implement concurrent school-based interventions. Goals would likely shift from parenting goals alone to child academic, social, and behavioral goals. Contingency management interventions for school-age children often involve the use of a Daily Report Card, where the teacher monitors and tracks the student's behavioral goals, determines if the student meets his/her daily goal, and then a reward is provided at home or school. Goals may include behaviors such as completing in class work on time, raising a hand to share information, or remaining seated. Other areas to target for this age group include teaching time management skills, enhancing social skills, and helping teachers modify the school setting to allow for more opportunities to be successful (Young & Myanthi Amarasinghe, 2010). For instance, goals and strategies may include independently using timers, learning to accept criticism, and relocating the student away from distractions such as a window or close peer.

A significant amount of research, supported by the National Institute for Health and Clinical Excellence, has been conducted with the school-age population that endorses parent training for children with ADHD (Young & Myanthi Amarasinghe, 2010). This wealth of research concurs that parent training for school-age children with ADHD demonstrates an increase in positive parent-specific skills, a reduction in child symptoms, and overall lower levels of family distress. However, Young and Myanthi Amarasinghe (2010) also reported that research is less ample for studies that included parents whom themselves have ADHD and studies targeting other ADHD-specific symptoms besides externalizing behaviors such as noncompliance and aggression. Despite positive outcomes for school-based interventions, additional research is still needed to create a sufficient evidence base for child-centered academic interventions (e.g., modification of instructions or materials and environmental manipulations), cognitive–behavioral therapy, and social skills training, in the absence of parent training (Young & Myanthi Amarasinghe, 2010).

Middle and high school adolescent parent training goals work toward maintaining and generalizing skills learned as school-age children. For instance, the Daily Report Card, which was previously monitored daily or several times a day, can now be assessed weekly. Individualized training is focused on specific academic challenges such as test taking, skills associated with executive functioning, and problem-solving skills, as well as continued practice and development of more complex social skills (e.g., dealing with peer pressure), self-management, and self-reinforcement strategies. Parent involvement is ongoing, but less direct and issues are addressed as they arise (Young & Myanthi Amarasinghe, 2010). Tweens and teens with ADHD may present with more complicated symptoms due to comorbidities such as depression, anxiety, and substance use, as well as transformation of their own ADHD symptoms. For instance, many school-age children and adolescents with ADHD show fewer or less intensive symptoms associated with hyperactivity as they get older and inattentiveness increases (Martel et al., 2016). It is important for clinicians to not only assess and treat the core ADHD symptoms but also comorbidity issues impacting this age group in the home, community, and school settings.

Although under-represented, the focus of fathers as the primary participant in PTPs suggests that fathers of children with ADHD are as equally as responsive as mothers to PTPs; however, maintenance and generalization of skills need to be further researched to ensure that these areas are thoroughly addressed (Fabiano et al., 2012). Frank et al. (2015) used a survey and focus group with a large sample of fathers to gather insight into approaches that may enhance promotion of PTPs to fathers and content fathers may be more inclined to show interest in or notice. It was suggested that fathers prefer programs that emphasize trained practitioners, include personalized content, and for the mode of delivery to be T.V., internet-based, or a fathers only group. For school-age children and adolescents with ADHD, additional research needs to investigate alternative non-pharmacological interventions, specifically working with parents, teachers, counselors, and adolescents collectively to make treatment decisions and target skills required to successfully transition to adulthood (Young & Myanthi Amarasinghe, 2010).

There is a vast amount of research in support of pharmacological treatments and behavioral interventions for specific age groups of individuals with ADHD, but few studies have specifically tackled the challenges of identifying the order or combinations in which these two treatments should be provided and what exact factors demonstrate the highest degree of managing symptoms with the fewest side effects (Pelham Jr et al., 2016). It is estimated that two-thirds of children and adolescents with ADHD are taking medication and 50% have participated in behavioral interventions (Wolraich et al., 2019). The American Academy of Pediatrics (AAP) has suggested diagnostic procedures and treatment guidelines based on approximate age of the client. The AAP suggests that preschool children should receive parent training/behavior management training first, and only if those methods fail to show clinically significant improvements should methylphenidate be considered. For children ages 6–12, medications approved by the US Food and Drug Administration (FDA) in combination with parent training/behavior management, including classroom interventions, are recommended. For middle and high school students (ages 12–18), the suggestions focus on educational interventions, behavioral interventions, and medication with child assent (Wolraich et al., 2019).

Pelham Jr et al. (2016) investigated different initial treatment patterns by comparing individuals who received several treatment options categorized as the following: behavioral-medication (BM); behavioral-behavioral (BB); medication-behavioral (MB); and medication-medication (MM). For each group, participants were first randomly assigned to either the behavioral (BehFirst; 8-week low dosage behavior PTP with concurrent social skills training sessions, and Daily Report Card) or medication (MedFirst; 0.15 mg/kg/dose of immediate-release methylphenidate) group. At follow-up (8 weeks or later), those parent/child group members who were determined to be insufficient responders (i.e., child gains were not sufficient in the home or school setting) were once again randomly assigned to a secondary treatment program. These new groups included either a combined program (BehFirst plus additional behavioral support [BB] or MedFirst plus additional behavioral support [MB]) or medication program (MedFirst plus increased dosage [MM] or BehFirst plus initial low dosage [BM]). One-hundred forty-six children (ages 5–12) participated in this 1-year study. Results revealed that the best outcome was produced by the BM group, meaning that adding a secondary treatment of a low dosage of stimulant to an already existing low dosage behavioral program produced the best outcomes for home and school. The group that showed the poorest outcomes and low parent participation was the MB group. The authors suggested that this may have been related to poor motivation to engage in a higher effort intervention, compared to giving their child medication, after 8 or more weeks of inadequate improvement (Pelham Jr et al., 2016).

Daley et al. (2018) conducted a meta-analysis of current best practices in the use of parent training and other behavioral interventions for children and adolescents diagnosed with ADHD. Results confirmed that these interventions not only benefit the child (i.e., improvements in skill development and behavioral issues), but also improve parenting behaviors toward their own children as well as parent self-report regarding confidence in their own abilities, thereby indicating a high probability that these improvements benefit the parent–child relationship. More research is still needed to assess specific caregiver involvement (i.e., fathers), degrees of training and supervision for caregivers, ways to motivate caregiver participation and help-seeking behaviors, parental characteristics (e.g., mental health issues, intellectual ability), integrated home-school interventions, and the impact these factors have on treatment (Daley et al., 2018). In addition, in order for research and program development to be thorough, it must address the other symptoms associated with ADHD besides the externalizing problem behaviors (Daley et al., 2018; Zwi et al., 2011) as well as further evaluate supplemental components, such as mindfulness exercises (van der Oord et al., 2012).

Clinically, more focus is still needed on increasing awareness about ADHD symptoms and treatment options for those directly involved in young children's lives from an early start, including caregivers, teachers, and pediatricians. Moreover, continued critical assessment of diagnostic measures for those with more inattentive symptoms, enhanced monitoring and management for those utilizing both medication and non-pharmacological treatments, as well as additional research on skill building for the transition period from adolescents into adulthood is still deficient (Lesch, 2015). One barrier of parent training for the ADHD population is that an estimated 25% of parents involved will have either have received an ADHD diagnosis or are undiagnosed. Therefore, not only are parents trying to manage their child's symptoms, but they are also battling with their own challenges and limited coping abilities which can affect their ability to participate and meet the expectations of the program (Lesch, 2015). PTPs for this subgroup should include modules explaining and discussing adult ADHD, modeling and role-play of specific skills associated with adult symptoms, and regular check-ins as well as booster session options.

Autism Spectrum Disorder

ASD is a neurodevelopmental condition characterized by limitations in social-emotional reciprocity and use of nonverbal behaviors (e.g., facial expression, eye-to-eye gaze), impairment in communication, developmentally inappropriate peer relationships, or reduced share enjoyment of activities and interactions (APA, 2013). Many children with ASD also display dangerous or disruptive behaviors such as aggression, self-injury, and noncompliance (Postorino et al., 2017). According to the CDC (n.d.-a), the up-to-date first line of treatment for young children with ASD includes a multidisciplinary approach (e.g., occupational therapy, speech therapy, applied behavior analysis [ABA]) in addition to parent-mediated interventions as well as employing interventions to target specific skills area directly impacted by ASD. Specific areas of ABA recommended by the CDC and National Standards Project that are considered emerging or evidence-based treatments include the early start denver model (ESDM), DTT, early intensive behavioral intervention, pivotal response training (PRT), and verbal behavior intervention, some of which are highly individualized or standardized treatment programs. Other types of treatments noted by the CDC include less supported options that are not evidence-based. These include dietary modifications and complementary and alternative medicine (CAM), such as chelation and supplements (CDC, 2015). FDA-approved medications are also listed as treatment options to alleviate specific subsets of behavioral or mood excesses and deficits (e.g., obsessive–compulsive disorder, poor attention, aggression) and include selective serotonin re-uptake inhibitors, tricyclics, antipsychotics, stimulants, and anti-convulsants (CDC, n.d.-c; National Institute of Health, n.d.). However, some medications can have negative side effects such as weigh gain (Postorino et al., 2017).

Despite the many treatment options available, both science and snake oil, behavioral interventions such as those based on ABA are by far the most effective and recommended

(Booth et al., 2018; World Health Organization [WHO], 2019) but costly (Lord & Jones, 2013; Postorino et al., 2017). Implementing a parent-mediated training model is one way to help reduce costs, promote generalization, and lead to improved outcome gains, since many individual programs do not have the supervision necessary that will lead to the best outcome (Booth et al., 2018). In addition, the literature on parent training interventions, specifically ones in which the parent is an active behavior change agent, have repeatedly demonstrated positive outcomes for core symptoms of ASD (Lord & Jones, 2013; WHO, 2019) and are considered a crucial component of ASD treatment programs (Baharav & Reiser, 2010; Booth et al., 2018).

Research supports early intervention services for young children, showing the best trajectory outcomes with substantially larger gains in various skills (e.g., language, social, adaptive skills) when there are parent-mediated interventions (Lord & Jones, 2013; Shire et al., 2016). Given the challenges individuals with ASD have with regard to natural (untrained) generalization and maintenance of skills, it only seems logical to have caregivers involved in the treatment process (Lord & Jones, 2013). Similar to children and adolescents with ADHD and other behavioral challenges, parent training for children with ASD focuses on modifying contingencies to promote prosocial behavior and reduce undesirable or dangerous behaviors, all while improving the parent–child relationship. Yet, over the last 15 years, there has been a rising concern regarding specific interventions that address the greater needs of children with ASD as well as their families. Individuals with ASD present with additional struggles that impact the entire family unit and require specific, longer term skill building to address (Lord & Jones, 2013; Schultz et al., 2011). Most interventions target the core symptoms of ASD such as social communication skills (Bearss et al., 2015), but may not address larger family issues. Given the evidence of heightened levels of parental stress for caregivers with a child on the spectrum (Dababnah & Parish, 2014; Postorino et al., 2017) compared to other intellectual or medical diagnoses (Booth et al., 2018), parent training for these families may also involve more psychoeducation. This additional component can benefit caregivers by increasing a family's knowledge of their child's diagnosis, helping to give parents a stronger sense of empowerment in advocating for their child's treatment, and helping parents address their fears as well as learning to adjust their expectations to better fit the development of their child (Bearss et al., 2015; Connolly et al., 2018; Lord & Jones, 2013). Psychoeducation alone, focused on discussions rather than live coaching, does not appear to support the same robust findings that parent-mediated interventions produce (Shire et al., 2016).

In a 2011 review of research in this area, primary limitations included lack of fidelity measures, predominantly one-on-one training (versus a more cost-effective group option), limited parent outcome measures, and a lack of consistency with number of sessions or length of treatment and intensity (Schultz et al., 2011). In addition, the growing number of treatment packages with varying target behaviors, ages, formats, and context (e.g., online, group, individual) makes it extremely challenging for not only parents to know which will be successful for their family and has previously demonstrated to be effective (Booth et al., 2018) but also for professionals to determine the right dose of those treatments (Postorino et al., 2017). Seeing how costly, lengthy, and at times, inaccessible the treatment for ASD is, the development of more cost-effective PTPs for this population needs to be a high priority (Bearss et al., 2015; Postorino et al., 2017). However, the literature suggests that caregivers prefer one-on-one training to group training, likely because the clinician or behavior analyst can modify and create a skills programs tailored for that child or family based on their needs (Booth et al., 2018). Access to quality services globally is a noteworthy problem, so the development of online platforms to train caregivers such as "Simple Steps" and "Challenging Behavior" may pose a solution

(Booth et al., 2018). Pyramidal training (e.g., caregivers training other caregivers) can also benefit this population, and research has demonstrated that fathers have had success in learning skills associated with improved parent–child interactions (e.g., following child's lead, non-speech vocalizations) and are also highly capable of training mothers who were then also able to apply the same skills with their child (Elder et al., 2010). In areas where service providers are few or for families who lack insurance coverage or have financial burdens, these training options, if made easily accessible and affordable, could help reduce the strain between need and services.

Another limitation in the research is identifying specific moderators (e.g., subgroups) and components of parent training (Farmer et al., 2012; Lord & Jones, 2013; Schultz et al., 2011). Having professionals better define and categorize programs to notify and allow consumers to be aware if they are parent-mediated intervention (PMI) or parent supported, primary (parent is primary change agent) or complementary (therapist initially works with child and then provides coaching), and the focus of treatment (e.g., core symptoms, behavioral), is essential (Bearss et al., 2015). Bearss et al. (2015) developed a model for categorizing PTPs into one of the following: parent support-care coordination, parent support-psychoeducation, primary PMI for core symptoms, complimentary PMI for core symptoms, primary PMI for disruptive behavior, or complimentary PMI for disruptive behavior. For instance, the ESDM has been classified as a PMI-Complementary-for Core Symptoms. Other criticisms have been raised regarding labeling these interventions as "parent management training" because they can provide a false perception that parents are to blame and suggest hierarchical power of the practitioner with the parent simply being the "trainee" (Sanders & Burke, 2014). Sanders and Burke (2014) explain that these labels do not empathize with the collaborative nature of the parent–practitioner relationship and could in turn deter parent willingness to seek treatment.

General Limitations and Barriers of Caregiver Training

Specific barriers noted in the parent training literature include situational (e.g., practical issues such as transport, childcare, scheduling) and psychological factors (e.g., fear of being judged, stigma, and concerns with confidentiality), as well as parent challenges with implementation of strategies, and lack of awareness of treatment programs (Danforth, 2016; Koerting et al., 2013; Smith et al., 2015). According to Smith et al. (2015), potential ways to address some of these barriers include having a therapist provide a clear description of what is involved in the PTP and the expectations, specifically addressing motivational issues and caregiver confidence as part of treatment. Furthermore, offering support outside of session and techniques that will help parents follow through at home (e.g., modeling and practicing in session) can address some of these barriers. Research has also indicated that specific advertisement strategies (e.g., clear, easy to understand content, offering open/free events), direct recruitment, certain program factors (e.g., flexible, individually tailored, phone support), and therapist factors (e.g., extensiveness of their training) can all play a role to addressing barriers (Koerting et al., 2013).

In order for caregivers to successfully use behavioral interventions and apply skills with their children, they must attend and participate in the PTP; which is why caregiver adherence and barriers to treatment continue to be a focus in the literature. Jensen and Grimes (2010) advanced the literature in this area substantiating that when caregivers had a child enrolled in concurrent skills training programs that attendance rates increased up to 52%. Only a few PTPS today have both parent and child concurrent but separate run programs. Instead, parents typically need to enroll their child in a in independent child-specific groups (e.g., local social skill group). In a seminal article published by Allen and Warzak (2000), the authors proposed the use of a functional assessment to identify what environmental contingencies could be altered to increase adherence to behavioral parent training. This was the first study to investigate caregiver adherence from a behavior analytic perspective, a common approach in this field to assess treatment effectiveness (Allen & Warzak, 2000). The outcome of this study identified four behavioral principles and components affecting caregiver adherence (see Table 34.1). It was suggested that in order to maximize treatment gains and child outcomes, professionals must take these contingencies into consideration. Moreover, professionals should be mindful of their own behavior and the contingencies that impact their behavior during parent training sessions (Allen & Warzak, 2000). Stocco and Thompson (2015) expanded this area of research by reviewing child-effect studies and identifying positive and negative reinforcement contingencies for parent behavior. For instance, Patterson's negative reinforcement trap is an example of how caregivers' escape and avoidance of problem behavior over time can lead to use of corporal punishment and intensifying child problem behaviors. Similarly, Wahler's positive reinforcement trap describes how a caregiver may inadvertently reinforce child undesirable behaviors, for instance, a parent threatening but not following through with time-out and, instead, accepting hugging and apologizing child behaviors immediately after the initial misbehavior. Behavior analysts, therefore, have an opportunity to improve parent

Table 34.1 Adherence variables

Establishing operations	
	Failure to establish intermediate outcomes as reinforcers
	Failure to disestablish competing social approval as reinforcers
Stimulus generalization	
	Trained insufficient exemplars
	Trained narrow range of setting stimuli
	Weak rule following
Response acquisition	
	Excessive skill complexity
	Weak instructional technology
	Weak instructional environment
Consequent events	
	Competing punitive contingencies
	Competing reinforcing contingencies

training methods with functional analysis (FA) technology to further asses these contingencies influencing parent behavior. Stocco and Thompson (2015) also reviewed older literature on the success in training children to be the behavior-change agent to influence caregiver parenting behaviors. Despite multiple studies showing the impact that children, acting as change agents, can have on parents and teacher behavior, this does not seem to be implemented in PTPs and recent caregiver training literature.

The therapeutic process has multiple phases (i.e., initial interaction, assessment, skills training, and termination) regardless of duration of treatment. At each phase, the clinician is working to set the client up for successful outcomes. This may include explaining a treatment program and its benefits to gain parent commitment during the initial interaction, selecting appropriate achievable goals during the assessment phase, teaching strategies in a meaningful and functional way during the skills training phase, or equipping parents with the tools to generalize skills for sustainability of treatment effects during the termination phase. Practitioners must be highly cognizant during each phase and all interactions during the sessions to monitor their own behavior and parent responses to provide the best services that encourage active participation and address parent resistance. As shown in Tables 34.2 and 34.3, Sanders and Burke (2014) published a beneficial outline of common issues that can arise during the therapeutic process between practitioner behavior and parent response, as well as details regarding a guided participation model with four key processes for promoting positive change in clients.

Yet another barrier published in articles on parent training is the deficiency of detailed, thorough step-by-step procedures or specific protocols for parents and that the access to such information is often only available through training, certification, and purchase of standardized manuals for evidence-based programs (Sanders & Burke, 2014). Specifically, to address excessive skill complexity to improve caregiver treatment fidelity, Danforth (2016) suggested clinicians create and utilize flowcharts to serve

Table 34.2 Common process problems during parent consultation sessions

Type of problematic practitioner behavior	Parents immediate reaction	Clinical consequence	Alternative practitioner behavior
Practitioner sets difficult or impossible tasks	Parent non complies	Parent drops out	Practitioner negotiates a more achievable set of goals and tasks
Practitioner becomes defensive when challenged	Parent reciprocates with defensiveness	Parent drops out	Practitioner remains non-defensive and clarifies the parent's referents before responding
Practitioner's demonstration of skill is poor	Parent becomes confused and fails to develop necessary skills	Intervention fails	Practitioner demonstrates more appropriate example of the being used correctly
Practitioner's explanation of a skill is vague	Parent lacks a clear rationale to support a parenting practice	Parent can't explain what she is doing to significant others	Practitioners provide reviews parenting strategy and develops a more convincing rationale to explain a strategy or skill
Practitioner provides a poor or incorrect response to parents questions	Parent implements a strategy incorrectly	Child does not improve	Practitioner reviews procedure and provides the correct answer to specific question
Practitioner assumes a parent is refusing to try a new skill	Parent becomes angry or defensive; refuses to try the strategy	Parent drops out	Practitioner acknowledges the difficulties associated with making change
			Practitioner assists parent to anticipate setbacks and other difficulties as a normal part of the change process
Practitioner fails to recognize that the change effort is hard	Parent becomes disheartened, sees self as a failure	Parent drops out	Practitioner negotiates a more achievable set of goals and tasks
Practitioner rescues an emotional distressed parent	Parent may become dependent	Parent fails to change behavior or becomes self-regulated	Practitioner acknowledges parental distress through summarization or reflection, then refocuses (if appropriate) parent's attention to the task at hand
Practitioner provides vague positive feedback	Parent does not improve performance	Parent continues to perform inadequately	Practitioner writes down specific verbatim examples of what the parent did well
Practitioner provides negative judgmental nonspecific feedback	Parent feels criticized and gets angry	Parent drops out	Practitioner writes down specific examples of what constitutes correct and incorrect implementation of a skill or routine

as a visual prompt for caregivers to follow. This can serve as a supplemental element to the current components most evidence-based, structured programs contain such as instruction, modeling, role-play, and feedback. In Fig. 34.1, the author first created a task analysis of a parent response behavioral chain, and from this produced a 30-step flowchart that helps walk caregivers through a compliance training protocol. The protocol includes giving instructions, responding correctly to complaint or noncompliant behavior, warnings, appropriate use of time-out, and praise (see Fig. 34.1). Besides presenting parents with a simplified visual/written version of the strategies taught during the parent training sessions, what may be even more beneficial would be laminating or providing multiple copies of this flowchart so that parents can track, identify, and then discuss areas of difficulty during therapy. Afterward, if needed, more specific

Table 34.3 Guided participation model for promoting change

Practitioner assumptions, beliefs, and behaviors	Introducing change	Supporting change	Preventing and managing resistance
Be curious	Client-driven goal selling	Collaborative exploration and discussion of presenting problem and potential solutions/strategies	Recognize discomfort/ disengagement in client or practitioner
Assume positive intentions from clients	Offer tentative suggestions	Check goals are realistic	Recognize and attend to any threat to practitioner's own values
Acknowledge own values	Provide rationale for suggestions	Acknowledge inherent difficulty of change	Explore client ambivalence to change
Be non-judgmental	Active client involvement	Identify client and contextual factors that support change	Validate client perspective
Be empathic	Matching pace of change to client needs	Identify and problem solve client and contextual factors that impede change	Gently raise issue with client
Demonstrate hope/ optimism	Balancing push for change with support	Build client self-regulatory skills	Identify source
View client as expert on their life	Check in (for understanding, agreement, and commitment)	Validate client change efforts	Clarify meaning
Be non-defensive	Clarify meaning (client and practitioner)	Encourage self-reinforcement	Problem solve solutions
Parents are doing the best they can	Validate client experiences Summarize regularly		Develop goals for moving forward

steps can be discussed, modeled, and practiced addressing those precise struggles (Danforth, 2016).

Parent Training Programs (PTPs)

Three of the more well-known and researched PTPs include The IY, PCIT, and Triple P. These programs are based off of the Hanf-Model, created between the mid-1960s and 1970s by Constance Hanf, whose significant contribution of combining social learning theory, operant conditioning, and family systems theory led to the birth of this model and future PTPs (Kaehler et al., 2016). There is a plethora of other PTPs with moderate-to-extensive research that have been shown to produce positive outcomes including but not limited to Parent Management Training-Oregon Model, Helping the Noncompliant Child, and Community Parent Education.

The Incredible Years

The IY parent, teacher, and child series is well-established in the literature as an intervention for children diagnosed with behavior issues (Webster-Stratton et al., 2011). First introduced approximately 40 years ago, it is designed to both treat and prevent substantial behavioral challenges in addition to improve prosocial behaviors and parenting skills (Webster-Stratton & Herman, 2010). The IY offers three central program components: IY Child Program/Dinosaur School, IY Parent Program (BASIC and ADVANCED), and IY Teaching Program. IY Child Program/ Dinosaur School is a prevention curriculum to be used in the classroom (Classroom Dinosaur Child Prevention Program) or as a small group intervention program (Small Group Dinosaur Child Treatment Program) for children ages three to eight. For the classroom, there are over 60 lesson plans, and for a small group, it runs approximately 18–22 weeks (2-h sessions) with treatment

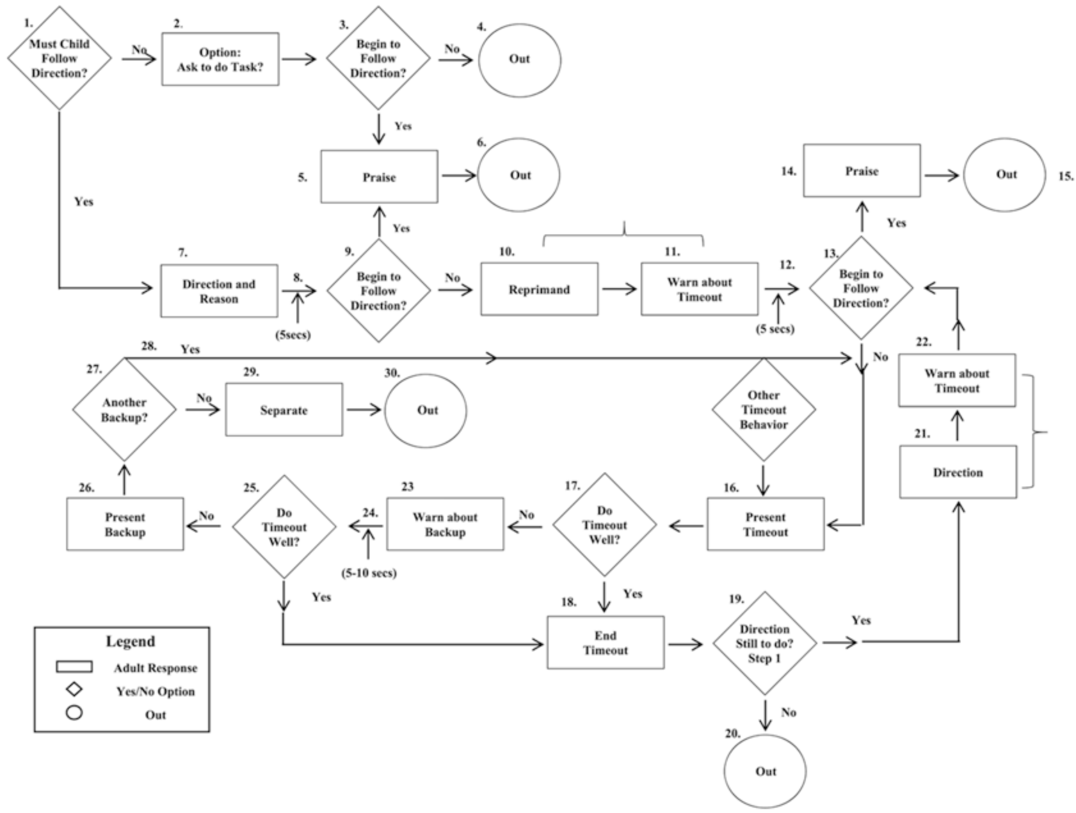

Fig. 34.1 Example of a behavior management flowchart

components, including video vignettes, roleplay, and addressing social as well as emotional competencies, such as following school rules, making friends, understanding feelings, and problem solving. The IY Parent Programs include the BASIC, which are separate programs based on child age (babies [0–1], toddlers [1–3], preschool [3–6], and school age [6–12]), and focus on enhancing the parent–child relationship, teaching appropriate ways to respond to undesirable behavior, and further developing prosocial skills (e.g., social skills, language skills). These run between 12 and 20 sessions (2–3 h per session). The ADVANCED IY Parent Program is an adjunct parent-focused treatment program targeting communication skills between caregivers. Auxiliary adjunct programs now offered include the School Readiness Program, Attentive Parenting Program, Autism Spectrum and Language Delays Program, and Well-Baby Program. Finally, the IY Teacher Program was created for educators of younger children (ages 3–8) to help teach classroom behavior management skills and promote prosocial behavior over monthly workshops, totaling 42 h. The IY also offers an Incredible Beginnings Program for day care providers and teachers of young children (ages 1–5) (The Incredible Years, 2013a).

The IY program comes at a hefty cost to its consumers at up to $4795 for the parent training series (Pidano & Allen, 2015), but is cost-effective when considering the expenditure of untreated antisocial behavior (e.g., crime and unemployment) on society (Charles et al., 2013; O'Neill et al., 2013). Of the IY programs, the parenting interventions have a rich body of literature. Webster-Stratton et al. (2011) reported that the research on the IY parent program is highly extensive, evaluating its effects on over 800 families with children (ages 3–7) diagnosed with

ODD/CD. Over the last decade, the literature has expanded greatly with multiple publications focusing on evaluating the IY parent program for other populations and ages. Specifically for the ADHD population, studies have compared the IY with medication (Lessard et al., 2016), preschool age children (Azevedo et al., 2013; Homem et al., 2015; Posthumus et al., 2012), the long term maintenance of effects (Drugli et al., 2010; Webster-Stratton et al., 2013) as well as the IY parent and teacher programs combined (Rimestad et al., 2018). Overall, these studies suggest that parents in an IY program versus medication group use more consistent and appropriate discipline strategies, that IY program effects can be seen up to 6 years after treatment, at-risk preschoolers are responsive as young as 3, and that combining parent and teacher IY programs is not more meaningful than parent training alone.

Fewer publications exist for the ASD population. An RCT and case study were completed in 2007 and 2008, respectively, but in the last decade, only a handful of articles have been published investigating the effects of the program on children with ASD (Dababnah & Parish, 2014) and children with a range of developmental disabilities (Kong & Au, 2018). Additional research with the ODD/CD populations have homed in on the impact effects of mediators and moderators, further advancing support of the IY. For example, studies have investigated its effects on children with heightened risk factors such as caregiver depressive symptoms (Boyd et al., 2017; Charles et al., 2013; Gardner et al., 2010), comparison of individuals with more severe emotional and conduct problems to those with fewer (Leijten et al., 2018a, b), shortened versions of the IY parenting program (Reedtz et al., 2011), cultural responsiveness (Lau et al., 2010), and high-risk and socially disadvantaged populations (Furlong & McGilloway, 2015; Menting et al., 2014; Scott et al., 2010; Sicotte et al., 2018).

The IY research has also demonstrated its efficacy with multi-cultural groups in various countries (e.g., Portugal, Russia, Finland) with exceedingly diverse populations (Maori tribes, Native Americans) (The Incredible Years, 2013b). The IY also continues to be supported with wide ranges of recipients and has demonstrated long-term maintenance of gains for many externalizing symptoms (Webster-Stratton et al., 2013; Drugli et al., 2010). However, less robust research has been produced for versions with fewer than the standard number of sessions when assessing child problem behaviors (Reedtz & Klest, 2016), the babies program (Jones et al., 2016), toddler and older children programs, in addition to research on component analysis, maintenance of skills beyond a 12-month follow-up (Pidano & Allen, 2015), combining programs (Rimestad et al., 2018; Webster-Stratton et al., 2011), and assessing transferability to non-US existing service delivery (Trillingsgaard et al., 2014). There is also a paucity of research on attrition in high-risk and socially disadvantaged populations as well as fidelity challenges (Furlong & McGilloway, 2015; McGilloway et al., 2012), as well as inconsistencies within the research on adjunct intervention strategies (Boyd et al., 2017) and effects on parental mental health (Charles et al., 2013; Leijten et al., 2018a, b).

Parent–Child Interaction Therapy

Another empirically supported intervention for families with children (generally ages 2–7) struggling with behavioral issues is PCIT. Developed over 40 years ago, this well-researched intervention is comprised of two phases and focuses on coaching sessions (in-vivo feedback) to teach parents how to manage and respond to behavioral issues as well as to teach skills that enhance the caregiver–child relationship. Similar to other PTPs, it is based on reinforcing desirable behaviors, not only of the child but as well as the parent during the "bug in the ear" coaching sessions, in addition to using behavioral strategies to decrease undesirable behaviors (e.g., tantrums, inappropriate attention seeking behaviors). The first phase of PCIT is child-directed interaction, where the parent is coached on how to respond and provide opportunities that foster more positive, healthy interactions between child and caregiver. Parent-directed interaction is the second phase in which the caregiver is taught how to discipline (e.g., time-out) in an appropriate, consistent, and nurturing way to decrease problem behaviors and improve compliance. PCIT typically takes place over 12–20 sessions in a clinic setting (PCIT International, 2015).

PCIT has also been adapted over the years to include group PCIT, home-based PCIT, teacher–child interaction training, infant behavior program (IBP), PCIT-ED (emotional development), PCIT with emotion coaching, intensive PCIT (I-PCIT), and PCIT-CALM. A third phase, referred to as bravery-directed interaction, can also be added for those children with separation anxiety (Lieneman et al., 2017). PCIT is internationally accepted, practiced, and researched in 11 countries and PCIT International provides training and certification (Lieneman et al., 2017).

Over the last decade, there have been continued advances with examining PCIT's effects on various communities and populations. Burgeoning research is with children diagnosed as having ADHD, anxiety (Carpenter et al., 2014), bipolar disorder, or depression (Luby et al., 2012). Multiple studies have also investigated treatment effects in community mental health centers both in the U.S.A. and internationally (Abrahamse et al., 2016; Bjørseth & Wichstrøm., 2016; Budd et al., 2011; Danko et al., 2016; Foley et al., 2016), domestic violence shelters and child-welfare agencies (Herschell et al., 2017; Keeshin et al., 2015; Lanier et al., 2014), foster homes (Mersky et al., 2016), correctional facilities (Scudder et al., 2014), and university-based outpatient clinics (Timmer et al., 2010). In addition, population-specific studies in the last decade have extended the literature and widened PCIT's applicability. For instance, modified programs targeting fathers (Bagner, 2013), socioeconomically disadvantaged populations (Fernandez et al., 2011; Nieter et al., 2013), and high-risk families (Chaffin et al., 2011; Galanter et al., 2012; Kimonis et al., 2014; Lyon & Budd, 2010), tailored treatment recommendations for children in foster care (Mersky et al., 2016), and children who are born preterm (Rodríguez et al., 2014). There have also been cultural adaptations for certain populations and groups, including ethnic minorities (McCabe et al., 2020, Chinese (Yu et al., 2011; Leung et al., 2017), Japanese (Hosogane et al., 2018), Latina/o (Niec et al., 2014; Ramos et al., 2017), Norwegian (Bjørseth & Wichstrøm, 2016), American Indian/Alaska Native (Bigfoot & Funderburk, 2011), Dutch, Mexican American, and caregivers in the military (Lieneman et al., 2017). For community populations, there is also evidence to suggest that a group format can be just as beneficial as individual, which has societal benefits as it can reduce discrepancies between the needs within some communities and access to services (Niec et al., 2016). Additional research, such as the article authored by Barnett et al. (2019), can assist by better identifying direct-to-consumer marketing techniques for certain culture groups. For instance, it is suggested that Spanish speaking caregivers may be more likely show intent to participate in PTPs when the advertisement is delivered by an actor therapist versus a parent.

In the last decade, the ASD research in this area has grown, with sustained positive outcomes. PCIT has also demonstrated its value when viewed as a preventative intervention with restricted but encouraging outcomes focused on counteracting child externalizing behaviors, prevention of maltreatment or reoccurring maltreatment (Kennedy et al., 2016), and developmental delays (Allen & Marshall, 2011; Garcia et al., 2014; Ros et al., 2016). PCIT literature continues to show several inconsistencies with maintenance of skills (e.g., young children may not require the same frequent follow-up) (Eyberg et al., 2014), caregiver characteristics (Lieneman et al., 2020), and parent outcomes (e.g., stress) (Fernandez et al., 2011). In a recent study, Woodfield and Cartwright (2020) investigated PCIT from a parental perspective, examining how parents' personal experiences throughout the program can help practitioners better understand component preferences and the possible impact of negative caregiver attributions (e.g., skepticism, doubt). Future studies should continue to assess newer adaptations such as the IBP (Bagner et al., 2015; Blizzard et al., 2018; Morningstar et al., 2019) and the I-PCIT (Graziano et al., 2015; Graziano et al., 2020) program, which have promising implications.

Triple P Program

The Triple P program is designed to be a population-based health approach, with the goal to serve as a preventative and treatment option for families with children displaying behavioral and emotional challenges. Triple P was developed in Australia, more than 40 years ago, and has grown to be one of the most extensively researched universal treatment programs available today. Triple P is based on the foundations of social learning theory as well as cognitive, behavioral, and developmental theories with the target being to reduce child behavioral and emotional issues by enriching parental knowledge, skills, and self-confidence. The primary program, Triple P, is designed for families with children in infancy up to age 12; however, there is also a teen version referred to as the Teen Triple P for ages 12–16. Similar to the IY and PCIT, adaptations have been made including specialist programs for families experiencing a separation or divorce (Family Transitions), children struggling with obesity (Lifestyle), children with disabilities (Stepping Stones), and Indigenous families (Indigenous) (Triple P International, n.d.-a).

Triple P has been determined to be cost-effective, culturally sensitive, and widely accessible, with parent resources that have been translated into 21 languages. It has been used in over 25 countries and data analyzed in over 980 studies and a plethora of published articles. The Triple P programs are offered as individual, group, online, or in a public seminar format to parents, teachers, and other paraprofessionals. Depending on the need of the consumer, Triple P offers a 5-level system in addition to the specialty programs. Level 1, also referred to as Universal Triple P, is a media-based information program designed to reach larger communities providing materials such as brochures, newspaper columns, and posters. The goal of Universal Triple P is to reduce stigma associated with support seeking behaviors, increase awareness of services, and counter negative messages in the media that suggest the caregiver is at fault (Triple P International, n.d.-b.). Level 2 is a basic, minimalist intervention for parents, offering short duration sessions ranging from 15 to 30-min consultations to three 90-min seminars for those caregivers seeking additional information, and has only general concerns about their child. The third level is for parents who have a child or teen with specific behavioral issues and can be delivered face-to-face, over the phone, or as small group sessions ranging from 2 to 4 h. Level 4 includes training in Triple P's 17 core positive parent skills and is intended for families with children experiencing severe problem behaviors. Delivery is in group format (five sessions and three follow-up consultants via phone), one-on-one (ten 1-h sessions), an internet-based service option, and a self-help workbook as well as weekly phone consultations options. Lastly, Level 5 is a rigorous support program for complex child and family issues offering two distinct formats based on family need. Formats include the Enhanced Triple P, offering three modules based on family explicit issues and include caregiver communication training and healthy adult coping skills in addition to addressing child-specific difficulties. The Pathways Triple P is designed to assist at-risk or vulnerable populations and includes anger management training (Triple P International, n.d.-b).

With the wealth of research evidence for this program, more recent studies have sought to investigate its effects on highly specific populations such as pediatric acquired brain injury, combinations of Triple P with other programs such as Acceptance and Commitment Therapy (ACT; Brown et al., 2015), further assessment of the Teen Triple P (Salari et al., 2014), and a community-based home visiting program targeting dietary intake (O'Sullivan et al., 2017). In addition, recent research has evaluated barriers to parental engagement (Eisner & Meidert, 2011), mode of delivery by context (Eisner et al., 2012), long-term follow-up (Hahlweg et al., 2010), and acceptability by culturally diverse parents (Morawska et al., 2011).

Despite the abundance of literature for these specific PTPs in general, there remains a scarcity in the literature investigating the effects on low- and middle-income countries (Hastings et al., 2012; Puffer et al., 2015), cultural adaptations (Baumann et al., 2015; Hamdani et al., 2017), programs for a wider range of child overall health issues, fathers as the primary participant (Sanders, 2012), treatment barriers (Lieneman et al., 2019), and further component analysis investigations (Lieneman et al., 2017; Pidano & Allen, 2015). There also remains need for more independent trials and replications with caution regarding investigator bias (Eisner et al., 2012; Sanders, 2012; Wilson et al., 2012). Surprisingly, even with attrition rates reported as high as 67%, a clear complication for many community-based PTPs, Lieneman et al. (2019) found that "drop out does not equate to failure" (p. 549). For instance, caregivers who attended at least four sessions prior to dropping out still had markedly higher improvements in child functioning. Timmer et al. (2010) found that mothers with depressive symptoms who generally tend to show high attrition rates showed meaningful gains after only the first phase of PCIT.

It is still crucial that clinicians assess for risk-factors and try to intervene to increase chances of success for caregiver and child (Bagner & Graziano, 2013). Evidence has been found that providing a post-training live video coaching session compared to a routine phone call can have an impact (Funderburk et al., 2015). Fowles et al. (2017) found that home-based treatment, compared to clinic-based, can indicate similar levels of positive outcomes, although a home-based program may be better for populations who tend to have poorer attrition (Fowles et al., 2017). Still, if these programs are to truly to become universal, researchers and developers have an obligation to work jointly and systematically with service-delivery professionals and policymakers (Pickering & Sanders, 2014).

Behavioral Skills Training

Caregiver training is now seen as an essential component to skills training programs in addressing limitations associated with generalization and maintenance of skills (Booth et al., 2018; Hsieh et al., 2011) and research has focused more specifically on the steps needed to teach caregivers these skills with long-term success. A training method that continues to gain interest in the ABA field is Behavioral Skills Training (BST; Crane, 1995). BST is an evidence-based teaching method typically comprised of four components: instructions, modeling, rehearsal, feedback (Ward-Horner & Sturmey, 2012; see Table 34.4).

Instructions often include providing a rationale for why a skill should be learned either verbally by an instructor or in written form. Handouts can be distributed on the steps required to complete the skill (i.e., task analysis) or what is expected from the learner. Next, the novel skill is modeled for the learner. This provides the learner with an opportunity to see the skills demonstrated correctly. Rehearsal or role-play provides an opportunity for the learner to practice using the new skill and it also gives an opportunity for the instructor to assess whether the skill is demonstrated correctly. The last step of the BST process involves providing feedback to the learner. Feedback has an informative component that can be delivered in the form of reinforcement (i.e., differential attention contingent upon correct performance), including tangible items, labeled (i.e., behavior-specific) or unlabeled praise, or corrective criticism to remediate incorrect performance. Overall, BST is a highly accepted and popular teaching procedure due to its ease of

Table 34.4 Components of BST

Teaching technique	Description
Instruction (tell)	State the name of the skill and provide a rationale (explain why the skill is important)
Model (show)	Demonstrate the skill either in person, through telehealth, or using video modeling
Rehearsal (practice)	Practice the skills with the caregiver or trainee in vivo and once mastered, practice in situ
Feedback (advise)	Give descriptive positive feedback (labeled/behavior-specific praise) and corrective feedback for incorrect responses

implementation. It is also recognized by the Behavior Analyst Certification Board (BACB) and is included as a requirement in the Supervisor Training Curriculum Online (2.0) (BACB, 2020).

Components of BST have been used to teach highly diverse populations (Hassan et al., 2018) such as children with or without a disability, staff, peers, young adults, adolescents, siblings, college students, and parents. BST has been used with a wide range of caregivers to teach diverse skills sets (e.g., safety skills, guided compliance, social skills) and reduce challenging behaviors (e.g., noncompliance) (Dogan et al., 2017). Within the last decade, the number of studies published supporting the positive effects of BST on caregiver skills training has increased substantially. Specifically, recent research has extended the literature in support of training caregivers to implement interventions to address food selectivity (Alaimo et al., 2017; Najdowski et al., 2010; Seiverling et al., 2012), social skills (Dogan et al., 2017; Hassan et al., 2018; Kornacki et al., 2013), DTT (Eid, Aljaser, et al., 2017b; Subramaniam et al., 2017), manding (Loughrey et al., 2014; Suberman & Cividini-Motta, 2020), incidental teaching procedures (Hsieh et al., 2011), PRT (Coolican et al., 2010), Natural Language Paradigm (NLP; Eid, Alhaqbani, et al., 2017a), parent responsiveness to improve language (Paul et al., 2013; Tsiouri et al., 2012), and behavior analytic strategies to decrease problem behaviors of children with ASD (Crone & Mehta, 2016). Furthermore, studies have proven positive results when teaching caregivers to implement a prompting procedure for noncompliance (Drifke et al., 2017), conducting functional assessments (Shayne & Miltenberger, 2013), arranging safe sleep environments (Carrow et al., 2020), training safety skills (Harriage et al., 2016; Ledbetter-Cho et al., 2019), daily living skills (Cruz-Torres et al., 2020), educators training parents to implement a tutoring program (Kupzyk et al., 2012), and parent training, specifically for single parents (Briggs et al., 2013).

Awarding caregivers even more liberty in the treatment process, Gabor et al. (2016) and Halbur et al. (2020) assessed parents' preference for various procedures, following BST to teach new skills. In the first study conducted by Gabor et al. (2016), five caregivers (four parents and one teacher) were taught how to implement noncontingent reinforcement (NCR), differential reinforcement of alternative behavior (DRA), and differential reinforcement of other behavior procedures (see Fig. 34.2). Following BST, caregivers participated in experience trials, where they practiced with their child until 90% integrity was established prior to moving onto choice trials. During choice trials, researchers used concurrent-chain arrangements to assess preferences and revealed that two caregivers distinctly selected DRA as the preferred choice and all but one participant had less definite preferences to the type of differential reinforcement but still more so than NCR.

Halbur et al. (2020; see Fig. 34.3) trained four parents, in five or fewer sessions, how to implement least-to-most, progressive-prompt delay, and most-to-least procedures to mastery. Once training was complete, parents were able to practice the procedures with their child in a quasi-random and counterbalanced order during experience sessions. Finally, parents participated in choice sessions, where researchers again used concurrent-chain arrangements to determine high-preference and moderate preference. All parents selected the least-to-most procedure as the high-preference intervention and the most-to-least procedure as the moderate preference. These studies are important because caregivers are beginning to take a greater role as the agent of change with their child in these types of training models. If more studies such as these are conducted to identify variables that influence preferences, this knowledge can then be used by behavior analysts to modify or create new procedures that are both effective and desirable to caregivers (Halbur et al., 2020), who ultimately, are the ones who will need to use these skills regularly in multiple settings with their child.

Beyond the basic four BST components, variations in more recent literature have included video review, structured observations (Pangborn et al., 2013), in-vivo feedback (Shanley & Niec, 2010), video modeling (Johnson et al., 2015), in-situ training (Hassan et al., 2018), and the

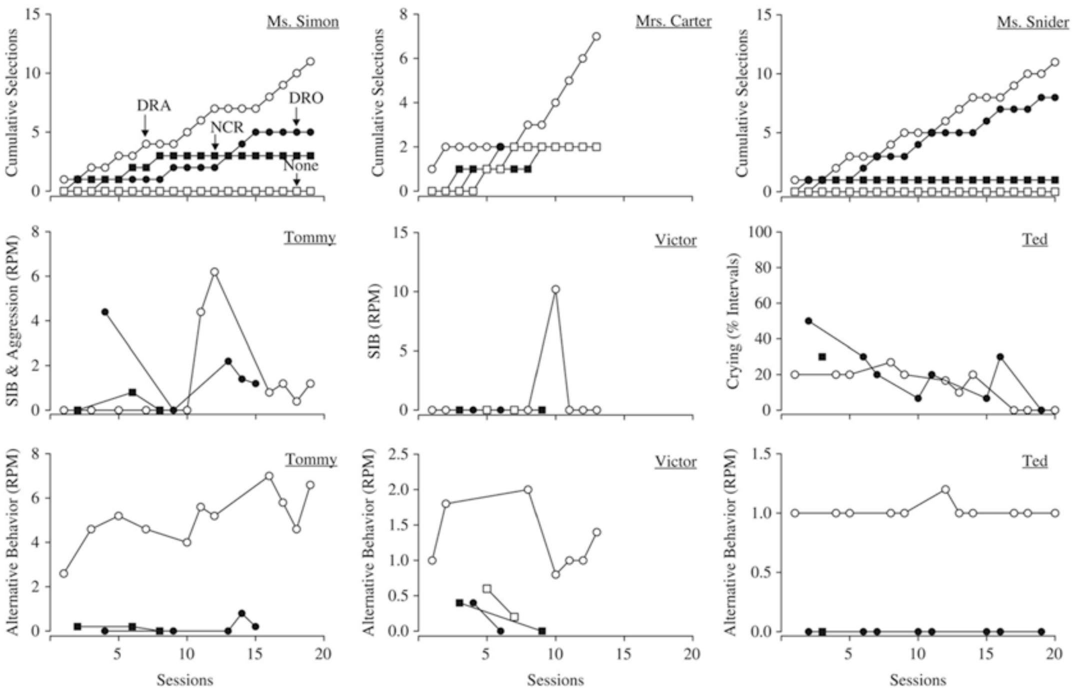

Fig. 34.2 Top graphs show cumulative treatment selections by caregivers during the choice sessions; the center and bottom graphs show problems and alterative behavior, respectively, exhibited by the child during each session. RPM responses per minute

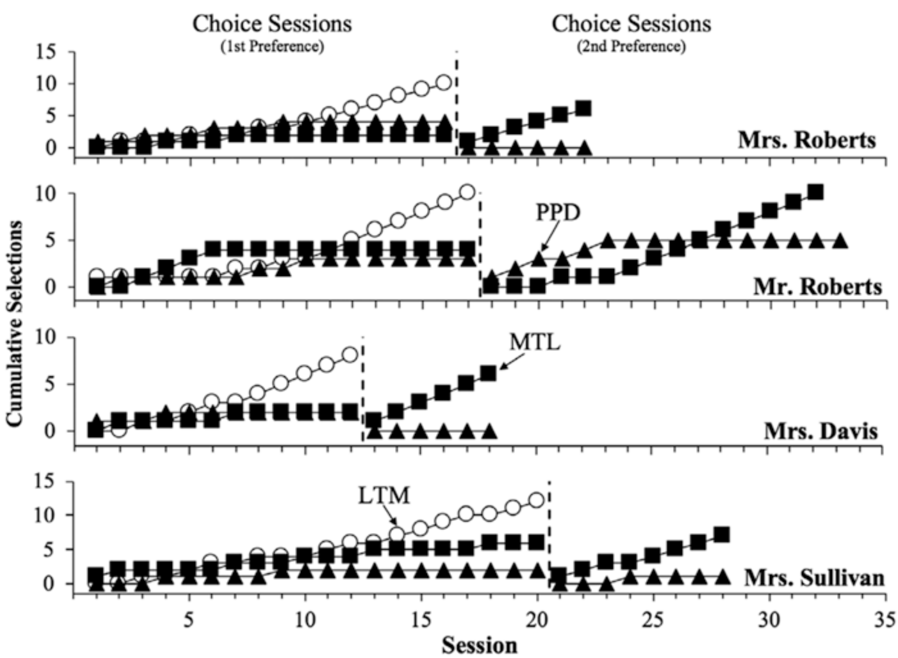

Fig. 34.3 Cumulative treatment selections for Mrs. Roberts (top panel) and Mr. Roberts (second panel), Mrs. Davis (third panel), and Mrs. Sullivan (bottom panel) during choice sessions. PPD progressive-prompt delay, MTL most-to-least, LTM least-to-most

addition of General-Case Training (GCT; Alaimo et al., 2017; Seiverling et al., 2010). According to Seiverling et al. (2010), GCT involves "training responses to the full range of discriminative stimuli in which responding should occur" (p. 55), and in combination with BST, it was found to be an effective package to train staff to conduct NLP room setup and procedures. In another study, Alaimo et al. (2017) also noted the benefits of BST and GCT, but suggested that ongoing feedback was not a necessary component to train caregivers to implement a feeding program; however, because a component analysis was not conducted, additional research is needed to see the role of other factors, such as multiple components beyond BST, or the addition of modifications (GCT).

Reoccurring weaknesses in the BST literature for caregiver training remain aimed toward identifying the fewest number of components and what formats (e.g., instructions provided as written vs. verbally) and promoting behavior change for both caregiver and child (Bachmeyer-Lee et al., 2020; Najdowski et al., 2010). In the 1980s, only three studies focused on conducting a component analysis of BST with findings suggesting instructions alone did not suffice and meaningful gains were only made with the addition of modeling and feedback (Ward-Horner & Sturmey, 2012). More recently, two additional studies produced inconsistent results with one noting that all steps were necessary for parents to meet the criteria (Drifke et al., 2017) and the other that feedback and modeling were the most effective (Ward-Horner & Sturmey, 2012). Pangborn et al. (2013) successfully taught caregivers to implement feeding protocols with a multicomponent treatment package using sequential application to evaluate essential steps. Of the seven steps included in the package, it was determined that instructions (written and verbal) were not sufficient. One parent only required an additional feedback component, another two parents required feedback plus video review, and the last participant required feedback, video review, modeling, and structured observation to meet criterion. These studies targeted different populations and behaviors, which suggests that researchers and practitioners should be cautious to draw far-reaching conclusions, and it would seem that individually tailored treatment options may be a way to provide efficient, effective training.

Current research has not drawn any firm conclusions regarding which components of BST produce the best results with various populations, settings, and behaviors; therefore, there will likely continue to be a growing number of studies that employ a limited number of BST steps as part of training new skills. For example, some researchers have examined BST without the modeling component. Forehand et al. (2011) achieved positive results for caregivers using instruction, discussion, and role-playing of child behaviors as part of a group curriculum based on the book *Parenting the Strong-Willed Child*. In a two-part study, researchers first examined the effects of a self-instructional manual, which included instructions, role-play (self-practice exercises), feedback (self-rated performance), and tests; adding video modeling for those parents who did not meet the mastery criterion. This was then compared to a more comprehensive package consisting of the self-instructional manual, video modeling, combined with role-playing with the experimenter as well as corrective feedback and if needed additional modeling conducted by the experimenter. The package with additional role-play/modeling/feedback with the experimenter produced far superior results (mean accuracy increased from 61.1% to 84.2%) compared to the manual and video modeling alone (mean accuracy increased from 43.4% to 64.5%) (Young et al., 2012). Vahidi et al. (2017) examined the effects of a PTP without the use of modeling, and moreover, feedback was only provided in the last (12th) session and results produced beneficial outcomes on child cognitive performance. Another PTP focused on a social communication intervention for children with ASD and found parent-implemented skills gains and encouraging child outcomes without a modeling component (Shire et al., 2015).

Studies have investigated the effects of BST without role-play. During group sessions, instructions, video modeling, and feedback were used to effectively teach parents PRT skills which led to an increase in child language (Boettcher Minjarez et al., 2011) and cognitive skills (Hardan et al., 2014). Landa et al. (2011) investigated the effects of a comprehensive intervention for parents and their children with ASD, including a 10 hour a week classroom teaching program, home-based parent training (modeling, feedback), parent education, instructional strategies, and a supplemental social curriculum. In addition, Radley et al. (2014) added to the literature on the value of training caregivers to be interventionists with the combination of social skills training (i.e., Superheroes Social Skills) and parent training without role-play (Radley et al., 2014). BST without feedback has also been examined. One study examined the effects of a brief behavioral intervention as part of a PTP; however, feedback was not incorporated, and booster sessions were optional for parents who reported continued problems with their child's behavior. Results revealed positive child and parent outcomes (Axelrad et al., 2013). Another study examined the effects of a brief PTP without feedback to improve parent knowledge and attitudes about adolescent sexuality in Ghana (Baku et al., 2017). Feedback was also not used when teaching parents how to implement activity schedules for children with ASD, but skills improved with instructions, role-play and video model alone (Gerencser et al., 2017). Finally, modeling, rehearsal, and feedback without clear instructions/rationale have been used to teach children with ASD fire-safety skills with success (Garcia et al., 2016).

Fewer than three of the four BST steps have also been assessed. Instruction (in baseline) and feedback (post baseline) alone were used for a feeding program with results, indicating that written instructions were not sufficient, but the added component of verbal feedback produced favorable results (Aclan & Taylor, 2017; Bachmeyer-Lee et al., 2020). Gerow et al. (2018) included only instructions (written and verbal) and feedback to teach parents to accurately implement functional communication training (FCT) with their child; however, one of the two parents who completed the generalization assessment required a self-monitoring booster session suggesting that these two BST components alone may not be sufficient. In addition, researchers have used instruction and rehearsal as part of a PTP for caregivers enrolled in the welfare system to reduce child behavioral issues (Greeno et al., 2016) and enhance the caregiver–child relationship (Li et al., 2013). Overall, across studies with modified or limited BST components, results have been somewhat inconsistent albeit hopeful for an even simpler training procedure, yet many studies fail to formally assess fidelity (Gengoux et al., 2015), and the lack of replication leaves professionals unaware if fewer BST steps can be used with a wider populations (ages, ability) or variations of behavioral targets. There are also a large number of PTP studies with what would seem to be BST components, but the specific techniques used were not explicitly stated or described, making replication insurmountable.

There is also a sizeable and important lapse in research applying BST to caregivers, other than the parents of younger children with behavior or developmental challenges. Caregivers working with individuals with physical or medical disabilities, such as dementia, often are not equipped with the skills needed to address behavioral concerns that arise (Buchanan et al., 2011); meanwhile, there is a significant demand and burden placed on these caregivers who would highly benefit from effective skill building. Numerous behavioral principles and techniques can be taught to individuals with dementia or Alzheimer's such as shaping to target remembering skills, errorless learning to teach face–name associations, use of external memory aids as well as role-play for improving communication skills, and modeling with rehearsal to recover ADL skills (Buchanan et al., 2011). Beyond the positive outcomes skills training would have on the care for the individual, these skills may also serve to reduce some of the negative consequences that can befall caregivers when they are overburdened (Kavanaugh et al., 2019).

Ninety dyads (caregivers and dementia patients) participated in a 5-day group residential training program, where caregivers were exposed to didactic sessions, modeling, and role-play focused on behaviors associated with reducing stress, use of coping techniques, behavior management, and problem-solving skills. Researchers revealed that caregivers reported an increase in needs being met, specifically relating to managing behavior, practical tasks, communication, and information, but level of burden and depression remained unchanged (Gresham et al., 2018). Potter et al. (2012) used an instructional DVD and diary log to reduce falling incidents among caregivers supporting individuals with cancer. Another study included a psychoeducation program, where caregivers of individuals with dementia were taught the TANDEM model, a communication training technique focused on the best ways to facilitate presentation, attention, comprehension of information, and finally, retaining that information. Once completed, participants engaged in role-play to practice newly learned skills and results demonstrated positive gains (Haberstroh et al., 2011). Similarly, Liddle et al. (2012) also used an instructional DVD to teach communication and memory strategies; however, modeling, role-play, and feedback were not noted. For caregivers of individuals with dementia, instructions, modeling, and role-play were used during a 2-h training to improve knowledge of ADL skills, yet caregiver burden and depression scores maintained (DiZazzo-Miller et al., 2017). Finally, two studies reported that the application of dialectical behavior therapy among other components, for caregivers of marginalized children and for caregivers of individuals with schizophrenia, suggested a reduction in mental health-related symptoms (e.g., distress, depression, and anxiety) (Behrouian et al., 2020; Woods-Jaeger et al., 2018). Unfortunately, many of these types of skills training publications do not provide detailed procedures; therefore, it is unknown if BST components were included. Still, it is probable that if BST were added, and it would further improve results.

Internet-Based Services

Telemedicine has been used for decades within the medical field and is defined as "the use of telecommunication and online technologies to provide healthcare at a distance" (Neely et al., 2017, p. 850). This service now goes by many terms including telehealth, telepractice, virtual-care services, and teletherapy, but for the purposes of this chapter, it will be referred to as telehealth. Distinguishing itself from other internet-based services or online training programs, telehealth involves online instruction and video conferencing connecting an interventionist, such as caregivers or teachers, with an expert (Neely et al., 2017). Over the last decade, to address the discrepancy between need and services provided due to geographic or financial barriers and long waitlists, telehealth research has flourished along with burgeoning publications that supports its effectiveness and societal benefits.

Telehealth has been shown to be cost-effective (Lee et al., 2015; Lindgren et al., 2016; Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, Dyson, et al., 2013b), time and resource efficient (Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, Dyson, et al., 2013b), and rated acceptable by participants (Bearss et al., 2018; Baharav & Reiser, 2010; Wainer & Ingersoll, 2015; Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, & Waldron, 2013a). Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, Dyson, et al. (2013b) completed a cost comparison for implementation of FAs and reported an average weekly telehealth cost of $58 per child compared to $335 for home-based services including travel expenses for the service provider. More impressive were the time and financial gains when telehealth was used for FAs and FCT combined (192 weekly sessions), indicating that the telehealth option was less expensive, with a savings of $44, 372 and saved services providers from spending over 1,000 hours of driving.

Online PTPs remain popular, especially for caregivers of children with behavioral issues (White et al., 2019). With rapidly developing technological advances, these programs are reaching further and with broader populations. For instance, Karr et al. (2017) connected the School for Global Inclusion and Social Development, University of Massachusetts, U.S.A. with parents in Bangladesh. Furthermore, the positive influence of gaming features (Bayley & Brown, 2015; Love et al., 2016), peer support (Wilkerson et al., 2020), and use of self-directed programs for various skills training such as PRT (McGarry et al., 2019) are trending. Blackman et al. (2020) compared the effectiveness of in-vivo and an online PTP and found both groups showed significant improvements in skills and knowledge. However, coaching is still encouraged, because a self-directed program may oversimplify treatment strategies (Irvine et al., 2015), which could have negative outcomes for families with more complex parent–child issues.

There have been a number of journal articles in support of behavior analytic interventions provided via telehealth (Suess et al., 2014), but many of the recent studies are focused toward individuals with developmental disabilities. This population has a clear need and substantial discrepancy between services needed and the availability and accessibility of services. Many recent studies have examined telehealth as a tool for teaching FCT and FAs. Wacker, Lee, Dalmau, Kopelman, Lindgren, Kuhle, Pelzel, and Waldron (2013a) used telehealth to coach parents to provide FCT to children with ASD displaying behavioral issues and found that not only were parents highly acceptable of the service but average reduction in problem behavior across children was approximately 93%. In addition, telehealth took an average of 16 sessions to meet the 90% criterion, whereas it took an average of 25 sessions for the same behavior improvements with a separate group of participants in a home-based program. The role of coaching has also been demonstrated as a favorable component of telehealth services for caregivers of individuals with disabilities (Benson et al., 2018; Ingersoll et al., 2016; Ingersoll & Berger, 2015; Simacek et al., 2017; Wainer & Ingersoll, 2015). For instance, Benson et al. (2018) demonstrated that telehealth with coaching was able to produce favorable outcomes even when targeting challenging behaviors such as self-injury while also increasing the use of mands.

Beyond parent training, a variety of online services have also been used in other caregiver settings, such as those caring for individuals with dementia. Kajiyama et al. (2013) assessed the program iCare (ICC), a web-based program designed to improve caregiver knowledge of dementia, relaxation skills to manage stress, behavioral activation strategies, effective communication skills, managing problem behavior of the care recipient, and health-related choices. While stress levels improved for the ICC group, dropout rates were high (31%). Online services may not serve as a replacement for in-vivo sessions but for some populations it could be a very advantageous adjunct service to address immediate geographic or financial barriers to accessing treatment (Blackman et al., 2020). Furthermore, in more rural communities, access to high-speed broadband may serve as yet another barrier to contact online services (Suppo & Mayton, 2014). As seen in Fig. 34.4, Lee et al. (2015) developed comprehensive guideline for technology when developing telehealth services and strategies to help address trouble shooting problems that may arise with connectivity, hardware, and software during behavior analytic interventions.

Future research for telehealth and internet-related caregiver training must continue to assess greater types of training opportunities and caregiver accepted interventions (Boisvert & Hall, 2014; Suppo & Mayton, 2014). Documenting and monitoring fidelity of implementation (Baharav & Reiser, 2010; Suess et al., 2014), technological issues such as challenges with headsets and viewing (Baharav & Reiser, 2010; Boisvert & Hall, 2014), and considerations for online programs such as lengthy videos compared to modules broken up into shorted durations (Ingersoll et al., 2017), are included as some of the areas that are still lacking sufficient data. In addition, the benefit of supplemental materials (Ingersoll & Berger, 2015), determining which subgroups of parents may be more responsive and accepting of telehealth (Ingersoll & Berger, 2015; Ingersoll et al., 2016; Suess

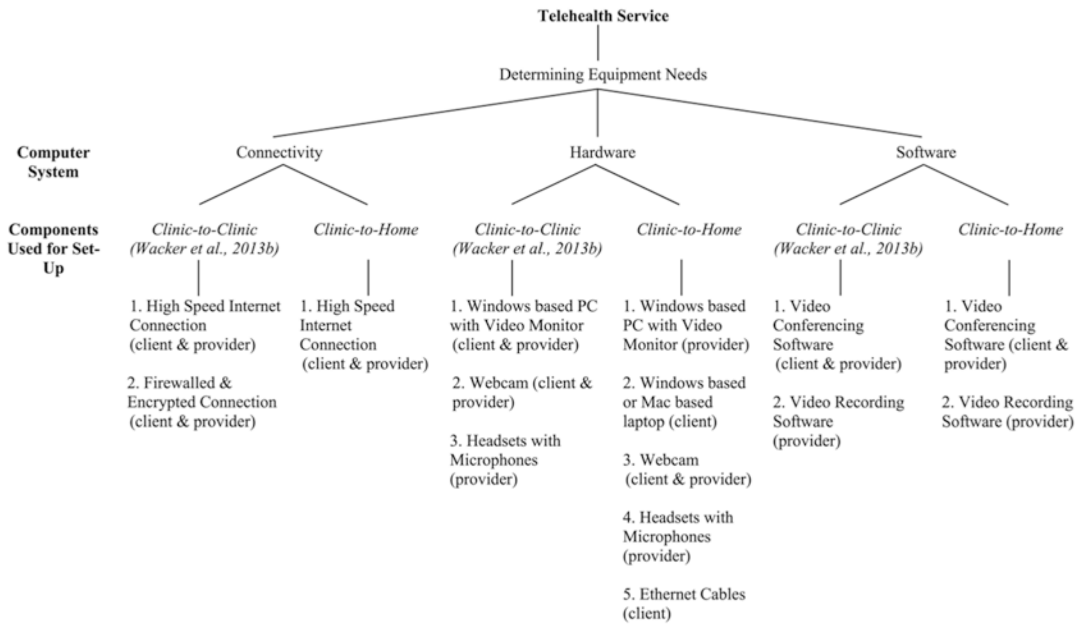

Fig. 34.4 Comparison of telehealth equipment needs between the clinic-to-clinic and clinic-to-home projects

et al., 2014; Wainer & Ingersoll, 2015; Vismara et al., 2012), and replication (Boisvert & Hall, 2014) must continue to be an area of focus for researchers.

Summary and Conclusions

Caregiver training has come a long way over the last several decades and now has earned universal recognition of its profound effect, on both caregiver and child behaviors. Development of caregiver training over the last decade has broadened its scope to new populations, improved ways of teaching, and equipped professionals and consumers with simpler, more efficient methods and tools. Caregiver training programs are nationally recognized in the U.S.A. and encouraged as part of state funded support systems; in addition to being globally applied as prevention models to reduce child maltreatment and boost societal gains. Given the advancement and accessibility of technology, telehealth options will continue to offer those individuals with situational barriers easier ways to get their family's needs met and will hopefully continue to magnify to reach populations across the globe, where psychological services are necessary but highly limited or nonexistent.

Without cures for cancer, Alzheimer's disease, and other degenerative conditions, and with mental health issues on the rise, caregivers demand our services and support. Particularly now more than ever, there is a worldwide necessity for access to telehealth services due to the coronavirus disease (COVID-19) pandemic that began making worldwide news in the early weeks of 2020 and continues to cause uncertainty regarding at what point face-to-face services options will return to normal. ABA and psychology researchers as well as service providers must continue to be zealous and efficient while continuing to develop, assess, and reevaluate the most accessible, affordable, as well as easy to implement caregiver skills training programs and resources. With cooperative actions between practitioners, researchers in the field, and policymakers, these assets can truly become universal for caregivers and care receivers, considerably adding to an improved quality of life.

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35 Staff Training

Jason C. Vladescu and Kathleen E. Marano

Staff training is an area of focus that falls largely under the scope of organizational behavior management, a subdiscipline of applied behavior analysis. The focus of this chapter is on performance management as it related to training staff in human service settings. Readers interested in other areas of organizational behavior management (e.g., systems analysis, behavior-based safety) should refer to other sources (e.g., Daniels & Bailey, 2014; Gravina et al., 2018; Lebbon et al., 2011; McGee & Crowley-Koch, 2019; Wilder et al., 2009, 2017).

Individuals seeking the credentials of Board Certified Behavior Analyst (BCBA), Board Certified Assistant Behavior Analyst (BCaBA), or Registered Behavior Technician must pass certification examinations that cover a variety of areas. For example, the BCBA and BCaBA examinations require individuals to receive training in the basic concepts and principles that make up the science of applied behavior analysis, as well as have applied training in ethics, behavior assessment, behavior-change procedures, selecting and implementing interventions, and personnel supervision and management (Behavior Analyst Certification Board, 2017). Therefore, those who provide supervision and training to the individuals entering the field are responsible for training a wide variety of skills. Such skills include training staff to conduct discrete trial instruction (DTI), conduct stimulus preference assessments (SPAs) to assess consumer preference, conduct teaching designed to teach communication skills, and manage the performance of other staff. Therefore, it is important that staff receive effective training for a variety of target skills.

Effective staff training techniques are also necessary due to the importance of high treatment integrity when implementing behavioral technologies with consumers with developmental disabilities. Treatment integrity refers to the extent to which an intervention is performed accurately (Gresham et al., 1993). That is, treatment integrity measures are used to assess whether behavioral interventions are implemented as intended. For example, a certified behavior analyst who is responsible for training a direct-care staff member to conduct DTI would collect treatment integrity data on how accurately the staff member performs each step as the program was designed. Researchers studied the effects of treatment integrity errors to evaluate the impact of errors on the overall efficacy of the interventions. Results demonstrated that treatment integrity errors decreased the efficacy of the intervention (Carroll et al., 2013; Fryling et al., 2012). Researchers demonstrated that interventions designed to decrease challenging behavior and skill acquisition interventions were both less

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_35

effective when implemented with low treatment integrity. For example, Wilder et al. (2006) found lower compliance in children when treatment integrity levels decreased. Breeman et al. (2020) found that skill acquisition was slower when auditory-visual conditional discrimination training occurred with low integrity and faster under the high integrity condition. Given that errors in the implementation of behavioral technologies can have detrimental effects on the efficacy of an intervention, staff training techniques must ensure that individuals learn to perform skills with high levels of accuracy.

The purpose of this chapter is to provide an overview of staff training techniques with a focus on application in human service settings. We will discuss behavioral skills training (BST), the components that comprise BST, and potential modifications that trainers can make to traditional in vivo training procedures. In addition, this chapter will describe methods for training staff to provide training to others using pyramidal training strategies. The chapter will also provide a description of how to provide ongoing support after initial staff training, including a discussion of assessment tools trainers can use to identify the variables maintaining performance and indicate the best ways to improve performance.

Initial Approaches to Staff Training: Behavioral Skills Training

BST is considered one of the most effective staff training procedures (DiGennaro Reed et al., 2018). BST involves instructions, modeling, rehearsal, and feedback, which are provided until the trainee meets a predetermined mastery criterion. Typical BST training sessions begin with a trainer providing a rationale explaining why learning the skill is important, explaining how to perform the target skill, and providing descriptions and operational definitions for all steps that comprise the skill. Then, the trainer provides a model of correct performance of the target skill. Next, the trainee practices performing the skill, while the trainer observes and delivers positive and corrective feedback regarding performance. The rehearsal and feedback steps are then repeated until the trainee correctly performs the target skill (DiGennaro Reed et al., 2018; Parsons et al., 2012). Therefore, BST training requires both performance- and competency-based components.

BST Components: Instructions

Instructions involve providing staff with a description of the target skill, including operational definitions for each step and describing how to perform all steps (DiGennaro Reed et al., 2018). The purpose of instructions is to provide descriptions of individual steps and to describe the contingencies under which staff should perform the target behaviors. Providing these descriptions likely leads to staff developing rules for the appropriate responses to engage in under various scenarios (Gutierrez et al., 2019). Essentially, instructions provide explanations for staff about what to do and when to do it. Simple instructions involve only descriptions of the steps, whereas enhanced instructions may include relevant pictures or diagrams.

Trainers can choose from a variety of modalities for delivering instructions, including spoken and written instructions. Spoken instructions involve the trainer orally describing the steps that make up the task analysis for the target skill. Written instructions typically involve a brief summary of the target skill (DiGennaro Reed et al., 2018) or can consist of a written task analysis containing operational definitions. Trainers should ensure that the written instructions are written succinctly and focus specifically on the necessary steps, rather than being part of a larger and lengthier behavior plan (Parsons et al., 2012). Trainers should provide both written and vocal instructions when possible (DiGennaro Reed et al., 2018; Parsons et al., 2012).

DiGennaro Reed and Henley (2015) conducted a study designed to identify the various types of training and performance management procedures that are commonly used in clinical settings. The results of the study indicated that didactic approaches, including providing vocal or written instructions, are the most commonly used staff training procedure. However, many studies have demonstrated that using simple instructions alone is not typically effective for increasing staff performance to desired levels (DiGennaro Reed et al., 2010; Feldman et al., 1989; Hudson, 1982; Krumhus & Malott, 1980). For example, DiGennaro Reed et al. (2010) conducted a study designed to train teachers to accurately perform behavioral interventions. During baseline, the experimenters provided participants with written protocols that explained all the steps required to implement the intervention and verbally reviewed all steps. Then, participants completed a written post-test and the experimenters provided feedback to the participants regarding their written responses. Despite the delivery of the instructions, participants' performance of the behavioral interventions remained below desired levels of performance. Similar outcomes have been observed in other studies (e.g., Gutierrez et al., 2019; Marano et al., 2020a, b), suggesting that the inclusion of simple instructions often does not lead to substantial improvements in staff responding.

Although simple vocal and written instructions alone are not typically effective, researchers identified modifications to written instructions that can improve their efficacy. Common enhancements to written instructions include adding pictures and diagrams that correspond to each step, adding video models that demonstrate performance of each step in a task analysis, and adding descriptions of relevant antecedent stimuli and consequences of performing steps correctly. For example, Graff and Karsten (2012) used enhanced written instructions to train teachers to implement SPAs. During baseline, participants were given simple written instructions that described how to perform the assessments, which did not result in mastery-level performance. During training, the experimenters provided participants with a detailed data sheet and enhanced written instructions, which were written without technical jargon and supplemented with diagrams. The use of enhanced written instructions resulted in mastery level performance for all participants. Al-Nasser et al. (2019) expanded upon the work of Graff and Karsten (2012) by providing participants with textual information that was enhanced with visual cues (e.g., detailed examples, pictures), and also found that the enhanced written instructions were effective. Tyner and Fienup (2016) enhanced a task analysis that described how to create graphs in Excel by including descriptions of relevant antecedents (e.g., the colors, shapes, and locations of buttons) and consequences for each step (e.g., describing what the graph should look like after phase change lines are inserted). A comparison of the original and enhanced task analyses demonstrated that the enhanced task analysis resulted in more accurate graphing behavior. Therefore, although simple written instructions alone are not often effective, adding supplemental materials and information have been shown to increase efficacy.

Overall recommendations for delivering instructions include avoiding technical jargon and using a combination of written and vocal instructions (DiGennaro Reed et al., 2018; Parsons et al., 2012). For example, trainers may provide staff with a written task analysis and then verbally review it with the trainee. Trainers should also include enhancements to written materials whenever possible, such as including pictures of the required materials, describing the stimuli and conditions prior to and following the target behavior, and including diagrams.

BST Components: Modeling

The second component of BST is modeling, in which staff view someone else performing the target skill. The purpose of the model is to demonstrate the correct way to perform a behavioral technology so that staff perform the skill in the same way as the model when they are in similar situations. Trainers can choose to provide models either in vivo or through video (Catania et al., 2009; DiGennaro Reed et al., 2018; Lipshultz et al., 2015; Vladescu et al., 2012). In vivo models involve the trainer performing the skill live in front of the trainee. For example, Adams et al. (1980) modeled the delivery of positive reinforcement, while staff observed. Although in vivo models are often beneficial, because they do not require the use of any technology, they also have some limitations. In vivo models may result in inconsistent performance across demonstrations, which may result in the trainer modeling the skill with low treatment integrity (DiGennaro Reed et al., 2018). This is potentially problematic because it may result in the staff performing the skill with errors.

To ensure that the modeled performance is accurate, trainers can create and use video models. Video models involve staff watching pre-recorded performance of the target skill. For example, Lipshultz et al. (2015) used a video model depicting the experimenter performing SPAs to train staff to perform the assessments themselves. Trainers can also incorporate an instructional component into the videos by adding on-screen text or voiceover instruction. These enhancements increase the likelihood the viewer attends to the relevant aspects of the video. Video models offer potential advantages over in vivo models because they ensure accurate demonstration of the skill and multiple trainers can use the same video, potentially saving organizations time and money (DiGennaro Reed et al., 2018). Additionally, staff can view the videos from their own homes, which eliminates the need for a staff trainer, and allows for training to occur in rural areas or when there is a relative shortage of trainers available to provide in vivo training (Gerencser et al., 2019; Graff & Karsten, 2012; Karsten et al., 2015). Video modeling research indicates that video models are commonly used and effective for training a variety of skills. Researchers successfully used video models to train staff to conduct DTI (Catania et al., 2009; Vladescu et al., 2012), SPAs (Deliperi et al., 2015; Delli Bovi et al., 2017; Lipshultz et al., 2015; Weldy et al., 2014), problem-solving interventions (Collins et al., 2009), individual behavioral interventions (DiGennero Reed et al., 2010), the Picture Exchange Communication System (Martocchio & Rosales, 2017), mand training (McCulloch & Noonan, 2013), graph creation (Mitteer et al., 2018), functional analyses (Moore & Fisher, 2007), providing performance feedback (Shuler & Carroll, 2019), and guided compliance procedures (Spiegel et al., 2016).

Given the favorable results of video modeling research, there is likely a benefit to using videos when providing demonstrations of target performance. If trainers cannot provide video models and must provide models in vivo, trainers should model the skill in the intended context when possible, ensure that the model depicts accurate performance, and provide multiple examples of the skill (DiGennaro Reed et al., 2018). For example, a trainer who is demonstrating how to perform an SPA might show a video of someone performing the skill with a child that shows multiple examples of each step.

BST Components: Rehearsal

The third component of BST is rehearsal, which consists of the opportunity for staff to practice performing the target skill after instructions and models are provided. When rehearsing the target skills, staff can imitate the model's behavior and compare their own performance to the model's behavior. If the staff's behavior is similar to the model's performance, this may reinforce the staff's performance, resulting in future correct performance of the skill. Similar to the research on instructions alone, researchers found that rehearsal alone is not typically effective for training staff to perform behavioral technologies at mastery levels (Jenkins & DiGennaro Reed, 2016; Ward-Horner & Sturmey, 2012). Therefore, rehearsal should always be used in combination with the other BST components.

Staff can practice performing the target skill in either the natural setting or in an analogue setting. The natural setting refers to the location where staff will be expected to perform the skill. For example, a skill that will be performed in a school setting would be trained in the actual school. Lavie and Sturmey (2002) trained staff to conduct a paired-SPA using a BST package consisting of brief instruction, a video model, and rehearsal with verbal feedback. Participants conducted the assessments in a specialized school for with children. Analogue settings are designed to simulate the natural setting. For example, Pence et al. (2012) taught classroom teachers to conduct SPAs in a library setting but assessed generalization in real classroom or clinic settings.

Staff can also practice performing skills with either actual or simulated consumers. For example, Lavie and Sturmey (2002) required participants to perform the skill with actual children with autism spectrum disorder. Simulated consumers are played by confederates who serve the role of a consumer. Analogue settings often involve staff practicing the target skill with trainers serving as confederates. For example, Pence et al. (2012) required classroom teachers to practice running preference assessments while trainers played the role of confederate consumers and then assessed the generalization of participant performance with actual students in their classrooms. During sessions involving a confederate, the confederate engaged in a combination of typical (e.g., selecting one item, playing appropriately with toys) and atypical responses (e.g., selecting multiple items, not playing with items).

There are multiple reasons that trainers should consider opting to use confederates when requiring staff to rehearse target skills. First, using confederates prevent consumers from being exposed to errors that staff may make prior to learning to perform the skill at mastery levels. For example, if a trainee is learning to perform DTI, the trainee is likely to engage in errors. These errors may negatively impact consumer outcomes due to interventions being implemented with low procedural integrity (Fryling et al., 2012). Second, the use of a confederate ensures that staff are exposed to the full range of potential consumer responses during training. When practicing skills with actual consumers, these individuals may engage in only a subset of potential responses (e.g., correct responses only), although the staff must learn to respond to the full range of consumer responses (e.g., disruptive behaviors, errors). Therefore, trainers can provide confederates with scripts to follow that include all possible consumer responses staff will likely need to respond to in the natural environment. This allows trainers to better program training to facilitate generalization to the natural setting where the skill will occur. Therefore, trainers should provide rehearsal opportunities in analogue settings with confederate consumers using scripts whenever possible.

There is also some variation in the number of rehearsal opportunities researchers have provide during training. Rehearsal opportunities refer to the number of times staff are required to perform the target skill during training. There is no consistent number of rehearsal opportunities within BST research, with some researchers requiring as little as three rehearsal opportunities (e.g., Lerman et al., 2004) or up to 20 rehearsal opportunities (e.g., Matthews & Hagopian, 2014). To address the lack of a consistent recommendation regarding the number of rehearsal opportunities, Jenkins and DiGennaro Reed (2016) conducted a parametric analysis of rehearsal opportunities during BST. The researchers compared 1, 3, and 10 rehearsal opportunities while training participants to perform functional analysis procedures. Rehearsals improved performance, regardless of the number of rehearsals required. However, the one rehearsal condition resulted in the most efficient training. Therefore, it is possible that requiring fewer rehearsals may result in both effective and efficient training, although additional research is needed to identify optimal procedures for the rehearsal component of training.

BST Components: Feedback

The fourth component of BST is feedback, in which a trainer provides information to staff after a performance that specifies how well the staff performed the skill, which may lead to performance improvements in the future (Alvero et al., 2001). Feedback involves both positive and corrective components. Positive feedback specifies which steps were performed correctly, whereas corrective feedback specifies which steps were performed incorrectly and how performance should be improved in the future (Parsons et al., 2012). For example, a trainer delivering feedback on staff performance of DTI may say, "Great job delivering reinforcement immediately! When you delivered the instruction, the student was not attending to the materials. In the future, make sure the student is looking at the materials for at least three seconds".

Similar to the research on the efficacy of the other components of BST, research demonstrated that feedback alone does not improve performance for all individuals (Alvero et al., 2001; Sleiman et al., 2020). Alvero et al. (2001) conducted a review of the literature that assessed the effectiveness of performance feedback and identified the essential characteristics of feedback. Results indicated that feedback does not uniformly improve performance, and is more effective when combined with other procedures (e.g., instructions, modeling, rehearsal). In a meta-analysis of the literature on feedback, Sleiman et al. (2020) also found that feedback combined with antecedent interventions and behavioral consequences was effective, although effect sizes were also large for interventions consisting of feedback alone. In a component analysis of BST, Ward-Horner and Sturmey (2012) found that the feedback component of BST resulted in more robust performance improvements and is likely a necessary component of BST. Therefore, although feedback alone does not uniformly improve performance to mastery levels, feedback is an important component of staff training procedures.

Trainers can choose from a variety of modalities for delivering feedback to staff, including verbal, written, or visual feedback (DiGennaro Reed et al., 2018). Verbal feedback is usually delivered face-to-face and involves the trainer describing the correct and incorrect aspects of trainee performance. One advantage of verbal feedback is that it provides an opportunity for immediate feedback and discussion. Written feedback involves a textual description of staff performance, and is often provided via online communications (e.g., email) after staff reach mastery levels of performance. Visual feedback involves graphical depictions of staff performance. Visual feedback is beneficial because a permanent product is produced that demonstrates trainee performance improvements over time (DiGennaro Reed et al., 2018). Feedback is most effective when trainers use a combination of all feedback modalities (Alvero et al., 2001). For example, during initial training sessions, a trainer should provide immediate verbal feedback. Then, after mastery is achieved, trainers can email staff written feedback and include visual feedback in the form of graphed performance data.

An additional area of research within the feedback literature is how and when trainers should deliver feedback. This includes the format in which staff deliver positive and corrective feedback and the feedback delivery schedule. For example, Henley and DiGennaro Reed (2015) evaluated three feedback sequences (i.e., positive-corrective-positive, positive-positive-corrective, corrective-positive-positive) on participant performance of simulated office tasks. Some researchers have suggested that a "feedback sandwich" approach, in which corrective feedback is preceded and followed by positive feedback, may reduce discomfort and anxiety for both the feedback deliverer and recipient (Berger, 2013). However, Henley and DiGennaro Reed found that the corrective-positive-positive sequence was the most effective for participants who received feedback following performance. These results suggest that the commonly used feedback sandwich may not be the most effective approach and trainers should instead deliver corrective feedback, followed by positive feedback.

The literature also suggests that more frequently delivered feedback (e.g., weekly) is most effective (Sleiman et al., 2020). Research also suggests that it may be beneficial to deliver feedback immediately prior to subsequent performance, rather than consistently delivering feedback immediately after performance. For example, Aljadeff-Abergerl et al. (2017) suggest that delivering feedback prior to subsequent performance may function as an antecedent cue for appropriate responding. Therefore, future research is needed to identify optimal feedback sequences and delivery schedules.

Overall, recommendations for feedback delivery include using vocal feedback during initial training sessions, followed by written and visual feedback after achieving mastery. Trainers should deliver positive feedback after every rehearsal during training (DiGennaro Reed et al., 2018), should avoid using the feedback sandwich (Alvero et al., 2001), and should provide corrective feedback prior to subsequent performance (Aljadeff-Abergel et al., 2017).

BST: Component Analyses

Researchers also evaluated the individual components of BST to evaluate each component's influence on the efficacy of the BST training package. Ward-Horner and Sturmey (2012) found that instructions and rehearsal alone were ineffective, modeling was moderately effective, and feedback was most effective for training staff to conduct functional analysis procedures. Drifke et al. (2017) conducted a component analysis of BST while training parents to implement three-step prompting procedures. The researchers found that instructions with modeling improved participant responding, but did not lead to mastery levels of responding. The full BST package was necessary to achieve mastery-level responding. Therefore, it is possible that the feedback and modeling components are most important, although additional component analyses of BST are warranted.

BST: Potential Target Skills

There is a substantial research base supporting the efficacy of BST for training staff to perform a wide variety of target skills. Some primary areas within the literature include training staff to implement skill acquisition programs, assess consumer preference, conduct mand training, and conduct programs that target leisure activities. For example, Lerman et al. (2008) used a 5-day summer training program consisting of lectures, discussion, modeling, and role-play with feedback to train special education teachers to implement SPAs and direct teaching. The results of other studies also support the efficacy of BST for training staff to conduct SPAs and DTI (Pence et al., 2012; Sarokoff & Sturmey, 2007). Fetherston and Sturmey (2014) trained staff to implement DTI, activity schedules, and incidental teaching by providing participants with task analyses, models, rehearsal opportunities, and feedback. The results demonstrated that BST was effective for training staff to implement a variety of behavioral interventions, with generalization demonstrated with novel instructional programs. Additional research also demonstrated that BST is an effective procedure for training staff to conduct mand training (Nigro-Bruzzi & Sturmey, 2010). The overall results of BST research indicate that BST is an effective training procedure for a wide variety of skills and is likely applicable for training other skills not yet evaluated in the research literature.

BST: Asynchronous Modifications

Although in vivo BST is an effective training method, there are often circumstances in which it is not feasible or possible to deliver in-person training. The majority of behavior analysts are located in the United States, and rural areas have a relative deficit of available trainers (Gerencser et al., 2019). Therefore, alternative training methods are often needed for individuals in rural areas or areas outside of the United States. Even in areas where trainers are available for in vivo services, there is often a large number of staff who require training relative to the number of trainers (Graff & Karsten, 2012; Karsten et al., 2015). In addition, the rehearsal and modeling component of BST is typically delivered individually, which can result in lengthy training durations for each trainee (Gutierrez et al., 2019). Therefore, trainers must find alternative ways to provide training in such cases.

To address the need for potential modifications to standard BST procedures, researchers evaluated asynchronous staff training procedures, in which staff can complete training in the absence of a trainer. A comprehensive review of the asynchronous staff training literature is beyond the scope of this chapter, but interested readers are directed to published reviews (Gerencser et al., 2019; Marano et al., 2020a, b). One option for asynchronous training involves self-instruction that does not involve the use of technology, including manualized instructions, task analyses, and enhanced written instructions that include supplemental materials. For example, Tyner and Fienup (2016) compared the use of a written task analysis and a task analysis that was enhanced with information regarding the antecedent stimuli and performance consequences for creating graphs in Microsoft Excel. The enhanced instructions included descriptions of the colors and shapes of buttons on the computer screen participants should click on to complete each step, as well as descriptions of what the screen should look like after each step was completed. The enhanced written instructions were more effective for producing accurate graphing performance. Manualized instruction involves detailed descriptions of a behavioral technology and often includes pictures, diagrams, and flowcharts (Gutierrez et al., 2019). For example, Gutierrez et al. (2019) provided participants with a manual that described how to implement a token economy and found that the manual was effective for improving responding and resulted in generalization of responding from a confederate consumer to a child with autism spectrum disorder.

Another alternative to BST that is delivered in vivo is computer-based instruction (CBI), which typically requires staff to complete computerized modules that include the components of BST. Instructions and modeling are provided via on-screen text and videos, rehearsal occurs through questions that are embedded within the modules, and feedback is delivered based on participant responses to the questions. For example, Marano et al. (2020a, b) used a computer-based training procedure to train participants to conduct an SPA. The training module was created in PowerPoint and consisted of on-screen text that described how to perform each step, videos that depicted correct and incorrect performance of each step, and questions that required participants to score depicted performance as accurate or inaccurate. The module also provided feedback regarding whether participant responding was correct or incorrect. Computer-based training was also effective for training participants to identify appropriate procedural modifications to functional analysis procedures (Schnell et al., 2018), conduct DTI (Eldevik et al., 2013; Geiger et al., 2018; Gerencser et al., 2018; Higbee et al., 2016; Pollard et al., 2014), implement photographic activity schedules (Gerencser et al., 2017), and visually analyze graphs (O'Grady et al., 2018).

Telehealth is an additional alternative to in vivo BST that uses video and teleconferencing technology to share information and provide clinical care, education, and administrative services from a distance (Darkins & Cary, 2000). Telehealth allows for service delivery when in-person services are unavailable but is not considered asynchronous because it often involves a trainer providing live training via video conferencing software. Higgins et al. (2017) used a telehealth package consisting of a multimedia presentation, feedback from previously recorded sessions, and scripted role-plays with feedback to train direct-care staff to conduct SPAs. Knowles et al. (2017) also used a telehealth procedure to train staff. The researchers created online training modules, answered questions via text, email, and phone calls, conducted video observations, and emailed feedback to staff regarding their implementation of teaching procedures. Results of both studies suggest that telehealth is a viable training procedure when in-person services are not possible.

Train the Trainer Approaches

Pyramidal training offers an additional alternative to approaches in which one dedicated staff trainer provides training to multiple staff members. In a pyramidal training approach, an individual with experience with the target skills trains a subset of individuals, who then provide training to additional people (Pence et al., 2014). Pyramidal training is often called a "train the trainer" approach because it involves training someone to train other people. Pyramidal training was effective for training teachers to conduct SPAs to evaluate student preferences (Pence et al., 2012). A follow-up study demonstrated that pyramidal training was also effective for training teachers to conduct functional analysis procedures and to train others to implement the functional analysis procedures (Pence et al., 2014).

Pyramidal training is a valuable method for training staff to perform BST. Rather than requiring one staff member to train all of the remaining staff members, pyramidal training allows multiple individuals to train their coworkers and other staff members. Parsons et al. (2013) used a pyramidal approach to train ten human service staff to conduct BST training with other staff. Staff practiced performing BST in a simulated setting, and results showed that the training procedure was also effective for training staff to conduct BST with actual staff in their regular work setting. Erath et al. (2020) expanded upon the previous research by conducting pyramidal training in a one-time group-training format. Twenty-five human service staff attended a group training, in which the experimenters delivered didactic training by providing a general description of BST, three modeled exemplars of each step, and practice guidelines. Then, participants rehearsed and provided feedback to one another in peer dyads. The training procedure was effective for training participants to deliver BST and results generalized to using BST to train other behavioral technologies. Therefore, pyramidal training is a useful procedure for providing training for various behavioral technologies that does not require the continued presence of a dedicated staff trainer.

Providing Ongoing Support

Even after staff demonstrate mastery level performance during initial training, it is important to continue to provide ongoing support to ensure maintenance of the target skills and troubleshoot problems that arise. Trainers should continue to collect treatment integrity data on staff performance after mastery-level performance is achieved. Observations should occur more frequently immediately following training. Then, contingent on the maintenance of accurate performance over time, staff can begin to conduct observations less frequently (DiGennaro Reed et al., 2018; Parsons et al., 2012). DiGennaro Reed et al. (2018) and Parsons et al. (2012) also recommend that trainers tell staff why they are collecting data on their performance, which behaviors they will score, and when they will conduct observations. The purpose of informing staff of these details is to maintain good rapport with staff. However, staff may respond differently in the presence of a trainer due to reactivity (Brackett et al., 2007; Kazdin, 1979). That is, the presence of a trainer may influence staff performance, resulting in accurate data collection during observations. Therefore, trainers should consider conducting observations in ways that minimize their presence. For example, trainers can observe from behind a one-way mirror or record staff performance and score responding from video. Trainers can then provide written and visual feedback that staff can apply to future performance to again reach mastery level performance. To be most effective, such feedback should be delivered frequently (e.g., daily or weekly) and delivered by team leaders or experts (Sleiman et al., 2020).

If staff performance does not maintain at optimal levels and feedback is not sufficient for improving performance, trainers will need to take additional measures. Some of the most common reasons for non-proficient staff performance involve a lack of skills that are needed to perform the target skill, insufficient resources or time, a lack of motivation to complete assigned tasks, and incapability of performing the task (Reid et al., 2012). For example, if staff members are lacking the necessary skills, trainers can provide additional training to ensure that staff have all the required skills in their repertoire. Oftentimes, staff do not perform skills adequately due to a lack of resources, making them incapable of performing their work tasks. For example, if a staff member is expected to conduct a toilet training program by bringing the learner to the bathroom at specified time intervals, a potential reason for non-proficient performance is lack of access to a clock or timer. A potential remedy for this problem is to supply a timer to the staff member.

Trainers can also implement antecedent interventions, which are designed to evoke the correct staff behaviors, typically by telling staff what to do and signaling that reinforcement for correct responses is available (Wine & Pritchard, 2018). There are a variety of antecedent interventions that are commonly used to improve staff performance. For example, task clarification specifies job requirements, job aides prompt correct responses by making specific aspects of performance more likely to occur, and goals set standards for how well a task must be performed within a specific timeframe (Wine & Pritchard, 2018). Adding checklists of necessary job tasks or setting goals for how many tasks staff members must complete correctly each day can often improve performance.

Performance Diagnostic Checklist-Human Services

For situations where there is not an easily identifiable reason for poor staff performance, trainers will need to take additional measures to identify the variables responsible for inadequate performance. One option for identifying the variables that contribute to suboptimal staff performance is the Performance Diagnostic Checklist-Human Services (PDC-HS). Austin (2000) created the Performance Diagnostic Checklist, which is an informant assessment designed to pinpoint the variables impacting poor employee performance. The checklist proved effective for identifying the variables maintaining performance and is a useful tool for designing interventions that are based on the functions of current employee behaviors. However, the initial checklist was designed for the business industry, so it is not entirely applicable for human service staff. Therefore, Carr et al. (2013) created the PDC-HS, which is designed specifically for assessing the performance of human-service staff who provide care and services for other individuals. The PDC-HS is designed to identify the environmental factors that contribute to performance problems. Once those environmental factors are determined, behavior analysts can then identify specific targeted interventions that address those variables. The PDC-HS is a particularly useful tool for improving performance problems that are not resolved with simple solutions.

The PDC-HS is performed in an interview format, with a consultant or behavior analyst interviewing the supervisors and managers about the staff member's performance (Wilder et al., 2020). The assessment consists of 20 questions, which are divided into four sections. The sections include training; task clarification and prompting; resources, materials, and processes; and performance consequences, effort, and competition (Carr et al., 2013). The staff member's supervisor can answer the majority of the questions, while some questions require direct observation of the staff member. If multiple questions within one section indicate performance problems, that area is likely a good target for intervention. The PDC-HS has good predictive validity for identifying effective interventions for improving staff performance. For example, Bowe and Sellers (2018) used the PDC-HS to identify factors contributing to poor implementation of error correction procedures during DTI by paraprofessionals. Based on the results of the PDC-HS, the researchers then implemented an indicated intervention (i.e., an intervention based on the assessment's results) and a non-indicated intervention (i.e., an intervention that was not based on an area identified as problematic by the assessment). Results showed that indicated interventions resulted in more behavior change. This demonstrates that the PDC-HS is effective for identifying the variables related to poor staff performance and can indicate which interventions will be most effective for resolving performance issues that are not fixed with simple solutions.

When the focus of training staff is on staff behaviors related to safety, trainers can use the Performance Diagnostic Checklist-Safety (PDC-Safety), which analyzes the environmental events that contribute to safe and at-risk employee behaviors (Martinez-Onstott et al., 2016). The PDC-Safety is similar to the PDC-HS, but involves modifications that make it specific to safety behaviors. For example, Martinez-Onstott et al. (2016) used the PDC-Safety to identify the variables that contributed to unsafe equipment usage and used an intervention indicated by the assessment to improve participant behavior. Therefore, the PDC-Safety is an effective tool for identifying interventions that are most likely to be effective for improving at-risk staff behavior (Cruz et al., 2019; Martinez-Onstott et al., 2016).

PIC/NIC Analysis

If trainers are having difficulty with improving trainee performance, an alternative assessment option is to conduct a PIC/NIC analysis. A PIC/NIC analysis is a formal, but not scientific, method for looking at behavior from the perspective of the performer that allows for an analysis of the antecedents and consequences that affect behavior (Daniels & Bailey, 2014). The analysis requires that the trainer identify all antecedents and consequences for the target behavior and then categorize the consequences as positive or negative, immediate or future, and certain or uncertain. Positive consequences refer to positive reinforcers, whereas negative consequences involve punishers or aversive stimuli. Immediate consequences occur within seconds of the target behavior, whereas future consequences occur at any later time. Certain consequences are those that always follow the target behavior, whereas uncertain consequences have a lower probability of occurring. Consequences that are immediate and certain are more likely to affect behavior than those that are uncertain and future. For example, answering a phone call at work has a positive, immediate, and certain consequence of hearing a friend's voice and having a conversation. The potential consequence of being reprimanded by a supervisor for being off task is uncertain because it is contingent on a supervisor being nearby and attending to the staff's behavior when the phone call occurs. Therefore, the staff member is more likely to respond based on the positive, immediate, and certain consequence and engage in the off-task behavior of answering the phone.

Trainers must complete six steps when conducting a PIC/NIC analysis. First, the trainer must identify the problem behavior. Second and third, the trainer must identify all relevant antecedents and consequences. Next, the trainer categorizes each consequence as positive or negative. Then, the trainer categorizes each consequence as immediate or future. Finally, the trainer categorizes each consequence as certain or uncertain based on the probability that the behavior will produce a given consequence. For example, a trainer may identify the target behavior as staff tardiness. Antecedents for this behavior include traffic on the way to work, waking up late, and stopping for coffee on the way to work. Consequences include having coffee, getting more sleep, and getting reprimanded. Then, the trainer analyzes each consequence to determine whether they are immediate, certain, and positive or negative. The goal of the PIC/NIC analysis is to identify which consequences are impacting behavior so that consequences can be modified to facilitate improvements in staff behavior. For example, if staff members are late to work because they are stopping to get coffee, trainers may choose to provide coffee at work contingent on a specific number of days with all staff reporting to work on time.

Other Forms of Assessment

Wilder et al. (2017) conducted an analysis of the commonality and type of preintervention procedures used in the *Journal of Organizational Behavior Management* between the years of 2000 and 2015. Results indicated that only about one-quarter of the published literature included preintervention assessments. The most commonly used assessment was indirect, in which researchers gathered information from interviews or questionnaires without directly observing the behavior or the environment. Descriptive analyses, in which behavior was directly observed, but the environment was not manipulated, were the next most commonly used. Historical assessments, in which prior data were examined before a study was completed, and systems analysis, in which the researchers evaluated behavior in the context of a larger process or system, were used the next most frequently. The least commonly used form of assessment was experimental analysis, in which the environment is manipulated to determine the effects of the manipulation on a dependent variable. These results indicate that although conducting preintervention assessments is likely beneficial, they are not commonly used. Researchers and clinicians may benefit from increased use of assessments.

Areas of Intervention Based on Assessment

After conducting the PDC-HS and PIC/NIC analyses, trainers must then implement function-based interventions that are informed by the assessment results. That is, trainers should implement indicated interventions after conducting assessments or completing analyses of staff behavior. There are a variety of potential variables that may influence responding and each intervention must be individualized based on the specific variables. Below are some examples of solutions to common performance problems based on potential results of the PDC-HS.

If a trainer identifies that variables related to training are responsible for poor staff performance, the best solution is to provide additional training so that the staff member can perform all the required skills at mastery levels. For example, Bowe and Sellers (2018) completed the PDC-HS with paraprofessionals and determined that insufficient training was responsible for errors with implementation of error correction procedures during DTI. Therefore, the researchers used BST to provide additional training to improve performance. In addition, the researchers provided a non-indicated intervention (i.e., positing reminders). The results showed that only the indicated intervention was effective for improving staff performance.

When the indicated variables maintaining poor performance are related to task clarification and prompting, trainers can provide checklists or written prompts. For example, Merritt et al. (2019) found that a lack of task clarification and prompting were influencing staff tardiness. The researchers scheduled meetings with participants to review the organization's expectations regarding coming to work on time, provided written summaries of those expectations, and had participants sign a summary form indicating they understood. The researchers also gave participants an opportunity to ask questions.

If resources, materials, and processes are identified as the variables contributing to suboptimal performance, trainers must ensure that staff have access to all necessary materials. Wilder et al. (2018) conducted the PDC-HS and found that staff were not conducting teaching of verbal operants as frequently as required due to issues with accessing a timer. Therefore, the researchers made a Motiv-Aider device more readily available, which resulted in improvements in staff behavior.

The performance consequences, effort, and competition domain is the most commonly reported domain that results in poor performance (Wilder et al., 2020). The best solution when assessments identify this area as problematic is to modify the consequences of staff behavior. A common method for modifying consequences is to deliver feedback for staff performance (e.g., graphed, written, or verbal feedback). For example, Ditzian et al. (2015) used the PDC-HS to identify the variables responsible for inadequate security of client rooms, which indicated that insufficient consequences were affecting performance. Therefore, the researchers provided graphed and written feedback on participant performance to improve responding.

Staff Training Recommendations

Staff training is an important component of the field of applied behavior analysis due to the importance of providing high quality behavior analytic services (Fryling et al., 2012; Van Houten et al., 1988). Trainers should use BST to ensure that staff are receiving optimal training based on evidence-based procedures. When delivering instructions, trainers should begin by providing written descriptions of all steps, reviewing the correct way to perform each step with the trainee, and avoiding using technical jargon (DiGennaro Reed et al., 2018). Additionally, trainers should include detailed data sheets and supplemental pictures or diagrams when possible (e.g., Graff & Karsten, 2012). For the modeling component, trainers should ensure that the modeled performance does not include any procedural integrity errors and is modeled in the context where the target skill will occur (DiGennaro Reed et al., 2018). In addition, trainers should ensure that the models include multiple exemplars of the full range of consumer responses staff will likely encounter in the natural environment to best facilitate generalization (Moore & Fisher, 2007; Stokes & Baer, 1977).

Trainers can use video models to ensure that the modeled performance demonstrates all steps accurately and ensure that all possible consumer responses are included in the modeled examples. During rehearsal, trainers should require staff to meet a predetermined mastery criterion (e.g., two or three consecutive sessions with correct responding) before terminating training (DiGennaro Reed et al., 2018). It is also beneficial to include a confederate (e.g., Lipshultz et al., 2015) to ensure that staff are exposed to all potential consumer responses during training. Finally, trainers should deliver positive and corrective feedback to staff following their performance of the target skill, including a combination of written, verbal, and visual feedback (DiGennaro Reed et al., 2018).

Although BST is often conducted in vivo, there are often barriers to training, including limited availability of trainers in rural areas or locations outside of the United States (Gerencser et al., 2019) and a limited number of trainers relative to the number of staff who require training (Graff & Karsten, 2012; Karsten et al., 2015). Therefore, in situations where it is not possible to provide in vivo training to all staff, trainers should consider using telehealth (e.g., Higgins et al., 2017), CBI (e.g., Marano et al., 2020a, b), or self-instructional packages (e.g., Graff & Karsten, 2012). These asynchronous training procedures allow for training to occur in the absence of a trainer.

When initial training is not sufficient for maintaining the target skills, trainers must identify the variables maintaining poor performance and implement indicated interventions to address those variables. The PDC-HS (Carr et al., 2013) and PIC/NIC analysis (Daniels & Bailey, 2014) offer viable options for identifying the factors that contribute to poor staff performance and can help trainers determine the interventions that are most likely to be effective. Thus, trainers have many options available for training staff to perform new skills and can select the training options that best meet their needs.

There are some final overall recommendations for training and improving performance in human service settings. Trainers should consistently contact the research literature to remain informed about possible training techniques and the most current recommendations, function as scientist-practitioners using science to guide clinical practice, and assess social validity to ensure that staff members are satisfied with the goals, outcomes, and procedures of staff training (Wine & Pritchard, 2018).

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Part VI

Health Issues

36 Enhanced Dental Care

Sara Kupzyk, Brianna Zey, and Keith D. Allen

Importance of Oral Health and Health Discrepancies

Individuals with intellectual and developmental disabilities (IDD) are less likely to access preventative, quality health care than those in the general population (Hosking et al., 2016). Unfortunately, this discrepancy is associated with higher rates of death, more than a third of which could have been potentially amenable to intervention (Hosking et al., 2016). Oral care is one area where there are significant discrepancies in care and outcomes for children with IDD (Hennequin et al., 2008). In fact, oral health care is the most prevalent unmet health care need of children with special needs (Lewis et al, 2005). This is concerning because this population is more prone to developmental defects, plaque build-up, untreated dental caries, infections (e.g., periodontal disease), dental traumatic injuries, malocclusion (poor fit between upper and lower teeth, overcrowding), and functional concerns (e.g., bruxism) (Camoin et al., 2020; Ferrazzano et al., 2020). When oral health problems are unmet, children might experience sleep disturbance, difficulty eating, and problems with self-esteem, which can lead to decreased overall quality of life (Anders & Davis, 2010).

The American Academy of Pediatric Dentistry (AAPD, 2018) recommends children have a dental home no later than 1 year of age. A dental home involves family-centered services for routine care, preventative health and education, dietary counseling, and referral to dental specialists. Children who have a dental home are more likely to receive routine dental care and less likely to require dental treatments and experience dental disease. Despite the value of establishing a dental home, 70% of parents of children with special needs report that their child had not visited a dentist for a routine appointment within the last year (Hendaus et al., 2020).

Barriers to Oral Health Care

Camoin et al. (2020) described three primary barriers to oral health care for children with IDD: socioeconomic, social, and medical-behavioral. First, families that have children with IDD frequently encounter financial difficulties due to the number of services required for their child's care and therapies. Given financial hardships, caregivers may have to make difficult decisions about whether or not to proceed with treatment. Those

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_36

who are uninsured are more likely to experience unmet dental needs (Newacheck et al., 2000).

Second, social barriers include difficulties finding providers that accept patients with disabilities. In one study, 35% of parents reported having difficulty finding a dentist to treat their child with special needs (e.g., cleft palate, cerebral palsy, seizure disorder) (Al et al., 2004). However, when children routinely see a medical doctor, they are more likely to have their needs met, which highlights the importance of comprehensive and coordinated care facilitated by children's pediatrician (Lewis et al., 2005). Although many dentists report willingness to provide care for individuals with mild special health care needs, fewer are willing to treat those with moderate-to-severe needs (Ziegler & Pilcher, 2020). Even when willing to provide care, many report the need to refer patients to other settings for various reasons (e.g., lack of confidence, lack of trained staff, lack of appropriate reimbursement; Abraham et al., 2019). Finding a qualified adult provider is even more challenging. In fact, many adults with IDD continue to receive care from pediatric dentists, which is problematic because pediatric settings are not typically equipped to provide adult-centered care (e.g., dentures, implants) and this decreases the number of appointments available for younger children (Chi, 2014).

Research suggests that dentists view this population as difficult to treat due to concerns with limited communication skills and uncooperative behavior as well as ethical concerns with consent for services, and inadequate reimbursement for the time required for procedures (Faulks et al., 2012). Many practitioners do not obtain adequate education or experience to effectively treat this population. In one survey, 75% of dental students reported little to no preparation in providing care to people with IDD (National Council on Disability, 2017). Limited preparation can influence the type of treatments prescribed (Faulks et al., 2012). For example, when dental practitioners were given clinical case scenarios that differed only in the child's disability status (i.e., cerebral palsy or not), practitioners were more likely to recommend tooth extraction for the child with the disability (54%) and a more conservative endodontic treatment for children without a disability (73%) (Camoin et al., 2020). In addition, when children present with uncooperative and challenging disruptive behaviors, dentists are more likely to use more restrictive means such as restraint or sedation (Casamassimo et al., 2004). In general, there are few incentives for dentists to use positive behavior management approaches that tend to require more effort and time (Newton, 2009). In response to the difficulty with finding a qualified provider, communities have developed web-based resources to connect individuals and caregivers with providers willing to treat children with special needs (Ziegler & Pilcher, 2020). Furthermore, specialized training programs are being developed to better prepare dentists to meet the unique needs of this population (see Holt & Barzel, 2020 for an overview of resources and programs available).

Third, individual medical and behavioral factors pose challenges to treatment. Specifically, children with IDD (a) have more difficulty understanding treatments and communicating their oral health needs, (b) demonstrate sensory sensitivities, (c) present with higher base rates of anxiety, and (d) are more likely to demonstrate uncooperative or noncompliant behavior during medical visits (Fallea et al., 2016; Pruijssers et al., 2014). For example, if communication skills are limited, children may not fully understand the reason or process involved in the treatment. As noted above, this can create challenges for providers with obtaining consent when needed and managing behavior. In addition, oral health problems might go unnoticed if children are unable to effectively communicate their discomfort or pain. Medical settings involve many sensory factors (e.g., bright lights, loud noises from equipment) that can be overwhelming for children with sensory sensitivities.

It is important to recognize that stimuli that commonly elicit fear in children are found in the dental care setting such as masks, unfamiliar settings and people, separation from caregiver, the dark, loud equipment, and injections. Although these fears are developmentally appropriate for young children (Gullone, 2000), individuals with

IDD present with higher prevalence of anxiety which is associated with increased pain perception and behavioral concerns or lack of cooperation with treatment. Anxiety and related behavior concerns are common in medical settings, particularly for individuals with IDD. For example, Fallea et al. (2016) administered the Dental Anxiety Scale to 700 patients with IDD. Overall, individuals with higher levels of intellectual disability and females reported more significant anxiety with dental treatments. In fact, 55% of individuals with moderate intellectual disability reported moderate-to-severe anxiety (21% severe anxiety, 19% high anxiety, and 15% moderate anxiety). In addition, younger individuals reported more anxiety. The difference in age may be related to the frequency or rates of exposure to dental treatments.

Concerns with limited understanding, sensory sensitivities, and anxiety are associated with higher rates of problem behavior in medical settings (Pruijssers et al., 2014). It is important to note that uncooperative behavior is common with young children. In fact, 23% of children ages 2–8 demonstrate negative acceptance during dental examination (Sharma et al., 2017). However, rates of noncompliance with medical treatment are higher for individuals with IDD. Taneja and Litt (2020) found that 39% of caregivers of children with autism spectrum disorder indicated uncooperative behavior as a significant barrier to accessing treatment. Uncooperative behavior increases the risk of injury and use of restrictive means of gaining compliance such as sedation and restraint (Camion et al., 2018). Additionally, the presence of significant problem behavior during medical appointments deters practitioners from providing services and parents from scheduling preventative or elective health care appointments (Lennox & Kerr, 1997).

Given the potential negative impact of noncompliance on access to oral health care services and daily hygiene, a conceptual analysis of these concerns is helpful for informing preventative strategies and treatment recommendations. The next sections provide an overview of conceptual considerations, followed by specific strategies to prevent and intervene to address behavioral concerns and thereby improve oral health of individuals with IDD.

Conceptual Considerations Related to Behavior Management Concerns

Conceptually, we understand fear responses as respondent events. Unconditioned stimuli in the dental care setting might include loud noises, prick of a needle, dark, and separation from caregiver. Although these stimuli are not a biological threat, they can elicit unconditioned responses including sweating, heat palpitations, shallow breathing, nausea, flinching or fainting. Through respondent conditioning, previously neutral, non-threatening sights (e.g., the dentists, room where services are provided) and sounds (e.g., whirring of the brush, clock ticking) in the dental care setting can become conditioned stimuli that elicit conditioned responses. Higher order conditioning can result in more previously neutral stimuli eliciting conditioned fear or emotional responding.

Conditioned emotional responses might also contact operant consequences that strengthen and maintain the behaviors. In particular, when individuals engage in emotional responses, the responses are often followed by escape or avoidance (negative reinforcement) from the feared stimuli. Behaviors maintained by escape or avoidance might include verbal (e.g., crying, moaning, complaining) and physical protests (e.g., pushing away, running away, biting, kicking, hitting, hiding). Unfortunately, because of repeated pairings of certain stimuli in the environment and the consequence of escape or avoidance, the previously neutral stimuli can acquire the ability to evoke noncompliant behaviors. Overall, this conceptual analysis suggests that the focus of treatment for medical noncompliance should center on respondent extinction of the fear responses, yet also consider strategies to address behavior maintained by consequences (operant conditioning). Therefore, it is not surprising that graduated exposure is one of the most common and important components of prevention and treatment (Kupzyk & Allen, 2019; Jennett &

Hagopian, 2008; Davis & Ollendick, 2006; Lydon et al., 2015).

Early Intervention Considerations and Strategies for Preventing Behavior Management Concerns

To begin, behavior analysts can become familiar with dental providers that have experience working with children with special needs (or a care team who is open to expanding their education) and help refer patients to establish a dental home (AAPD, 2018). Similar to questions related to medical care, questions upon intake in early intervention or behavioral health services should include those about oral health care. It is important for behavior analysts to be aware of financial and social barriers to oral health care in order to promote access to care and provide anticipatory guidance. For example, families might benefit from meeting with a social worker or family support personnel or advocate to explore programs to decrease the financial burden of proposed dental treatments. In addition, behavior analysts can provide caregivers with information about the important role they have in supporting their child's oral hygiene habits (e.g., limited juice, candy, regular brushing and flossing) to prevent the toothaches and dental caries.

The goal of prevention strategies is to provide children with positive experiences during home dental care and office visits and reduce the likelihood of conditioning fear and avoidance responses. Positive experiences can be accomplished by carefully preparing for appointments and using graduated exposure. To effectively prepare for an appointment, it is valuable to inform parents that most young children will experience some anxiety or negative acceptance when visiting the dentist so that they can be prepared to respond to such concerns (Sharma et al., 2017). Parents can be encouraged to expect that their child will be successful and show confidence in the dental care team. When an initial dental appointment is scheduled, parents can share information about their child with the provider so that they can best prepare for a successful visit/positive exposure (e.g., adaptive aids, communication modalities, preferences, potential triggers in the office and challenging behaviors). Parents can also request information about what will happen during the appointment (e.g., will the parent stay with the child, what procedures will be completed, how the child will be seated, positive behavior management strategies). This information can be used to help the family prepare and practice behaviors needed prior to the appointment.

Preventative graduated exposure strategies include establishing positive routines, providing instructions and modeling, reinforcing appropriate participation in care tasks, and using gradually introducing new care tasks and situations (see Allen & Wallace, 2013; Kupzyk & Allen, 2019, 2020). When developing routines, visual schedules can be used to add predictability, which can make the exposure more positive. Instructions and modeling allow the child to become comfortable talking about and seeing what the task will entail before engaging in the task themselves. This can include (a) a parent or sibling showing how to do a task (e.g., brush, floss), (b) reading books or watching videos that provide developmentally appropriate information about what daily oral health routines (e.g., brushing, flossing) or a visit to the dentist will entail, and (c) taking a tour of the dentist office. Therefore, when introducing a task, a graduated tell-show-do model can be followed. This involves verbally explaining what will be done, modeling the task with another person or a stuffed toy, and then completing the action with the child (Orellana et al., 2014).

Parents and other caregivers can also make positive statements about oral care (e.g., "Brushing our teeth makes our mouths healthy" "It is fun to brush while I listen to music) and reinforce cooperative behavior and completion of daily oral care tasks. Behavior analysts can aid parents in determining potential reinforcers to use during these tasks by completing a functional assessment and preference assessment. A likely function of uncooperative behavior is escape.

Therefore, providing brief, yet frequent breaks during tasks might decrease the value of escape. Preferred tangibles can also be provided to the child during the task to encourage relaxation (i.e., counterconditioning). Offering choices can also increase preference and value of engaging in the care tasks for some children. It is best if these choices are directly related to the exposure. For example, the parent or provider might ask questions such as: Do you want to lean back with the light on or the light off? Should I count your freckles first or your teeth? Do you want me to show you how the light turns on first or how this squirts water? Should I use a red or blue toothbrush?

When introducing a new oral care task, routine, or dental appointments behavior analysts can provide guidance in the use of graduated exposure. For example, when introducing tooth brushing, the parent might be advised to reinforce the small steps such as opening the mouth, then tolerating the toothbrush in the mouth, then movement of the brush, and then brushing for increased amounts of time. Approaching new tasks in this way might decrease the likelihood of a stimulus eliciting a fear response. Similarly, families can visit the dentist office for brief field trips. These trips are how counterconditioning and graduated exposure get accomplished. They may require recruiting a dentist and/or assistant to participate and understand that the point of the visit is not to get dental work done, but to make sure the child has a lot of exposure to the dentist, assistant, and office in small doses with lots of breaks and relaxing, positive experiences. Therefore, during these trips, parents can provide access to preferred items, attention, or activities to increase positive associations with the dentist office and staff. These visits might be very brief initially so that the visit is ended when the child is relaxed and enjoying themselves. Overtime, additional stimuli can be added to the environment (starting with those that are not aversive).

Interventions to Address Behavior Management Concerns

When preventative strategies are not successful or there is a history of uncooperative behavior during oral health care, more intensive intervention is warranted. Interventions may vary in type and form depending on the severity of the noncompliance. Similar to prevention strategies, the treatment for medical noncompliance should focus on its central respondent conditioning characteristics, with graduated exposure as an essential component. Table 36.1 provides a brief description of common evidence-based strategies used to treat medical noncompliance. It is important to note that the majority of intervention studies use a multi-component treatment package (see Kupzyk & Allen, 2019 for a review of the literature).

Respondent Conditioning Strategies

Graduated exposure Graduated exposure involves arranging exposure to steps in a procedure or a hierarchy of stimuli that have been conditioned in the past to elicit fear responses. The stimuli are commonly arranged in a hierarchy according to either (a) the order in which they would be encountered in the procedure or (b) reordered so less salient stimuli are presented first so that the initial exposures do not elicit fear or evoke avoidance behavior. Before starting treatment, a task analysis can be conducted to individualize the steps in the hierarchy. As treatment progresses, it may be necessary to revise or incorporate necessary substeps. See Altabet (2002), Cuvo et al. (2010), Carter et al. (2019), and Kupzyk and Allen (2020) for sample dental exam procedural steps and hierarchies that can be modified for individual clients.

Within the steps in the hierarchy, the salience and dimensions of a stimulus can also be varied by size of the stimulus (e.g., size of X-ray bite-

Table 36.1 Strategies to reduce the probability of behavior concerns and increase compliance with dental routines, visits, and procedures

Strategies to reduce the probability of behavior concerns	Description
Graduated exposure	The child is gradually exposed to steps in a procedure or a hierarchy of stimuli from least to most feared that have been conditioned in the past to elicit fear responses and escape behavior. The hierarchy is arranged so that less salient stimuli are presented first so that the initial exposures do not elicit fear or evoke avoidance behavior
Systematic desensitization	The child is taught relaxation responses or presenting stimuli associated with being relaxed to try to elicit positive responses to counter the fear response
Contingent reinforcement	A reinforcer (e.g., break, preferred activity, item, or token that can be exchanged) is given to the child for meeting specific expectations (e.g., compliance, opening mouth for a certain amount of time, completing a step). It is important to note that the expectations must be reasonable and gradually increased so that the child can receive the reinforcement Potential reinforcers can be identified through caregiver interviews or preference assessments
Noncontingent escape	The child is given brief breaks at regular time intervals during the procedure. The breaks are not contingent on the behavior displayed
Modeling and prompting	An in vivo model, video, pictures, or stories are used to demonstrate the step/what will happen for the child. For example, the provider might tell and show the child what will happen before administering the procedure
Behavioral Momentum	The child is given high-probability demands followed by low-probability demands.
Escape Extinction	The child's attempts to escape the procedure or setting are physically blocked or the child is guided to complete the task. Escape is only available when the child demonstrates cooperative, compliant behavior.

Modified from Kupzyk and Allen (2020)

wing; amount of toothpaste), distance from the stimulus (e.g., distance of light from dental chair), and/or duration of exposure (e.g., length of time with mouth open). Then, the salience of the stimulus exposures can be increased slowly so as not to elicit fear and avoidance responding. Hypothetically, when completed successfully, the graduated exposures result in respondent extinction, so that the conditioned stimuli no longer elicit a fear response and in habituation so that the unconditioned stimuli result in a less intense fear or emotional response. Increasing the frequency of graduated exposure sessions can help to achieve these outcomes more quickly (Szalwinski et al., 2019).

Systematic desensitization Graduated exposure can be enhanced by presenting the feared stimuli while the individual is relaxed. This form of graduated exposure is known as systematic desensitization (King et al., 2005). This requires either teaching the individual a relaxation response (e.g., progressive muscle relaxation) or evoking one by presenting stimuli that previously have been associated with being relaxed, such as watching a movie, holding a favorite blanket, or listening to music. This process of pairing relaxation with graduated exposure can result in counterconditioning, in which previously feared stimuli eventually come to elicit less intense fear responses and instead may even elicit pleasant, relaxed responses. For relaxation to be effective, the individual must be relaxed *before* the presentation of the feared stimuli and maintain the relaxed state during subsequent presentations.

Operant Conditioning Strategies

Given that uncooperative, noncompliant behaviors are also likely to be maintained by operant contingencies, additional evidence-based strategies can be combined with graduated exposure including contingent reinforcement, noncontingent escape, modeling/prompting, and behavioral momentum, and escape extinction.

Contingent reinforcement Contingent reinforcement involves delivery of reinforcement contingent on incompatible or alternative behaviors (differential reinforcement of incompatible or alternative behavior). Here, the delivery of reinforcement occurs *after* the presentation of the feared stimulus contingent on the individual's cooperative behaviors. Given that the uncooperative, noncompliant behaviors are likely to be maintained by escape or avoidance, brief breaks from the procedure may be one of the most potent reinforcers (i.e., contingent escape; Allen et al., 1992). Providing brief breaks is also more practical than delivering a tangible reward in the middle of treatment. For example, when the child demonstrates cooperative behaviors, the provider pauses the procedure to reinforce the behavior in the presence of the stimuli included in the graduated exposure hierarchy. Over time, the stimulus comes to signal that reinforcement is available for the cooperative instead of uncooperative problem behavior (if these behaviors have no longer been reinforced). In turn, this can decrease the likelihood of the stimuli to evoke problem behavior. After the individual has had success (i.e., regularly accessing reinforcement for appropriate behavior) with less aversive conditions in the hierarchy, the more threatening or fearful stimuli associated with a dental routine are introduced. Lastly, delivery of reinforcers can be faded contingent on participant compliance and speed of completion of the tasks to more closely represent rates of reinforcement possible in routine care (Carter et al., 2019).

Noncontingent ESCAPE In noncontingent escape, the child is provided brief breaks at fixed time intervals throughout the procedure. This differs from contingent reinforcement as the child is given the break regardless of the behavior they are engaging in at the end of the specified interval. For example, Allen and Wallace (2013) asked dentists to provide with breaks every 15 s at the beginning of a procedure with children ages two to nine and thin the schedule in 15 s increments every 3–5 min. Compared to a control group who received treatment as usual, the treatment group demonstrated significantly fewer physical and vocal disruptive behavior. Conceptually, this noncontingent escape might decrease motivation to engage in problem behavior because the reinforcer is freely available.

Modeling and prompting Other literature have used modeling and prompting to evoke the desired compliant and cooperative behaviors. Modeling can include the child watching someone else in person or via video demonstrate desirable behaviors during the procedure or watching themselves complete the procedure (Orellana et al., 2014). With improvements in technology, providers and staff can easily create brief video demonstrations of typical procedures including reinforcement for compliance that can be shared with families prior to a child's appointment (Hine et al., 2019). Some examples of prompts include visuals of each step in the procedure and social stories that show desired behavior during a medical procedure (Cavalari et al., 2013). Modeling and prompting might aid in helping the child understand and anticipate the steps that will be completed. Care should be taken, however, to make sure that the visual or social story does not elicit fear responses, which may happen if there is a significant history of discomfort associated with the images (Marion et al., 2016).

Behavioral momentum Behavioral momentum has also been used to increase compliance with medical procedures. Behavioral momentum focuses on delivery of high-probability demands, followed by more difficult, low-probability demands. Studies show that presenting high probability requests before a low probability request (e.g., the fear evoking request or stimulus) can increase compliance during medical procedures (McComas et al., 1998; Riviere et al., 2011).

Escape extinction Escape extinction involves physically blocking attempts to escape or physically guiding compliance (escape prevented). In other words, escape is only provided contingent on compliance with the routine. This approach works to further weaken undesirable behaviors by eliminating one of the main consequences assumed to be responsible for maintaining noncompliance. Although this procedure is effective, it is (a) challenging for dental practitioners to implement while also attending to the ongoing treatment and (b) can be dangerous to implement as extinction can result in "bursts" of intense escape behavior, which can further increase the risk of harm to individuals involved in the dental procedure (i.e., the individual, medical provider, and caregivers) (Allen & Wallace, 2013). Therefore, escape extinction should not be used in isolation; it should be accompanied by other procedures that allow the individual to contact reinforcement (e.g., contingent differential reinforcement of incompatible or other behavior).

In response to noncompliance or uncooperative behavior, practitioners can consider one of the following techniques (a) take small breaks from trials, ignore the problem behavior, and continue exposure trials (escape permitted for brief periods), (b) end the exposure trials when escape maintained behaviors occur (escape permitted that day), or (c) return to earlier steps in the hierarchy that are less likely to elicit fear responding and evoke noncompliance. In contrast with escape extinction, these approaches offer only temporary escape, which may be sufficient to maintain fear and noncompliance (Allen & Wallace, 2013). Again, regardless of the approach taken in response to noncompliance, these procedures should only be used in combination with other strategies described above.

Future Directions

Given the importance of dental care and the risk uncooperative behavior and noncompliance poses for all individuals involved in the dental procedures, additional research is needed to identify (a) ways to increase efficiency of treatment, (b) levels of generalization across providers, caregivers, and settings and maintenance of the effects of treatment, and (c) levels of satisfaction and acceptability of the procedures among children, parents, and providers (Carter et al., 2019).

Efficiency of treatment might be enhanced by only using necessary components and progressing quickly, yet successfully through exposures. Conducting a component analysis of common treatment packages may aid in determining the individual and summative effects of the components. The components that do not result in compliance may be omitted in future applications. Criteria for advancing to the next step in a graduated exposure hierarchy typically involves mastery with the current step for at least two or three sessions before advancing to the next step. In some cases, this may prevent more rapid completion of treatment. In other cases, two to three sessions may be insufficient for extinguishing the fear response even if the individual is compliant, which might result in later increases in conditioned emotional responding. However, it is unknown if asking practitioners to continue with exposures until more calm behavior is observed adds value to a protocol. Furthermore, the operational definition of "calm" is not clear; therefore, research that adds more objective measures of fear responses (e.g., heart rate) might be useful.

Unfortunately, little is known about the levels of generalization across providers, caregivers, and settings as well as maintenance of the effects of treatment (see Carter et al., 2019). Researchers are encouraged to conduct follow-up and generalization probes to more fully capture the effectiveness of treatment. Long-term studies would also provide valuable information about the timing and effects of treatment across an individual's lifespan. For example, increasing access to routine care and use of prevention and intervention strategies from an early age might help to decrease oral health care discrepancies for individuals with IDD. Indeed, effective prevention provides the greatest opportunity for improvement of oral health care for individuals with IDD (Anders & Davis, 2010).

More data are also needed to determine levels of satisfaction and acceptability of the procedures among children, parents, and providers. If procedures are too cumbersome with regard to time and effort, they are not likely to be used in routine practice especially if rates of reimbursement remain the same for providers. Interventions with poor contextual fit are also at higher risk for treatment integrity concerns. Therefore, it is important to involve relevant stakeholders in designing, implementing, and evaluating interventions.

Much of the intervention research targeting dental noncompliance in individuals with IDD has employed data-driven individualized interventions evaluated using single-case research designs. Within these studies, demonstrations of functional relations and internal validity are demonstrated (see Kupzyk & Allen, 2019). However, to improve generality and dissemination of treatment components or packages, a standardized or manualized approach would be useful. The manual could include guidance related to determining which components are needed and recommendations for progressing through steps in the graduated exposure hierarchy. A randomized controlled trial could provide additional demonstrations of the generality of the treatment (Barlow et al., 2009).

Conclusion

In summary, behavior analysts are positioned well to help decrease disparities in oral health care for individuals with IDD. Clinicians can incorporate questions related to oral health into routine intake procedures to determine if children have an established dental home and if they experience difficulties with daily oral hygiene. If a dental home is not established, behavior analysts can coordinate with health providers and social workers or advocates to increase access to care. In addition, they can provide parents with anticipatory guidance strategies to prevent uncooperative and other problematic behavior during appointments and daily care tasks at home. Lastly, when behavior management concerns interfere with dental care, behavior analysts can complete the following steps to increase compliance and decrease fear and emotional responding as well as escape-maintained behaviors.

1. Identify local dentists that are experienced and comfortable managing behavioral concerns and working with children with disabilities.
2. Coordinate with the dentist to conduct a task analysis to determine steps/stimuli to include in graduated exposures.
3. Conduct a functional assessment to identify consequences of uncooperative behavior and a preference assessment to identify tangibles and passive activities that can be used as reinforcers delivered contingent on desired behavior.
4. Design a treatment package that includes at a minimum graduated exposure (core component of treatment). Additional strategies may be incorporated as needed to enhance treatment (see Table 36.1). Clinicians might progress to the next step of the hierarchy when the child has shown success (compliant, calm) with a step. It might be necessary to back up to previous steps to establish success. In particular, if graduated exposure is completed in a clinic or home setting, it might be necessary to return to earlier steps in the hierarchy when implementing the procedure in the dentist office as the behavior may not generalize to the new setting.
5. Develop a plan for responding to problem behavior (e.g., brief break, end session, return to earlier step). Determine when escape extinction, restraint, or sedation might be necessary based on treatment necessity. Researchers have typically found success without the use of these more restrictive strategies, but treatment requires a more gradual approach that lengthens the course of treatment.
6. Plan for maintenance to encourage continued cooperative behavior during dental visits and home daily oral hygiene tasks. This might involve fading of reinforcers and periodic practices with the procedures.

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37 Self-Care Skills

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Introduction

Self-care skills can involve many daily living routines, which are often necessary for individuals to carry out to maintain general health, hygiene, wellness, and safety (Centers for Disease Control and Prevention, 2016). For example, bathing, dressing, eating a meal, brushing one's teeth, washing the hands, and putting on shoes before leaving the house are just a few examples of the self-care skills and routines that we, as adults, must carry out on a daily basis. We acquire these skills over the course of our lives, with the more complex or chained tasks, such as driving a car to the pharmacy or cooking a meal, becoming relevant and routine later in life. First, we must establish critical prerequisite skills to become independent.

Taking a few steps back and a closer look into early childhood, normative studies have shown that children must first acquire important gross-, fine-, and oral-motor skills that will serve as the necessary prerequisites to develop self-care skills and routines later in life (Carruth & Skinner, 2002; Fauth et al., 2017). For example, infants learning to reach for and grasp a spoon or to open their mouth to accept solids comprise a few of the first skills needed for later development of the ability to self-feed. Young children learning to refrain from urinating in their diaper, displaying the correct fine-motor skills to grasp and pull down their pants, and the appropriate gross-motor strength to lift themselves to a toilet seat, are examples of the first steps required for appropriate, independent toileting.

Children typically acquire the skills necessary to carry out various self-care routines such as toileting, self-feeding, and general hygiene during their early toddler years. In most cases, this developmental sequence occurs over the course of several years, often as a result of different experiences, peer and adult models, or direct teaching (Schlinger Jr, 1995). Children begin to carry out self-care tasks with heavy guidance from caregivers. Over time, caregivers step back to allow the child greater opportunities to exercise autonomy. In some cases, caregivers may need to provide the child with guidance or additional practice to facilitate skill acquisition. These developmental progressions are also influenced by a number of other factors, such as culture, health status, and physical wellness (Churcher et al., 1993; Rosser & Randolph, 1989).

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It is important for children to develop self-care skills to not only increase their general independence and reduce reliance on caregivers, but also to promote health and safety. Children identified as neurotypical may advance through more predictable developmental progressions. Children with autism or related disabilities however, may progress in a unique manner or require additional teaching strategies to directly intervene on self-care skill deficits. In fact, studies have shown that children with autism display more pronounced self-care skill deficits relative to same-age, typically developing peers (Flynn & Healy, 2012). Without the ability to carry out self-care routines independently, the child would likely require more constant support from adults or might be stigmatized by peers once they reach school age. If caregivers must guide or implement routines for the child, it could lead to problem behavior (e.g., elopement, aggression) which could pose risks to the child, caregiver, or others in the environment. A lack of independent self-care skills has been associated with a greater likelihood of child abuse, caregiver stress, and increased costs across the lifetime (e.g., Barrett et al., 2015; Macias et al., 2006; Sevlever et al., 2013). Alternatively, greater independence with self-care skills has been identified as an important indicator of positive outcomes for children with autism as they enter into adulthood (Klinger et al., 2015).

Children with Avoidant Restrictive Food Intake Disorder (ARFID) represent another group who may not develop important self-care routines according to a more typical progression. This particular diagnosis is defined as generally impaired oral intake that is not age appropriate and is associated with medical, nutritional, skill, or psychosocial dysfunction (American Psychiatric Association, 2013). Feeding disorders, such as ARFID, affect nearly 20–50% of children who are typically developing, and 80–90% of children with developmental disabilities (Benjasuwantep et al., 2013).

Children with ARFID and Self-Care Skill Development

Although the characteristic features of ARFID are principally associated with feeding and nutrient intake, related deficits often span across a variety of important domains. First, children with feeding difficulties are at greater risk for developing cognitive or learning delays (Freedman et al., 1999; Schreck et al., 2004), which could affect their acquisition of self-care skills similar to children with autism or related disabilities. Second, children with ARFID often have long and complex histories involving painful medical conditions and invasive medical interventions, some of which include aversive procedures to the face or mouth (e.g., naso-gastric tube placement, endoscopy; Goday et al., 2019; Ibrahim et al., 2009). It is likely that the same procedures or aversive stimuli that contribute to or are a result of the child's refusal to eat also affect the child's cooperation with or tolerance of other critical self-care tasks that involve the same areas of the body (e.g., tooth brushing, flossing, rinsing; taking medication by mouth; self-feeding and drinking; face washing). These challenges could worsen over time or result in missed opportunities for independence and skill acquisition, but also could lead to other behavioral concerns. For example, children who have learned that when a caregiver approaches them with an unfamiliar tool or utensil (e.g., toothbrush, nail clippers, spoon, syringe), it could be that a painful or uncomfortable procedure is impending. In these situations, the child may engage in learned behavior to escape or postpone the uncomfortable or aversive procedure (e.g., screaming, running away, aggression). If the behavior becomes sufficiently intense (i.e., frequent and severe), the caregiver may inadvertently reinforce the response by allowing breaks or providing soothing attention, which could result in the child developing a general repertoire of problem behavior during self-care routines. Third, children who have a long history of receiving inadequate nutrition also tend to suffer from painful conditions such as chronic constipation, diarrhea, or general gastrointestinal dysfunction (Goday et al., 2019; Manikam & Perman, 2000). These conditions could serve as the underlying reasons for the feeding difficulties and could be the result if the child's diet primarily consists of foods lacking in nutritional value and variety (e.g., diets high in sugar or lacking in fiber; Manikam & Perman, 2000). These adverse gastrointestinal problems could contribute to why the child has difficulty with independent or consistent toileting, another important self-care routine. For example, children who experience pain when they attempt to have bowel movements may begin to withhold or engage in challenging behavior when caregivers instruct them to sit on the toilet.

Given that the prevalence of feeding difficulties is so high among children with autism, it is also not surprising that some children with ARFID display change-resistant behavior during feeding or other self-care routines (Crowley et al., 2020). Although some type of routine is inherently necessary for many self-care tasks (e.g., fixed sequence of steps for tooth brushing before going to sleep), certain forms of rigidity can prevent children from being successful when unpredictable changes occur. A child's insistence on sameness might result in emotional outbursts when there are unexpected changes to a familiar routine that, for most, would be seemingly minor. For example, children with change-resistant behavior might avoid independently brushing their teeth if their caregiver presents them with a new toothbrush. Repetitive and change-resistant behavior also can affect the child's ability to develop and tolerate new self-care routines (e.g., getting haircuts, nail trimming) if the child insists on exclusively allocating their responding toward change-resistant behavior and routines.

The negative impacts of resistant to change in the context of self-care skills can lead to undesirable consequences such as poor personal hygiene (Conyers et al., 2004) and nutritional insufficiency (Crowley et al., 2020). Interestingly, some researchers have used brain-imaging techniques to understand why children with autism respond differently to changes in environmental stimuli (Bonnet-Brilhault et al., 2018). Results of these studies show neurophysiological markers that stand out in children with autism, which appear to be critical in our understanding of the etiology of change-resistant behavior (Gomot & Wicker, 2012).

Out team of researchers regularly assesses and treats feeding difficulties in children with and without autism. In our clinical setting, it is not uncommon for caregivers to report to us that their child either has concerning self-care skill deficits or exhibits behavioral challenges during self-care routines, especially those related to mealtimes or involving the mouth. This is concerning because there are long-term implications of self-care skill deficits relative to mealtime and eating if children with feeding disorders do not advance through typical progressions. Most major social, cultural, and religious events such as birthdays and holidays involve consumption of food; when a child's feeding disorder prevents the family from engaging in typical social activities, it can be stressful and problematic. Families report avoiding social events altogether or must carefully arrange their daily routines to avoid unexpected changes.

In the following chapter, we provide an overview of current research on teaching important self-care skills and routines to children with autism or related disabilities. Given our area of clinical and research expertise, we confined the focus of our review to specific self-care skills that are critical for children with feeding disorders to develop. We feel it is especially important to intervene on self-care skills in this population, given the unique history and environmental variables that contribute to the development and maintenance of pediatric feeding disorders. We organized the chapter according to self-care skill areas with a general review of current research for each topic. Given the limited research on teaching self-care skills to children with ARFID, we identify specific studies to highlight ways in which current research might extend to this population, and conclude by providing important implications for future research.

Feeding as Self-Care

Etiology and Overview

In part, the extent to which children successfully perform self-care skills that are near to or involve an oral route (e.g., self-feeding, oral medication taking) depends on their learning history with these tasks. Children with feeding disorders often have complex medical histories (Davis et al., 2010), including exposure to unpleasant tests and procedures. For example, some children might require a nasogastric tube as a temporary bridge to enable growth and hydration. Inevitably, placement of this feeding tube requires insertion through the nasal canal, which can be painful and distressing (Farrington et al., 2009). Moreover, a nasogastric tube often requires routine management and potentially ongoing aversive experiences like intermittent dislodgement (Northington et al., 2017).

In the case of self-care related to feeding, caregivers of children with persistent feeding difficulties report high levels of anxiety, stress, depression, social stigmatization (Graves & Ware, 1990), feelings of rejection, anger, and lack of self-confidence (Greer et al., 2008). Their stress can be a function of a lifestyle that requires frequent contact with medical personnel (e.g., gastroenterologist), and the unconventional feeding routines (e.g., nasogastric tube, serving foods on a specific plate) required to manage the child's medical and nutritional needs (Franklin & Rodger, 2003). Given that food is an unconditioned reinforcer for many children, caregiver prompts or guidance is rarely necessary to get them to eat. Caregivers of children with feeding difficulties, however, likely experience stress due to their child's over-reliance on them to carry out or prompt all feeding routines.

Non-self Feeding

Children who are identified as neurologically or developmentally typical often begin self-drinking between the ages of 12 and 36 months, and start self-feeding (e.g., with the fingers) by 12 months (Carruth & Skinner, 2002). One of the necessary prerequisite skills for children with feeding disorders to eventually eat independently is first to accept bites and drinks from another person in the absence of inappropriate mealtime behavior (e.g., head-turning, batting at the spoon). At first glance, it does not seem as though acceptance of food or liquid should require a specific or extensive skill set. However, based on the unique medical or behavioral history for children with feeding disorders, it can be critical to break each step down and teach the skills sequentially. Components of the feeding chain are different based on the activity, but generally consist of touching the feeding utensil to the lips or placing it in the mouth; using the lips to initiate or facilitate the process (e.g., closing the lips around a spoon to pull the food from the spoon); forming the food or liquid into a bolus; chewing, if necessary; elevating the tongue and propelling the food or liquid backward toward the pharynx; swallowing; and retaining the food or liquid (Arvedson & Brodsky, 2002). Disruptions can occur at any point in the chain of this process. Because children with feeding disorders often engage in challenging mealtime behavior, the early focus of intervention should be on building new, safe routines and developing the necessary strength and stamina before teaching more effortful or challenging skills.

Fortunately, there is now a wealth of empirical support for behavior-analytic interventions that promote acquisition of age- and developmentally appropriate feeding skills (Volkert & Piazza, 2012). Given that caregivers of children with feeding disorders have likely attempted a number of strategies in the past to get their child to eat (e.g., coaxing, offering rewards, providing breaks; Borrero et al., 2010), clinicians treating the feeding difficulties should first create a "clean slate" or a more predictable mealtime environment from which to build and teach new skills. One of the first important steps should be to structure the mealtime environment and create consistent routine surrounding meals. Structuring the meal might begin with something as simple as setting a regular meal schedule, creating a clean and appropriate feeding environment with safe seating, and setting time or volume caps or bite-pacing criteria (Peterson & Ibañez, 2018). If the mealtime environment is predictable and the same from day to day, the researcher or clinician can ensure that any change in child behavior is likely a result of the planned intervention and not another variable (e.g., difference in food type, time of day, or bite size). Creating a structured mealtime environment also provides a platform for systematically advancing to more independent feeding skills.

After implementing a structured meal routine, researchers can then assess the conditions in which a child refuses or accepts food, the variables that likely maintain inappropriate mealtime behavior (e.g., through use of functional analysis; Bachmeyer et al., 2009), and the function- or evidence-based interventions that will treat the feeding disorder (e.g., Groff et al., 2014; Patel et al., 2002; Peterson et al., 2016; Rivas et al., 2010). For example, Bachmeyer et al. (2009) showed that withholding the identified functional reinforcers for inappropriate mealtime behavior, escape and attention, was necessary to reduce inappropriate mealtime behavior and increase acceptance (i.e., escape and attention extinction). Even before the development of functional analyses of inappropriate mealtime behavior, numerous studies showed similar outcomes in that putative escape-extinction procedures (e.g., non-removal of the spoon; Cooper et al., 1995) were often necessary to treat pediatric feeding disorders.

Children who begin accepting bites and drinks by mouth without engaging in inappropriate mealtime behavior are then eligible to make gains in terms of increasing their overall independence during mealtime. For example, clinicians could begin to make tube reductions or eliminations, increase the variety of healthy options in the diet, reduce the number of restrictions in terms of where and when the child will eat, and take the initial steps toward promoting independent feeding behavior. Relatedly, with initial improvement in non-self-feeding routines, children can progress and develop important self-care feeding skills.

Self-Feeding and Self-Drinking

Ultimately, children will progress to become age- or developmentally appropriate feeders when they gain independence during mealtime. Researchers have evaluated a number of interventions to teach children more advanced feeding skills which includes, but is not limited to increasing (a) self-feeding and self-drinking skills (Peterson et al., 2015; Rivas et al., 2014), (b) chewing (e.g., Volkert et al., 2014) and other skills required to consume table-textured foods (e.g., appropriate tongue lateralization; Adams et al., 2020), (c) consumption of age-appropriate portion-based meals, and (d) the child's acceptance and tolerance of foods presented in their natural forms (e.g., presenting a hotdog in a hotdog bun). For example, Peterson et al. (2015) used differential reinforcement to increase self-drinking of formula from an open cup for two children with a feeding disorder. In this study, researchers started with a smaller amount of liquid in the cup and increased the amount after the child mastered self-drinking with the smaller amount. Developing appropriate and safe chewing skills is another necessary step toward increasing child independence. Volkert et al. (2014) evaluated a multicomponent intervention to increase chews per bite, increase mastication (i.e., the extent that food was broken apart into small pieces after chewing), and eliminate early swallowing (i.e., swallowing of whole bites before they were sufficiently chewed). This study was unique because caregivers served as feeders and used graduated verbal, model, and physical prompting to teach the child sequential steps that ranged from chewing on an empty strip of plastic airline tubing to chewing food placed inside the tube. Eventually, caregivers presented small, loose pieces of table-textured food to the child, which they systematically increased in size.

Medication Taking

In addition to food and liquid, children may need to acquire the skills and behavior necessary for taking medications by mouth. It is not uncommon for children with feeding disorders to take medications on a regular basis, especially given the high prevalence of comorbid medical conditions in this population (Rommel et al., 2003). It could be that a child dependent on tube feeds previously received medication parenterally (i.e., directly to the intestine through tube feedings). However, once the child begins consuming food and liquid regularly by mouth and the tube has been removed, the child will need to adopt a more typical route for medication consumption. In addition, children who are tube-fed may have insufficient opportunities to practice the skills associated with eating by mouth (Piazza, 2008), which likely extends to taking medication by mouth. If the child will consume some food or drink by mouth, caregivers still might observe challenging behavior when delivering oral medications (Schiff et al., 2011) due to insistence on sameness or oral aversions to medical supplies (e.g., syringe).

Outcomes of research have shown that stimulus fading along many dimensions can successfully increase child cooperation with numerous medical procedures (e.g., Birkan et al., 2011; Cuvo et al., 2010), including swallowing medication (Beck et al., 2005; Ghuman et al., 2004; Schiff et al., 2011). For example, Schiff et al. (2011) used differential reinforcement and stimulus fading in the form of increasing the complexity or response effort associated with the demands. Steps included empty syringe presentation, decreasing the proximity between the empty syringe and the participant, and gradually increasing the ratio of placebo liquid medication to water in the syringe. This intervention may be particularly relevant for increasing medication consumption, especially for children with feeding disorders. Using a similar arrangement to treat feeding difficulties, Groff et al. (2014) used a syringe to deposit bites and drinks into the mouth of a child who clenched his teeth during spoon presentations. Groff et al. then gradually increased the volume of solids and liquids in the syringe and faded from a syringe to a spoon for solids and a syringe to a cup for liquids. Presumably, clinicians could extend Groff et al. (2014) by replicating the intervention with liquid medication. In addition to targeting liquid medication, researchers have also explored methods to increase child cooperation with swallowing pills. Beck et al. (2005) developed a protocol which they referred to as a form of systematic desensitization. In this study, researchers established steps with placebo pills that progressively increased in size.

Cooperatione with oral-medication taking, especially for groups of children who might be at higher risk of having oral aversions, is an important area that requires additional research. If caregivers struggle to deliver important pain-relieving medications (e.g., lansoprazole for reflux), the child may continue to experience discomfort during meals which could have deleterious effects on their overall feeding progress (e.g., relapse in problem behavior during mealtime). In other cases, medications may be necessary to optimal maintain health (e.g., daily multi-vitamins) or are prescribed as vital to treat an illness. In addition, children must eventually develop the necessary medication-taking skills to become independent with this process throughout child- and adulthood. Without establishing prerequisite skills of medication acceptance and consumption, this transition will likely be much more challenging. Finally, when addressing these challenges in practice, clinicians must recognize the role that medical professionals play in the delivery or transfer of oral medications previously delivered parenterally. First, some medications cannot be liquidized, crushed, or mixed with other food or liquid; others can only be administered at certain times of day or under specific conditions (e.g., following a meal). In addition, some medication dosages may need to be altered when administered through a tube because of the additional steps required to flush and clean out the tube with water (Williams, 2008).

Hygiene and Medical Routines as Self-Care

Overview

When children have a history of frequent invasive and uncomfortable procedures, particularly near the face and mouth, the child may associate the presentation of any items to the face, mouth, or body with discomfort, pain, or both. From the child's perspective, a medication syringe, nail-clipper, or toothbrush may be indistinguishable from devices that medical professionals use during invasive procedures or tests. Caregivers of chronically hospitalized children have reported that medical procedures have affected their child's cooperation with non-feeding-related self-care activities. In addition, individuals with autism or related disabilities often have programmed therapeutic goals to increase their independence with self-care skills due to general deficits in this area (Flynn & Healy, 2012; Roane et al., 2016).

Self-care skills that involve maintaining proper hygiene and healthy management of medical concerns or status can span a wide range of tasks. We have streamlined our review of self-care skills in this domain to discuss routines that are near the face or mouth, or involve specific utensils, including brushing the teeth, routine grooming activities (e.g., hair brushing or cutting, nail clipping), and general medical procedures (e.g., blood draws or enduring painful or uncomfortable procedures). Many behavior-analytic studies have identified that some variation of stimulus fading, with or without differential reinforcement, is often efficacious in teaching these types of important self-care routines (Kupzyk & Allen, 2019).

Tooth Brushing

Children with a feeding or developmental disorder often display difficulties with tolerating or independently completing routine dental hygiene procedures. Jawadi et al. (2004) found that children with a gastrostomy tube were more likely to have plaque and calculus build-up in their teeth than children without gastrostomy tubes. Gum bleeding is also common among children with feeding disorders who are not conducting daily oral-hygiene routines, especially when those children have had prolonged exposure to diets lacking in Vitamin C (Swed-Tobia et al., 2019). For example, Ma et al. (2016) reported that five of the seven children in their study who were diagnosed with food selectivity and scurvy also had swollen or bleeding gums. In addition, Vajawat and Deepika (2012) found that children with autism had a higher rate of periodontal disease and difficulty with manual dexterity to accomplish high-quality tooth brushing. The researchers posited that perhaps oral hygiene was problematic in children with autism due to a preference for sweeter foods or pervasive issues with packing food in the mouth and not swallowing. Having poor oral hygiene is problematic because it may lead to caries, periodontal disease, and other serious health conditions over time (Vajawat & Deepika, 2012).

There is a critical need for interventions that teach children how to brush their teeth effectively, efficiently, and consistently, especially given that this is a common problem area for young children with autism or ARFID. For example, the Assessment of Functional Living Skills™ (AFLS; Partington & Mueller, 2012) is an assessment, skills-tracking system, and curriculum guide that clinicians often use for treatment planning. This tool has entire sections dedicated to assessing and designing goals to teach dressing, toileting, grooming, and other important self-care skills. Previous research has focused on teaching the tooth-brushing sequence using chaining techniques and varying reinforcement contingencies to break down the individual steps of the process until the child is proficient (Bishop et al., 2013; Bouter & Smeets, 1979; Horner & Keilitz, 1975; Poche et al., 1982; Snell et al., 1989; Wolber et al., 1987).

More recently, Bishop et al. (2013) evaluated a behavioral intervention targeting cooperation with tooth brushing, which included stimulus fading and reinforcement-based components. Bishop et al. created a 60-step hierarchy that began with the clinician presenting the toothbrush in front and within sight of the participant from approximately 61 cm away (step 1) and ended with the participant tolerating the clinician brushing the participant's teeth for up to 60 s (step 30). Participants had to reach 100% cooperation for each session before progressing to the next step and were provided access to a highly preferred item (e.g., toy) contingent on cooperation. Researchers also periodically probed tasks from several steps ahead in the hierarchy, to determine whether the participant was ready to skip steps in the progression. Bishop et al. determined that this combined chaining and differential reinforcement intervention was successful at increasing three participants' cooperation with tooth brushing with a clinician. More importantly, Bishop et al. conducted caregiver probes upon completion of the terminal step, during which, participants and their caregivers remained successful at 100% cooperation and integrity, respectively. The use of probes to evaluate if participants could skip unnecessary steps resulted in the elimination of about 50% of the total number of initially identified stimulus-fading steps, thereby resulting in a more efficient intervention.

Researchers should continue to evaluate these and other strategies for increasing tolerance of effective tooth brushing in children with autism or related disorders (e.g., ARFID). The terminal goal should be for children to engage in appropriate and thorough tooth brushing (at least 2 min per tooth-brushing event), in which all areas of the mouth are brushed sufficiently (American Dental Association, n.d.; Nguyen & Martin, 2008). This includes the front, back, and top areas of the teeth, gums, tongue, and roof of the mouth. It could be that some children require more intensive approaches (e.g., escape extinction) if their behavior is sensitive to negative reinforcement in the form of escape or that others require more intensive focus on skill acquisition or refinement (e.g., placement of the bristle-side of the brush on the tooth).

Researchers should also make plans to transition from non-self tooth-brushing routines to promoting child independence. Recently, our team of researchers began evaluating a backward-chaining intervention (similar to Bishop et al., 2013) that included differential reinforcement and three-step guided cooperation to teach children with feeding disorders to first tolerate non-self and then progress to independent tooth-brushing. To begin, clinicians identified each of the primary areas of the mouth that required thorough and regular brushing, and then gradually increased the duration and number of brush strokes per area that the child needed to complete. The child continued to advance until we observed 80% or greater cooperation with the full routine. If chaining alone was insufficient to increase tolerance of or cooperation with the full routine, researchers added differential reinforcement (e.g., access to iPad following successful steps) and provided guidance to ensure the child completed the step. Our team has found preliminary success and generally idiosyncratic outcomes with this intervention (e.g., some children only required backward chaining, others required the full sequence of backward-chaining steps plus reinforcement). Given these mixed results, we have not yet isolated which intervention component(s) is critical.

Other areas of future direction could include evaluating additional stimulus-fading interventions (e.g., fading from a preferred utensil to a non-preferred utensil, like the toothbrush) or treatments involving response-effort reductions (e.g., brushing only one area of the teeth and then removing the brush from the mouth) and reinforcement manipulations (e.g., magnitude or schedule adjustments). Additionally, researchers should attempt, when possible, to isolate the variables that contribute to a child's cooperation with tooth-brushing routines (e.g., determine whether specific putative aversive stimuli evoke challenging behavior, such as the bristles or the buzzing sound of the electric brush) to better inform treatment. Finally, tooth brushing is merely one component of the overall oral-hygiene skillset, albeit an important one due to the importance of preventive care. Researchers should evaluate interventions for other routine preventive dental care, such as flossing and rinsing, or regular attendance to and cooperation with dental visits and recommendations (e.g., Kupzyk & Allen, 2019).

Routine Medical and Grooming Tasks

In our clinical experience, caregivers of children with autism, feeding, or related disorders frequently report difficulties during their attempts to promote their child's cooperation or independence with routine medical care or daily grooming tasks. In addition, studies have shown that some children will display challenging behavior during routine medical procedures and appointments (Allen & Kupzyk, 2016). In these cases, it is not uncommon for medical professionals to use restrictive or sedative approaches if the child's behavior becomes too disruptive or challenging (Shabani & Fisher, 2006). Caregivers of children with autism also report having to physically restrain or use general anesthesia to get through medical or hygiene procedures with their child, such as dental visits, wellness checkups, or specific medical tests (e.g., dental surgery, procedures; Rada, 2013). Many children engage in uncooperative behavior (e.g., aggression, elopement) during routine grooming activities (Collado et al., 2008), such as when an adult applies lotion to the child's skin (Ellis et al., 2006) or when a child receives a haircut (Schumacher & Rapp, 2011). This behavior likely interrupts the grooming procedure, which then interferes with the caregivers' ability to help their child maintain appropriate hygiene and health, or might result in the caregiver avoiding the process altogether. Without treatment, these behavioral challenges could affect a child's overall health or medical management, leaving the child vulnerable to undiagnosed problems or safety risks (Collado et al., 2008).

In terms of increasing cooperation during routine medical procedures and appointments, studies often include treatment packages that have multiple components, such as escape extinction, differential reinforcement, stimulus fading, contingent escape, and modeling. For example, Shabani and Fisher (2006) implemented a stimulus-fading hierarchy with differential reinforcement to increase one child with autism's cooperation with blood draws. Shabani and Fisher (2006) were successful with increasing the child's cooperation, and the intervention resulted in behavior generalizing to natural settings (e.g., blood draws carried out in the nurse's station instead of a structured clinical setting).

The same conceptual interventions for routine medical procedures could be applied to routine grooming procedures. For example, Buckley et al. (2020) evaluated a graduated hierarchy of stimulus-fading steps along with a reinforcement contingency and determined that this package was successful at increasing two participants' tolerance of haircuts. Our team recently began investigating ways in which to reduce problem behavior during nail-clipping procedures. For this study, we first evaluated whether differential reinforcement of other behavior (DRO) alone would increase cooperation with fingernail clipping and reduce avoidance behavior for three children with autism. Avoidance behaviors were defined as the child (a) removing their hand from the therapist, (b) blocking or batting at the therapist, or (c) elopement. When we determined that DRO was insufficient to reduce challenging behavior, we applied a similar stimulus-fading and differential-reinforcement intervention package as Shabani and Fisher (2006), which was successful at increasing cooperation with fingernail clipping. We also taught caregivers to conduct the protocol with high integrity.

Shabani and Fisher (2006), Buckley et al. (2020), and our research team have successfully treated challenging behavior during important medical or grooming routines without the use of escape-extinction interventions. Even though participants in these studies exhibited behavior that suggested a negative-reinforcement contingency (e.g., historically, problem behavior during the routine resulted in breaks from or termination of the routine by caregivers or other professionals), escape extinction may not always be an option if the implementers of the intervention cannot carry out the intervention with high integrity. Attention to safety measures becomes especially critical when the routine involves potentially dangerous equipment (e.g., hair cutter, nail clippers, syringe for blood draws). Future research should conduct component analyses to evaluate whether stimulus fading alone would suffice in reducing challenging behavior and increase cooperation during routine medical or grooming activities.

Appropriate Toileting as Self-Care

Along with tolerance of routine medical or grooming procedures, self-care activities can also encompass independence with appropriate toileting. Most children between the ages of 18 and 30 months have the necessary prerequisite skills to begin toilet training; however, not all children with autism or feeding difficulties progress according to this typical sequence (Greer et al., 2016). Teaching children with autism to engage in appropriate toileting routines can help the child achieve an important goal toward becoming more independent. It can also greatly reduce caregiver stress or the costs associated with prolonged incontinence (e.g., diapers, wipes, supervision during bathroom trips). By teaching appropriate toileting skills, researchers could help children with feeding difficulties and comorbid gastrointestinal dysfunction increase their regularity with bowel movements. Poor diet, especially diets lacking in fiber or appropriate hydration, can be one of the primary contributors to chronic gastrointestinal conditions, such as diarrhea or constipation (United States Department of Health and Human Services, 2017). Therefore, it is not surprising that children with ARFID often display challenges with independent toileting, and why it is a critical area to address.

Currently, there is a wide breadth of empirically supported interventions for teaching children appropriate toileting steps and routines, including children with autism and related disabilities (Azrin & Foxx, 1971; Cocchiola et al., 2012; Greer et al., 2016; Hanney et al., 2013; LeBlanc et al., 2005). Most often, these interventions involve: differential reinforcement for appropriate eliminations, regularly scheduled toilet sits, overcorrection procedures, wearing underwear instead of pull-ups or diapers, fluid-loading, teaching effective communication skills, and some type of urine sensor or alarm system.

Greer et al. (2016) conducted a component analysis of common toilet-training procedures with children who were identified as neurotypical. Greer et al.'s intervention procedures included having the child wear underwear, use of differential reinforcement, and a dense toilet-sit schedule that began with the researcher prompting the child to sit on the toilet in 30-min intervals. Greer et al. found that wearing underwear was the most essential component of this intervention package. Perez et al. (2020) extended the Greer et al. study by evaluating a similar progression and package for 11 children with autism. Overall, Perez et al. found that the intervention package described by Greer et al. was effective for the majority of their participants. Combined, the outcomes of these two studies suggest that the more intensive intervention components (e.g., overcorrection, urine sensors, timed sits) may only be necessary for a subset of children, but additional research is needed.

Although many studies have identified effective strategies for teaching appropriate toileting for children with autism or developmental disabilities, more research is needed to evaluate the generality of these interventions to other settings and for children with feeding difficulties specifically. It would be helpful to know whether intervening on appropriate toileting could serve as one step toward addressing gastrointestinal dysfunction for children with ARFID. Future researchers should also evaluate toilet-training procedures in relevant settings, such as at home, school, or daycare locations. Perez et al. (2020) conducted their study solely in an early intervention center in which the participants were receiving behavior-analytic treatment for other goal areas (e.g., language, pre-academic skills). This location is important and relevant for many children, but may not capture whether children could achieve similar progress or maintain success in the natural environment. In addition, researchers may wish to expand the scope of toilet-training studies to involve bowel movements and to increase children's independence with initiating bathroom trips.

Conclusion

Overall, the current literature is replete with strategies for teaching important self-care skills to children with autism or related disabilities. Previous research has identified that there are specific needs in these populations for more intensive intervention relative to children who develop according to more typical progressions. However, more research is needed to identify the prevalence of self-care skill deficits in other vulnerable populations, such as among children with ARFID. In our clinical experience, we have identified that children with feeding disorders often display marked self-care skill deficits across a variety of domains (e.g., tooth brushing, appropriate toileting, cooperation with medication taking). In addition to skill deficits, children with feeding difficulties often have oral aversions due to long histories of complex medical interventions, or they engage in change-resistant behavior during meals or other self-care tasks. These situations can be stressful and problematic for caregivers for a number of reasons.

Failure to progress through developmental milestones or acquire the skills necessary to perform self-care tasks independently could affect the child in a number of ways. For example, children who refuse to brush their teeth independently and consistently consume diets that are high in sugar could be at greater risk for poor oral health (Ma et al., 2016). This situation is further complicated if the child repeatedly engages in challenging behavior during the caregiver's attempts to brush the child's teeth. In some cases, the caregiver may give up trying the routine altogether. Over time, the child will likely develop concerning oral-health conditions, which then require potentially painful, expensive, or invasive procedures later in life (e.g., root canal, dental surgery; Rada, 2014). In other cases, children who have not acquired the necessary skills to self-feed must rely on caregivers to ensure sufficient intake or they will likely continue consuming diets that are lacking in nutrition. Over time, prolonged exposure to poor diet could lead to many serious side effects (e.g., obesity-related illnesses, learning problems; Freedman et al., 1999). Children who engage in challenging behavior during medical procedures or grooming routines could be at risk for injuring themselves or others, especially if the equipment involves sharp or dangerous objects (e.g., syringes for blood draws and scissors for haircuts).

Future researchers should focus their efforts on developing efficient and effective strategies for filling gaps in the self-care literature. These might include strategies to advance children toward all types of age-typical feeding practices, such as eating foods in their natural form or in a variety of locations and public settings. Interventions that promote or serve to teach advanced feeding skills have benefits that go far beyond supporting physical growth and development. For example, teaching children to consume meals according to a more typical routine could increase the opportunities for that child to engage with family members or friends during shared meals at home or school. As mentioned earlier, the social implications of eating include many different meaningful opportunities, such as friends and family coming together to interact around the dinner table. In these cases, effective feeding interventions could actually serve to expand a child's access or ability to contact numerous reinforcers. Massey (2004) noted that mealtimes are one major activity during which children learn and practice their social skills. Therefore, if a child has difficulties during mealtime in terms of their insistence on sameness or level of dependence on others, progress in this domain might be limited. Alternatively, in the home setting, caregivers might continue to experience high levels of stress if they must physically guide their child to complete self-care skills at an age in which the child would be expected to be independent. If a child is able to efficiently consume meals with minimal oversight and in the face of unpredictable changes, the benefits for the child and their family are countless.

Other important directions for future research include increasing independence, not just tolerance of, critical hygiene routines and grooming tasks. Teaching children to become more independent with self-care skills could greatly reduce safety risks, and increase the likelihood that children will continue to thrive independently as they progress through school-age years and into adulthood. In addition, teaching children how to engage in appropriate grooming or hygiene routines could provide increased self-esteem or confidence. When the child reaches adolescence, they may be more confident to leave the home to meet up with friends, attend social events, visit new places, or even apply for jobs.

The implications of achieving a certain level of independence with self-care skills extend well into adulthood, particularly for individuals with autism and related disorders who continue to struggle with areas like personal hygiene (Eaves & Ho, 2008). Although children with autism are often eligible for services through educational institutions and other public and private programs (Thomas et al., 2012), there are generally a fewer number of supports for adults with autism and related disorders (Schott et al., 2020). The support programs that are currently available (depending on the state or funding options) span a wide range of areas, such as employment or vocational services, educational programs, and residential housing facilities. These support systems or organizations might expect or require a specific baseline level of independent self-care skill performance for individuals to access the service. For example, generally appropriate hygiene and basic self-care skills are necessary to provide support in many different employment settings (Garff & Storey, 1998). Therefore, an individual with a greater number of independent self-care skills might have increased eligibility to enroll in vocational training or supported employment programs. Considering these factors, it becomes even more crucial for healthcare providers to focus on acquisition of self-care skills that will better prepare an adult to navigate the obstacles or meet eligibility requirements for limited adult services.

It also may be important for researchers to evaluate the long-term effects of interventions on acquisition of self-care skills during childhood. Studies have shown that intervening in these areas can decrease the likelihood of child abuse and caregiver stress (Macias et al., 2006); however, less is known about the long-term outcomes of specific interventions or whether children will sustain the progress they have made after initially acquiring self-care skills. Relatedly, more research is needed to determine whether children with feeding disorders who receive effective intervention at a young age continue to eat appropriately years after treatment ends. Researchers should also assess the factors that affect whether successful teaching strategies generalize and maintain (e.g., do caregivers continue to practice the skill, are there relapses in problem behavior). Researchers should focus their efforts on identifying optimal training environments, planning for long-term maintenance and generalization, including caregivers as trainers early in the process.

In terms of teaching environments, there is currently a growing wave of interest in telehealth-based options. Historically, telehealth alternatives became a viable solution for families of children who lived at a greater distance from clinical settings (e.g., rural or remote areas; Peterson et al., 2017; Wacker et al., 2015). Recently, the COVID-19 pandemic has required that many clinical spaces shut down due to social distancing and safety restrictions. This pandemic has placed an even greater emphasis on the provision of services to families from a distance. However, there are also many practical reasons that delivering interventions to teach self-care skills using telehealth might be relevant. First, the caregivers could practice the skills with the child in the natural setting, where the routine is most likely to occur and where there has been a history of challenging behavior (instead of a novel clinical setting). Second, conducting sessions via telehealth would allow the clinician to identify whether there are specific barriers that may hinder success during the self-care routine (e.g., meal utensils are not developmentally appropriate, seating at the dinner table is unsafe). Finally, teaching in the home or public setting could provide another avenue for promoting long-term maintenance. For example, teaching the caregiver to embed strategies into their existing routines or modifying the strategy to fit the materials or resources the caregiver has on hand might lead to greater success overall. Teaching a child to tolerate haircuts at the salon while the clinician observes and provides feedback via telehealth can offer invaluable opportunities for necessary generalization.

Boutain et al. (2020) used behavioral skills training and telehealth to teach caregiver how to develop three important self-care skills with their children (i.e., face washing, lotion application, and hand washing). Following the intervention, all three caregivers could carry out the teaching strategies with high integrity and all three children displayed high levels of cooperation and accuracy with the self-care skills. Future researchers should continue to evaluate the efficacy of telehealth as a medium for teaching self-care skills.

In summary, researchers and clinicians should continue to focus their efforts on developing important self-care skills in these vulnerable populations of children. When caregivers bring their children in for treatment of autism or feeding difficulties, self-care skill development may not be the initial or most pressing focus. However, clinicians should be mindful of these deficits as they plan goals for the child's admission. It may be important to obtain baseline measures of self-care skill performance initially, and then to regularly check in on whether skills have developed over time. For example, it is plausible that because of exposure to intervention for the feeding disorder (e.g., escape extinction to increase bite acceptance from a spoon), the child might engage in less problem behavior when caregivers attempt to present a toothbrush to the child's lips, without specific or formal programming with the toothbrush.

Ultimately, eating, grooming, toileting, and carrying out important medical or safety routines are all regular activities that occur multiple times a day and throughout our lifetimes. Therefore, the impact of these deficits on a child's health and development, and their family's wellness, and quality of life, cannot be overstated.

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38 Preschool Life Skills and the Prevention of Problem Behavior

Tracie B. Mann and Einar T. Ingvarsson

This chapter is organized into two parts. In part one, we provide an overview of the Preschool Life Skills (PLS) program, including the rationale for conducting the original study in 2007, discussion of the replications and extensions, and its status today. In part two, we look to place PLS in the context of popular early childhood prevention programs. We provide a brief overview of several commonly used models and their respective salient features, and critique PLS as a preventative model. We conclude with recommendations for researchers and clinicians. To date, there have been two PLS reviews published by Fahmie and Luczynski (2018) and Luczynski and Fahmie (2017). Our aim is to update the information covered in previous reviews by including PLS studies published since 2018 and to extend the reviews by comparing PLS with popular mainstream prevention programs.

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Part One: Preschool Life Skills

Original Study Description

The PLS program was born from the relatively recent (at the time) finding from the National Institute of Child Health and Human Development (2013) that children who spent a significant amount of time in non-familial child care were more likely to develop problem behavior. This relationship should not be mischaracterized; child care is a necessary part of life for many families and quality child care programs and preschools can provide many benefits for young children, particularly in the area of academic skill development (e.g., Bakken et al., 2017; Meloy et al., 2019). However, like most environments, the contingencies arranged within them, if not thoughtfully designed, can also contribute to the development of problem behavior. A thorough discussion of factors that influence the development of problem behavior in children is well beyond the scope of this chapter (see Komro et al., 2011; Luczynski & Fahmie, 2017), but they are often characterized on a spectrum from distal (poverty) to proximal (daily interactions in the home or school setting). It is the latter with which this chapter is concerned. Children in child care or preschool experience dozens, if not hundreds, of interactions with teachers and children every day. These interactions can influence the development of both prosocial behavior and

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_38

functionally equivalent problem behavior. Thus, although the link between non-familial child care and the development of problem behavior is perhaps tenuous, it suggests a practical approach to mitigate its development. Almost one quarter of children under the age of five are in some kind of organized child care arrangement (Laughlin, 2013). What a perfect opportunity to intervene and make a difference.

Greg Hanley and his graduate students recognized this opportunity and designed a curriculum to teach prosocial skills to children in a university-based preschool (Hanley et al., 2007). They identified 13 skills across 4 broad units: instruction following, functional communication, tolerance for delay, and friendship skills. These skills were derived from two sources: the functional analysis and the school readiness literature. From the former came an understanding of common situations that reliably produce problem behavior, and the knowledge that strengthening functionally equivalent replacement behaviors is the "gold standard" treatment for reducing it (Luczynski & Fahmie, 2017). The second source, the school readiness literature, strengthened the rationale for teaching skills in the first three units and informed the addition of the fourth unit. In their survey of kindergarten teachers, Lin et al. (2003) found that teachers valued self-regulation behavior over early academic skills and also rated friendship skills, including empathy and sharing, in their top five skills for incoming students. More recent survey data support the rationale behind an emphasis on skills that can be conceptualized as socio-emotional behaviors over academic skills (e.g., Hustedt et al., 2012).

When designing their instructional package, Hanley et al. (2007) departed from most mainstream early childhood prevention programs guided by developmentally appropriate practice (DAP). DAP was then, and is still the guiding force behind preschool program development. It is a practice that promotes young children's optimal learning and development, and is heavily influenced by the work of developmental psychologists. As such, DAP is underscored by philosophies of development that emphasize maturation and readiness. Experience is not ignored, but moderated by the internal state of the child (i.e., age, maturity, developmental stage, etc.). This philosophy influences how preschool directors and teachers arrange their program to promote prosocial development. For example, the National Association for the Education of Young Children published a position statement in 2009 detailing how to use DAP to teach prosocial skills (Copple & Bredekeamp, 2009). The strategies are overwhelmingly antecedent-based and include practices such as building strong teacher–child relationships, modeling prosocial behavior, and giving plenty of opportunity for collaborative play (specific programs aimed at building prosocial skills are discussed in detail later in the this chapter). Although these are crucial characteristics of quality child care, are they sufficient to impart the prosocial skills that elementary teachers value? Maybe for some children, but certainly not for all. Thus, instead of primarily focusing on antecedent manipulations, PLS incorporates explicit, repeated practice in relevant situations and immediate feedback following the presence or absence of the desired skill. The *piece de resistance*, so to speak, of PLS is the evocative situation. The evocative situation, whether contrived or naturally occurring, is the event that sets the stage for the child to engage in a PLS. If practicing instruction following, the evocative situation is the delivery of an instruction. If practicing greeting a friend, the evocative situation is the arrival of a newcomer to the child's immediate area. Although PLS incorporates proactive teaching in the form of behavioral skills training (BST) (specifically the instructions/rationale and modeling components), it is the repeated presentation of the evocative situation and delivery of differential consequences that drives the bus. As reference, see Table 38.1 for a description of the 13 skills and relevant evocative situations from the original 2007 study:

To teach these 13 skills, Hanley et al. (2007) trained preschool teachers to implement PLS with 16 children. They used a multiple-probe design across skill units to evaluate the effects of a class-wide BST approach to teach PLS. During the initial baseline, teachers arranged the evocative situations throughout the regular preschool

Table 38.1 Thirteen skills and relative evocative situations from Hanley et al. (2007)

Unit	Skill	Evocative situation
1: Instruction following	Responds appropriately to name	Name call
	Complies with a simple, single-step instruction	Delivery of an instruction
	Complies with a multi-step instruction	Delivery of a multi-step instruction
2: Functional communication	Requests assistance with, “help me, please”	Child needs help
	Requests adult attention with, “excuse me,”	Child needs attention
	Requests using a framed response, “may I…”	Child needs an item or materials (from adult)
	Requests to peers using a framed response, “may I…”	Child needs an item or materials (from peer)
3: Delay tolerance	Tolerates delays imposed by adults	Is instructed to wait by adult
	Tolerates delays imposed by peers	Is instructed to wait by peer
4: Friendship skills	Says “thank you” after receiving an item	Receives an item
	Acknowledges or compliments newcomer	Newcomer arrives in area
	Offers toys/materials to newcomer	Newcomer arrives in area
	Comforts others in distress	Someone is in distress

day and measured the presence or absence of the desired skill. Next, teachers used BST to teach children how to emit the skills in Unit 1 (one skill at a time). After children had experienced 10 trials for each of the skills in the unit, another baseline probe was administered. This was followed by instruction in the subsequent units, until the children had received instruction for all skills and completed the final baseline probe. The results from this study were compelling. Overall, researchers observed a more than four-fold increase in PLS and a 74% decrease in problem behavior.

The authors concluded the article with many suggestions for future research, including programming for and evaluating durability and generality, including less-experienced teachers, higher-risk children, and more typical teacher-to-student ratios, modifying the dose of instruction by manipulating mastery criteria and intensity of instruction, refining the evocative situations to more closely resemble those that occur naturally in preschool settings, and evaluating PLS as a preventative model. The first direct replication was conducted soon after the original study, but not published until 2014. Hanley et al. (2014) replicated the procedures in two Head Start classrooms using a consultative model with preschool staff. They extended the 2007 study by including teachers with varied backgrounds in a program with larger teacher-to-student ratios. Although they also observed improvement, gains were not as robust and considerable variability was observed between children.

Since 2007, several researchers have performed systematic replications and extensions of the 2007/2014 studies, many addressing the areas of future research suggested by the original authors. We will discuss these studies by examining how they contributed to the understanding of different PLS components and effects, including the target skills, teaching method, and learning outcomes. To date, close to 115 children have participated in published PLS research and benefited from such instruction.

Target Skills

Unit 1: Instruction Following Teaching precursors to compliance, and compliance with one- and two-step instructions seems a good place to start in a curriculum designed to teach prosocial skills. If children are not attending to the teacher before she delivers an instruction, or if they do not complete simple instructions, then teaching more complex skills might be difficult. This is, of course, an empirical question, and no study has looked at the benefits or limitations of a linear progression through PLS (i.e., the importance of mastering skills 1–13, in order). However, Beaulieu et al. (2012) conducted a form of this analysis with skills 1 and 2. They first conducted a descriptive assessment in a preschool setting and determined that, most of the time, when a teacher called a child's name, an instruction followed. They also found that a child was more likely to comply with an instruction if he either stopped his activity and/or looked at the teacher following a name call. These findings provided the rationale for teaching critical precursors to compliance: stopping, looking at the teacher, saying "yes?" and waiting for a response. In the second part of their study, they found that teaching these precursors improved compliance for all children. Moreover, they found that children in a control group did not show improvement, suggesting that the much espoused advice to wait for children to naturally develop prosocial skills through experience of high-quality early child care environments might not always bear the fruit it promises.

In two related studies, Beaulieu and colleagues found peer mediation can maintain precursor behavior once teaching discontinues (Beaulieu et al., 2013), and that teaching precursors and using peer mediation could be "scaled up" and taught class-wide using BST to improve preschoolers' compliance (Beaulieu & Hanley, 2014). The results of these follow-up studies provide tentative evidence that the PLS model can be adopted by larger classrooms, an important quality when considering its viability in mainstream early childhood settings. Further, the peer mediation component may have implications when considering long-term maintenance and generalization. Leveraging peers, who are a consistent presence in a classroom environment, to provide prompts and reinforcement for target behaviors may be another tactic to promote lasting change. This will be discussed again later in the chapter.

Units 2 and 3: Functional Communication and Delay Tolerance Units 2 and 3 comprise the six skills that might be considered the "meat" of PLS. The evocative situations arranged in these units are common events which evoke problem behavior in young children. In the original study, Hanley et al. (2007) demonstrated a 67% increase in functional communication skills and an 88% increase in delay tolerance (Luczynski & Hanley, 2013). However, not all children learned these skills and the design did not completely rule out the possibility that preschool children would simply learn these skills over time, presumably as a function of experience with the regular preschool programming.

To address these limitations, Luczynski and Hanley (2013): (1) expanded the social skills to include precursor behavior (stopping, looking, and raising hand before making a request), (2) multiple functionally equivalent response forms ("Excuse me" and "Pardon me" to get attention/"May I" and "Can you" to request items or attention), (3) taught children to tolerate delays and denials, (4) used performance-based criteria rather than time-based, (5) taught skills in a small group format, and (6) included a matched control group for comparison. All children in the experimental group learned every skill, demonstrating the skill in over 80% of opportunities. By contrast, children in the control group did not learn these skills, and in fact, the control group children's problem behavior worsened over time (more evidence to move away from a purely developmental approach to teaching prosocial skills).

No other study has looked at functional communication and delay tolerance skills independent from the other units (aside from the follow-up to this study by Luczynski et al., 2014, which will be discussed later), but there are noteworthy findings from replications. First, in several studies, researchers noted that these particular skills were rarely observed in children before teaching (Gunning et al., 2020; Hanley et al., 2014; Luczynski & Hanley, 2013; Robison et al., 2020), but responded well to intervention. There is also some tentative evidence that individual skill repertoires moderate outcome. Falligant and Pence (2017) found that participants with less advanced verbal repertoires required more extensive instruction and procedural modifications to acquire skills in these units. Gunning et al. also found that participants with autism who demonstrated limited language, play, and listener skills required more support and modifications. These findings are important if PLS is to develop into a widely adopted prevention program. Teachers of children with repertoires that might not be responsive to the "standard" PLS should have a road map of modifications to make when results are not optimal.

Unit 4: Friendship Skills The Friendship Skills are an interesting group. These skills do not fit quite as neatly within the conceptualization of "preventative" skills in the preceding units. That is, teaching to greet, offer toys, and show empathy are not likely to prevent the development of problem behavior directly because they do not serve as appropriate replacement behavior to evocative situations which reliably proceed problem behavior. They are important, however, considering studies referenced earlier related to the kinds of prosocial skills elementary teachers rate as foundational and important to success (e.g., Hustedt et al., 2012; Lin et al., 2003). Further, there can be little argument that a classroom of socially responsive children who compliment and show empathy to others creates a more pleasant environment than one whose children do not.

Compared to the other skill units, these skills have been relatively understudied (McKeown et al., 2021) and, interestingly, tend to show more modest and variable improvement following intervention. In their recent evaluation of friendship skills, McKeown et al. (2021) identify several possible reasons why friendship skills responded differently in previous studies. The first two reasons are related to the context in which friendship skills typically occur in preschool settings: during play. Children actively engaged in play may be unlikely to pay attention to others bidding for their attention or newcomers entering their area, and thus, unlikely to respond to or initiate a bid. Further, children may avoid these social skills because emitting them requires termination of a preferred activity. Third, children participating in previous studies may not have received the appropriate "dose" of instruction (i.e., not enough practice trials). Finally, previous studies may not have adequately measured friendship skills by only assessing two opportunities per skill following teaching.

To further examine and extend this unique set of skills, McKeown et al. (2021) taught four children with and without disabilities five friendship skills and evaluated generalization of skills to a same-aged peer. In contrast to the original 2007 study, they delivered the instruction in a one-to-one format, expanded the friendship skills to include empathy toward positive responses, modified the *welcoming a newcomer* skill to include complimenting, and included more stringent mastery criteria. Overall, these procedures improved friendship skills for the two neurotypical children; however, several modifications were needed for the children with ASD to learn three of the five skills. Further, one-to-one teaching with an adult experimenter did not result in satisfactory generalization to the same-aged peer. Improvement in generalization was only observed after the experimenter delivered feedback following opportunities to emit the friendship skill.

To the best of our knowledge, this is the only study that has taken a closer look at the friendship skills; however, the authors identify important considerations when designing instruction for these skills. They note that the likely reason performance with the peer was so variable was because toy play competed with attending to the relevant features of the evocative situation. They suggest solving this problem by making features of the evocative situations more salient. For example, they increased the saliency of the peer's arrival by having the peer initiate a greeting and tap the participant on the shoulder. The authors also suggest learning more about how peers typically interact in a classroom environment to inform the design of evocative situations and target responses, thus improving ecological and social validity (see Gunning & Holloway, 2021, for a recent descriptive analysis of preschool social interactions).

In summary, the target skills included in PLS have largely remained stable over several replications and extensions. Each unit of skills has also been evaluated independently from the others, but not thoroughly (i.e., three studies for Unit 1 skills, two studies for Units 2 and 3, and one study for Unit 4). Future research should aim to continue to make refinements within each skill unit. Several researchers have recently emphasized the importance of assessing the instructional context before teaching in order to identify target behaviors teachers and parents value. With the widespread use of technology as leisure items, parents in particular may be interested in modifying Units 2 and 3 skills to focus on denying or terminating access to electronic devices. On the other hand, teachers may be more interested in expanding the Unit 1 skills to include more sophisticated rule following behavior during a variety of classroom routines, or in strengthening and expanding the Unit 4 skills. Thus, future research should also identify methods to identify meaningful skills across settings. After all, at the heart of PLS is the mission to "create a nurturing classroom environment in which all teachers and young children promote and reinforce prosocial skills" (Luczynski & Fahmie, 2017, p. 10). To this end, it should be flexible, and not promote a strict adherence to the original 13 skills. Finally, it is important to evaluate the preventative validity of PLS, especially if PLS is to have a seat at the table with other early childhood prevention programs. We have little data to suggest that teaching these skills will reduce the likelihood that children will develop problem behavior over time.

Teaching Method

BST is the most common procedure used to teach PLS. There are several advantages to using BST. It is: (1) evidence-based and incorporates several components of effective instruction, (2) "low-tech" in that it is low-cost, requires no devices or internet access, is easy for teachers to learn, and can be implemented immediately (Twyman & Heward, 2016), (3) flexible in that it can be delivered in a variety of settings, with groups of children of different sizes, and can accommodate a variety of modifications, and (4) highly acceptable as reported by teachers and parents on social validity assessments (see Kirkpatrick et al., 2019 for a brief review of using BST with teachers and Gunning et al., 2018, 2020; Luczynski & Hanley, 2013; Hanley et al., 2007 for PLS-specific examples).

Moreover, BST is compatible with the primary group-instruction period in preschools and child care centers: circle time. Circle time is a ubiquitous preschool practice; it typically occurs first thing in the morning, and involves children sitting in a semi-circle around a teacher, moving through various activities related to early learning goals. In the 2007/2014 studies, and in several of the replications (e.g., Gunning et al., 2018; Robison et al., 2020), researchers used circle time to conduct the initial BST. It looks like this: the teacher presents the particular skill to the children, perhaps provides a rationale, models the evocative situation and the target skill, and then moves around the circle practicing with each child and delivering differential consequences. Following this class-wide instruction, children are directed to participate in typical center-based activities, evocative situations are contrived or occur naturally, and feedback is delivered depending on the child response. This process continues until the mastery criteria are met.

There have been both minor and more significant modifications to the standard teaching procedure since the 2007/2014 studies. Minor modifications include withholding experimenter attention following errors (extinction; Luczynski & Hanley, 2013), incorporating "booster" sessions following skill and unit probes (Gunning et al., 2018; Robison et al., 2020), introducing visual cues to prompt responding (Falligant & Pence, 2017; Luczynski & Hanley, 2013; Robison et al., 2020), accepting modified vocal responses for children with speech deficits and delays (Falligant & Pence, 2017; Robison et al., 2020), and introducing tangible and edible reinforcers (Falligant & Pence, 2017; Gunning et al., 2018; McKeown et al., 2021).

Of note, many of the modifications listed above were designed to facilitate skill acquisition in children with developmental disabilities. An emerging theme of recent PLS research is how children with disabilities respond differently to the "standard" PLS procedures compared to neurotypical children. In the 2007/2014 studies, children who attended a university-based and Head Start classroom, respectively, participated, and, with the exception of two children diagnosed with developmental delays (one in each study), all children were neurotypical. Because both studies were designed as class-wide interventions, there were no systematic measures to improve performance in either child; however, Hanley et al. (2007) noted that the child with developmental delays did experience more teaching opportunities than other participants. Both children showed modest improvement in PLS. As mentioned earlier, Hanley et al. (2007) noted that future research should evaluate the procedures with children with disabilities. Ten years later, Falligant and Pence (2017) published their study examining a tiered instruction model on eight children with developmental disabilities. This was followed by a similar study with nine children with disabilities (Robison et al., 2020), a parent training study with seven children with ASD (Gunning et al., 2020), a study with a 5-year-old girl with a symptoms consistent with attention-deficit/hyperactivity disorder (ADHD) (Víðisdóttir & Sveinbjörnsdóttir, 2021), and the friendship study mentioned above which included two children with ASD (McKeown et al., 2021). The authors of these studies all noted that modifications were needed to promote acquisition and, in those that measured them, generalization and maintenance.

A more sophisticated modification of the standard BST procedure, primarily used in studies with participants with developmental disabilities, follows a recommendation from the original authors to vary the "dose" of instruction to match individual need; or, to arrange the instruction to be delivered on a continuum of least to most intensity or intrusiveness. When considering the heterogeneity of preschool and early childhood classrooms, it is likely that not all children will learn all skills via class-wide instruction, even if they are all neurotypical. Thus, incorporating a model that provides tiers of instruction might be a good solution to maximizing outcomes. Enter the response to intervention (RTI) model—a process of modifying instruction for students not making adequate progress during regular classroom instruction by providing increasingly intensive support (National Center on Response to Intervention, 2007). RTI is an evidence-based model commonly applied in public school classrooms that provides three levels of support, ranging from least to most. Within Tier 1, all children experience the same class-wide instruction. Children who do not show adequate progress move to Tier 2, in which they will receive targeted interventions, usually in a small group. Students needing more support are moved to Tier 3, and are provided with individualized, intensive intervention.

There may be many ways to apply an RTI model to PLS, but the most common way evaluated in the literature is, as mentioned above, to vary the "dose" of instruction defined primarily by the group size within which the instruction is delivered. Luczynski and Hanley (2013) were the first to modify class-wide BST by delivering instruction to the children in a small-group context with no more than three children in an instructional group. These children did not experience the progressively "tiered" approach inherent in RTI; nonetheless, this study was the first example to show how PLS can be delivered in a smaller, more supportive setting. Falligant and Pence (2017), Gunning et al. (2018) and Robison et al. (2020) included tiered approaches to instruction to ensure that all children learned all skills. In these studies, participants had the opportunity to first learn the skills in a class-wide format (Tier 1). If any did not meet the mastery criterion, they moved into either a small-group or individualized format. The small-group, or Tier 2, intervention format varied only by the number of children participating. The individualized, or Tier 3, instruction was unique in each study. Gunning et al. replicated the teaching procedure across all tiers of instruction (thus, tiers only varied by group size). Falligant and Pence introduced a prompt delay procedure in Tier 3, in addition to individualized modifications (modified response topographies, edible reinforcers, visual prompts, and less stringent acquisition criteria). Robison et al. used a progressively increasing intertrial interval approach (PITI, Francisco & Hanley, 2012) in tier 3, during which evocative situations were presented at 3, 10, 30 s, 2, 4, and 16 min after the termination of the previous trial. These Tier 3 approaches were successful in teaching all PLS to all participants in the Gunning et al., and Robison et al. studies, and all but one participant in the Falligant and Pence study.

In a unique application of PLS, Víðisdóttir and Sveinbjörnsdóttir implemented PLS with a 5-year-old girl with symptoms consistent with ADHD. Because she was the only participant, the experimenters implemented one-to-one instruction (consistent with Tier 3) from the start. Additionally, they conducted the one-to-one teaching in a separate classroom, relatively free from distractions, and probed for mastery in her regular classroom with other children present. They found that the participant acquired eight PLS (instruction following, functional communication, and tolerance of delays and denials) using the BST procedures originally described by Hanley et al. (2007). However, the participant received a relatively larger number of teaching opportunities (578 across all skills), suggesting that some children with special needs may acquire PLS given a higher dose of the original procedures. Interestingly, both parents and teachers reported a lower number of ADHD symptoms (inattention, hyperactivity-impulsivity) following the intervention. Future research should further explore the utility of the PLS program for children with this common diagnosis.

A final noteworthy variation of the standard teaching procedure is teaching parents, rather than teachers, to use PLS at home. Gunning et al. (2018) taught parents of both neurotypical children and children with autism to use PLS to improve prosocial skills. The authors found that BST was effective in teaching parents to deliver PLS to both groups of children; however, children with autism needed more modifications. Further, the effects generalized to a classroom setting for the neurotypical children. This is a critical extension of the classroom PLS research. Parents of children with disabilities are less likely to access quality early childhood programs than parents of neurotypical children for several reasons: (1) unwillingness of caregivers to accept children with disabilities, (2) transportation and logistical barriers, (3) difficulties coordinating early intervention and child care services, (4) lack of appropriately trained providers, and (5) cost (Novoa, 2020). Teaching parents to use PLS at home gives them a tool to promote important prosocial behavior while their children are young. Further, even if children are in early childhood programs, teaching parents to use PLS is likely to facilitate generalization and maintenance of the intervention effects.

So, what do we know? BST is an effective strategy to teach class-wide PLS and it seems to be highly compatible with instructional routines in early childhood and preschool programs. Modifications to instruction will surely be needed if all children in a classroom, particularly those in inclusion and special education classrooms, are to acquire all skills. Researchers should carefully document these strategies to aid clinicians in the problem-solving process. Delivering instruction using RTI is a promising approach to maximizing acquisition for all children; plus, aligning PLS with a traditional framework might help with the dissemination of PLS to mainstream early childhood settings. Future studies might address the feasibility and efficiency of a multi-tier approach.

Generalization and Maintenance

The question as to whether class-wide BST, modified as needed, is effective in teaching children PLS has been convincingly answered. The extent to whether the effects maintain over time and generalize to novel contexts, however, has not. This is a critical area for future research, particularly because PLS is promoted as a preventative early childhood curriculum. If skills learned in preschool do not follow children through kindergarten and beyond, PLS is unlikely to prevent problem behavior. Stokes and Osnes (1989) outlined specific tactics to promote stimulus generalization across three broad categories: use of functional contingencies, training diversely, and including functional mediators. Although it was not assessed, the original study included several of these tactics to promote generalization: (1) teaching responses likely to contact naturally reinforcing consequences, (2) programming multiple exemplars by including different adults and peers and teaching across different activities at different times of the school day, and (3) incorporating common stimuli in the teaching session (Luczynski et al., 2014).

Luczynski et al. (2014) expanded these tactics to assess the extent to which the self-control skills they taught in a previous study (Luczynski & Hanley, et al., 2013) maintained over a 3-month period and generalized to new teachers and classrooms. They made modifications to train more "loosely" than researchers in the original study by adding unsignaled delays and denials (e.g., a teacher ignoring an appropriate request for attention) with vague cues (e.g., a teacher shaking her head instead of delivering a vocal cue to wait following an appropriate request) and incorporating longer delays to reinforcement. In almost all cases, generalization was initially observed, but declined after a few trials. It was not until they provided additional training to the generalization teacher on the specific skills the children were learning and how to respond to them that they observed satisfactory levels of generalization. Similarly, partial maintenance was observed after 3 months, but increased to high levels once the experimenters trained teachers using the same technique.

Similarly, McKeown et al. (2021) evaluated the extent to which friendship skills generalized to a novel same-aged peer. They also found that generalization was fleeting and it took adult feedback to participant responses following evocative situations to observe acceptable friendship skills to a peer. Subsequent studies obtained mixed results after assessing generalization and maintenance. In their pilot study replication of PLS, Gunning et al. (2018) observed some degree of maintenance and generalization to a new caregiver. In their 2020 study, Gunning et al. found that children who learned PLS from their parents at home were able to demonstrate many of them in their preschool.

Although programming tactics to promote generalization and maintenance appear helpful to improve the durability of responding (e.g., Luczynski et al., 2014), it seems that "priming" the novel instructional environment holds the most promise to facilitate long-term generalization and maintenance. This includes preparing teachers and peers to continue to deliver evocative situations and provide reinforcement and error correction. How often and for how long is unknown and future research should begin to evaluate variables that influence the extent to which teachers should continue with these practices. With respect to peers, there is tentative evidence that peer mediation may be helpful. Beaulieu et al. (2013) showed that peer prompting and feedback improved short-term maintenance. Peer mediation should continue to be studied as a tactic to promote generalization and maintenance.

PLS holds promise for building kind, caring, and nurturing classroom cultures. The studies discussed above show that children with and without disabilities can learn these skills, and with support, can demonstrate them in novel settings with new friends and teachers. Further, parents and teachers find PLS to be highly acceptable and the outcomes meaningful (e.g., Gunning et al., 2018, 2020; Hanley et al., 2007; Luczynski & Hanley, 2013). PLS is only one of many programs designed to promote prosociality and prevent the development of problem behavior. In the second part of this chapter, we will discuss some of the more common and well-established prevention programs and how PLS might be complimentary to them. We also take a closer look at the evidence to support PLS as a preventative program and end with a discussion of other considerations related to problem behavior prevention.

Part Two: Comparison to Popular Programs and Evaluation as a Prevention Program

Other Problem Behavior Prevention Programs

As noted above, the goal of PLS is to increase adaptive social and interpersonal skills and reduce the likelihood of the development of problem behavior. While PLS has a unique standing within the field of applied behavior analysis (ABA), several programs with similar goals (e.g., teaching social and emotional skills) have originated in other fields (e.g., education and psychology). Some of the more popular of these programs have been evaluated in randomized controlled trials and found to reduce behavior problems and improve social behavior and academic outcomes (Jones et al., 2017). As an example, *The Incredible Years* (Reinke et al., 2018) consists of a group of programs aimed at parents, teachers, and children, focusing both on universal prevention and risk factors associated with particular diagnoses (e.g., ASD, ODD/CD, and ADHD). The programs are based on developmental theory, and aimed jointly at promoting "…emotional, social, and academic competence and to prevent, reduce, and treat behavioral and emotional problems in young children" (The Incredible Years, 2020). The programs rely on video vignettes and trained facilitators for implementation. The parent and teacher training programs focus on aspects such as proactive strategies, relationship-building, effective use of praise and other incentives, how to react to problem behavior, how to teach and promote empathy, social skills, and problem solving. The overall goals include teaching "emotional literacy," empathy and perspective-taking, friendship skills, problem solving, anger management, and rule-following (Webster-Stratton, 2017).

I Can Problem Solve (ICPS; also known as *Interpersonal Cognitive Problem Solving*) (Boyle & Hassett-Walker, 2008) is another program with similar content and goals. Based on the conceptual systems of *Social and Emotional Learning,* the program is focused on reducing impulsivity, and improving problem solving and social skills (I can Problem Solve, 2021). A distinctive aspect of ICPS is the concept of *Dialoguing,* which describes different kinds of two-way communication strategies between an adult and child regarding a challenging situation. The lowest level of dialoguing is the "power approach" in which adults provide direct demands or directives to the child, and the highest level is the "problem solving approach", in which the adult prompts the child through a process to find potential solutions to the challenging situation. ICPS includes separate programs for preschool, kindergarten and primary grades, and intermediate elementary grades. As an example, the preschool program includes 59 brief (5–10 min) scripted lessons for teachers, to be delivered 2–3 times per week over 3–5 months, in a small group of 10 children or fewer. The lessons focus on "pre-problem solving skills" such as "feelings and preferences" and "listening and paying attention", as well as problem solving skills labeled as "alternative solutions thinking" and "consequential thinking." For each age group, ICPS offers strategies for teachers to integrate the lessons into curricular content. Finally, ICPS also offers a curriculum for parents: *Raising a Thinking Child.* Completion of 2-day training by ICPS-approved trainers is required for implementing the programs.

The above-mentioned programs, along with similar programs such as *PATHS* (Domitrovich et al., 2007), *Second Step* (Upshur et al., 2019), and *Tools of the Mind* (Barnett et al., 2008), could be viewed either as alternatives or complements to PLS. There is some overlap in the targeted skills and instructional strategies between PLS and many of these programs. For example, PLS focuses on broadly similar interpersonal skills and self-control/self-regulation skills (i.e., tolerance for delays and denials) as several other programs (e.g., ICPS, PATHS). Further, PLS incorporates instructional strategies that are common to other programs, such as a didactic component (i.e., circle-time in PLS), role-play, and visual prompts (Jones et al., 2017). However, several important features set PLS apart. First, while PLS includes a fixed set of skills drawn from the behavioral literature on functional assessment of problem behavior and functional communication training (FCT), it also incorporates teacher preference in selecting skills that are perceived as important in elementary school. Second, PLS incorporates repeated practice of objectively defined skills to a greater extent than other programs and emphasizes embedding these practice opportunities into challenging contexts in a programmatic way. As an example, the primary instructional strategy used in ICPS is discussion (used in 63% of activities), with some role-play (23% of activities), but no activities including skill practice (Jones et al., 2017). In contrast, the majority of instruction in PLS consists of direct skill teaching and practice. Finally, PLS relies more explicitly on direct observation data to evaluate mastery and assign children to tiered and individualized instruction.

PLS has unique strengths that are not found in other programs aimed at pro-actively building a pro-social repertoire and preventing problem behavior. Importantly, it involves deliberately arranging challenging contexts that are likely to evoke problem behavior, and teaching desirable alternative behavior in these contexts. It involves repeated practice with modeling and feedback, and the possibility of teaching each skill to mastery using tiered and individualized instruction as needed. Further, determination of mastery, maintenance, and the need for additional tiers and individualized teaching is based on direct observation data. PLS is, however, relatively more limited in scope in terms of the number and complexity of skills that are included (cf., the Incredible Years program). The social-emotional learning programs discussed above typically involve a greater number of relatively complex problem-solving skills, as well as skills that are more precisely tailored to particular developmental levels. Further, these programs often have a more extensive didactic and discussion-based components, which may be more appropriate for slightly older children. Instead of pitting these two approaches against each other, it seems possible to design a comprehensive curriculum for problem behavior prevention that combines the strengths inherent in both ABA and social-emotional learning.

PLS and Prevention of Problem Behavior

PLS can help reduce challenging behavior and improve socially important appropriate behavior in the short run, as shown in multiple studies (e.g., Hanley et al., 2007; Robison et al., 2020). However, one of the ultimate goals of PLS is to prevent the development of problem behavior in future environments. To the best of our knowledge, only one study on PLS has directly addressed this question (briefly mentioned in a previous section, but described in more detail here). Luczynski and Hanley (2013) conducted a study with 12 preschool children between the ages of three and five who were nominated by their teachers due to concerns with emerging problem behavior and lack of self-control and communications skills. These children were randomly assigned to a test and control group. The experimenters taught three PLS to the children in the test group: requesting attention, requesting materials and assistance, and delay and denial tolerance. Meanwhile, the children in the control group participated in free-play sessions in which adult attention and high-quality play materials were noncontingently available. Prior to and following the intervention, both groups participated in probe sessions in which the experimenters presented evocative situations (typical of other PLS studies) but did not prompt or follow through with the life skills. As an example, the experimenters would deliver an item after a delay, regardless of behavior during the delay (correct life skill, problem behavior, or error of omission). These probes were meant to simulate conditions under which problem behavior might be likely to emerge in the absence of a PLS repertoire. During baseline probes, children in neither group emitted any of the PLS, and the test group was slightly more likely to engage in problem behavior. Following the intervention, only the test group was found to reliably emit the PLS. More importantly, the mean level of problem behavior decreased to zero for the test group, while all the children in the control group engaged in problem behavior in the post-test, with a mean of over 50% of trials. These results suggest that establishing a repertoire of PLS can reduce the probability of problem behavior emerging when challenging (evocative) situations are presented. Thus, this study provides important evidence for the effectiveness of PLS to prevent the emergence of problem behavior, at least in the short term.

Additional literature on the prevention of problem behavior Independent of the PLS framework, several authors within the fields of ABA and positive behavior support have written about the importance of preventing problem behavior (Ala'i-Rosales et al., 2019; Dunlap et al., 2001, 2006; Powell et al., 2006; Williams et al., 2016). However, apart from general recommendations, little research has focused specifically on prevention. A notable exception is a study by Reeve and Carr (2000), who identified eight children (ages 3–5) with developmental disabilities who were reported to engage in minor problem behavior (e.g., whining to get someone's attention). Similar to the study by Luczynski and Hanley (2013), the authors randomly assigned the children into two groups. The treatment group received FCT, while the control group received expressive language instruction. The FCT intervention consisted of training the children's teachers to teach them to appropriately request attention, for example, by tapping the teacher on the arm and saying "Look what I'm doing!" This skill is similar to the one targeted in PLS, which is not surprising given the common influence of the FCT literature (e.g., Carr & Durand, 1985). However, Reeve and Carr's intervention lacked the structure of PLS, particularly the deliberately planned and contrived evocative situations that are characteristic of the approach. Instead, Reeve and Carr trained their teacher participants to prompt the responses during naturally occurring opportunities, to minimize attention (and continue to periodically prompt) during problem behavior, and to maximize their attention when the appropriate functional communication responses occurred. The authors found that with only one exception, the number of intervals of problem behavior, as well as the intensity of the behavior, was more likely to increase over repeated sessions for the children in the control group than the children in the FCT group. Thus, teaching simple functional communication responses, per se, may decrease the likelihood that relatively mild problem behavior escalates in frequency and intensity over time. These results are consistent with the results of Luczynski and Hanley (2013), albeit less robust, possibly due to the absence of planned evocative situations and standard instructional procedures (e.g., BST).

In recent years, Tara Fahmie and colleagues have published a series of innovative translational studies on the early emergence and potential prevention of problem behavior (Fahmie et al., 2016, 2018, 2020). The general purpose of this line of research is twofold: first, to identify evocative environmental conditions that occasion emerging problem behavior (i.e., mild problem behavior that might become more intense and frequent if reinforced over time), and second, to evaluate procedures (e.g., differential reinforcement of alternative behavior) that might prevent these emerging behaviors from becoming more severe with repeated exposure to the evocative environmental conditions. This line of research has the potential to strengthen the empirical basis of PLS by (a) providing further evidence for the validity of the evocative situations included in PLS, (b) identifying potential alternative evocative situations to include in future versions of PLS, (c) developing a process for individualizing evocative situations, and (d) evaluating the effectiveness of differential reinforcement procedures (DRA) to prevent the development of severe problem behavior.

In the first of these studies, Fahmie et al. (2016) conducted "sensitivity tests" with a 20-year-old man with autism who did not have a history of severe problem behavior, but had been identified as being at risk at developing problem behavior evoked by restricted access to preferred items. These sensitivity tests were similar to the trial-based functional analysis (Bloom et al., 2011; Sigafoos & Saggers, 1995). The sensitivity tests are similar to the evocative situations of PLS in that they involve systematically programming challenging environmental conditions that might evoke problem behavior. The authors conducted five different sensitivity tests: Restricted access to preferred items, removed access to preferred items, blocked access to preferred items, a work-task (silverware sorting), and a request-access test (i.e., the experimenter requested the item while the participant had access to it). After initial screening trials, the authors conducted repeated sessions in which both appropriate behavior (e.g., requests for preferred items) and mild problem behavior were intermittently reinforced and severe problem behavior was reinforced on an continuous schedule (in order to simulate reinforcement schedules that are likely to operate under naturalistic conditions). The authors found that problem behavior reliably occurred in the first four conditions. Further, in the restricted-access and removed-access test conditions, problem behavior seemed to get gradually worse over repeated sessions. The authors then implemented the intervention, referred to as "FCT Inoculation" (implying that the intervention should inoculate the individual against reinforcement contingencies that maintain problem behavior) in a staggered manner across the restricted-access and removed-access test conditions. The intervention consisted of teaching the individual to appropriately request the preferred items. The authors observed a post-intervention reduction in the problem behavior under both conditions, even as the reinforcement schedules for both appropriate behavior and problem behavior remained unchanged. Further, these effects generalized to the third condition (blocked access) without direct intervention. This study provides preliminary evidence that FCT, very similar to that included in PLS, can prevent the development of problem behavior under conditions in which problem behavior is likely to contact reinforcement.

To further evaluate the generality of the sensitivity tests, Fahmie et al. (2020) conducted a study with 21 typically developing children between the ages of 4 and 6. These children were included in the study due to teacher reports of moderate (but not severe) problem behavior. Similar to Fahmie et al. (2016), the sensitivity tests were based on common test conditions included in functional analyses of problem behavior (Hanley et al., 2003) and consisted of test for attention, escape, and tangible functions. In addition to problem behavior, the researchers measured appropriate requests evoked by the sensitivity tests (e.g., "Excuse me, I want my toy back"). The authors found that 86% (18/21) of the participants engaged in mild or moderate problem behavior (e.g., grabbing items, loud vocalizations, facial expressions of disgust) evoked by one or more of the test conditions. The tangible condition was most likely to engender problem behavior, which is noteworthy, because it has typically been found to be among the least common functions of problem behavior in reviews of the functional analysis literature (e.g., Beavers et al., 2013). This may be a reflection of a population difference, as most published research on functional analysis of problem behavior has been conducted with individuals with developmental disabilities. It is also noteworthy, especially when considering the purpose of the PLS program, that only 52% (11/21) of the children engaged in appropriate requests during sensitivity tests. Overall, 71% of the children engaged in problem behavior with no functionally matched appropriate requests, 14% of the children engaged in problem behavior and functionally matched appropriate request, while another 14% showed low levels of both. These findings indicate that (a) the sensitivity tests are capable of detecting functionally differentiated emerging problem behavior in typically developing children, (b) the majority of these children (71%) are likely to engage in emerging problem behavior at the exclusion of appropriate requests when evocative contexts are presented, and (c) only about half of the children engaged in functionally relevant appropriate requests at all. These results provide evidence for the validity of the sensitivity tests, as well as potential way to individualize skill instruction based on the results on these tests.

In order to more systematically evaluate DRA as a prevention strategy, Fahmie et al. (2018) conducted a translational study with 48 undergraduate college students who responded by clicking on squares presented on a computer screen. While such studies lack ecological validity, they allow researchers to more precisely control environmental conditions and program reinforcement contingencies for arbitrary responses that serve as analogs for problem behavior and appropriate alternative behavior. The participants were randomly assigned to one of three groups: Control, DRA, and NCR. In each condition, they were presented with a screen consisting of 320 squares, one of which was designated as the target square (analog for problem behavior). In baseline (all participants), clicks on the target square were reinforced on an FR1 schedule, while clicks on any other square had an overall 0.33 probability of being reinforced (reinforcers were points that could be exchanged for a gift card). This was meant to simulate conditions in which problem behavior would be unlikely to develop. The control condition, in contrast, was designed to simulate a naturalistic conditions in which problem behavior is gradually shaped by prevailing contingencies. Based on where on the screen participants had been most likely to click in the baseline, the computer program (using percentile schedules) automatically adjusted the probability of reinforcement such that clicks closer and closer to the target square were differentially reinforced. This was meant to simulate the process in which a caregiver unsuccessfully attempts to extinguish problem behavior, but ends up inadvertently shaping up the intensity, frequency, or duration of the behavior instead (e.g., an extinction burst results in escalation in behavior to the point that the caregiver has no choice but to "give in" and deliver reinforcement). The results of the control condition were compared against two conditions that simulated intervention: DRA and NCR. In the DRA condition, a percentile schedule was used in the same manner as in the control condition, except that responses closer and closer to the square representing alternative behavior were reinforced. This square was located in the opposite corner of the screen from the target square. Finally, in the NCR condition, points were delivered for clicking on any square, but point delivery for each participant was yoked to randomly selected participants in the DRA condition. This was meant to simulate conditions in which caregivers deliver frequent reinforcers independent of behavior. The experiment concluded with a test condition which was identical for all groups. In this condition, only clicks to the square were reinforced, which simulates an environmental condition in which problem behavior should be likely to develop, because it is the only way to obtain reinforcement.

The results of Fahmie et al. (2018) showed that 100% of participants in the control group developed "problem behavior" (i.e., clicking on the target square). However, only 24% of participants in the DRA group and 8% in the NCR group developed problem behavior. It is important to note that the differences between the control group and the two experimental groups were statistically significant, the difference between the two treatment groups was not. While it might be tempting to conclude that these results demonstrate that noncontingent reinforcement is an equally good prevention strategy as DRA, this would be a premature assumption, because the NCR procedure employed in this study was fundamentally different from other studies employing such procedures. Typical NCR procedures entail response-independent stimulus presentation in which stimuli are delivered either on a time-based schedule (e.g., Vollmer et al., 1993) or are continuously available, independent of responding (e.g., Hernandez et al., 2007). In contrast, the NCR schedule employed by Fahmie at all involved reinforcing *any response*. Therefore, it was perhaps functionally more akin to a DRA procedure in which multiple response topographies are reinforced. Nevertheless, the overall results are consistent with previous research (e.g., Fahmie et al., 2016; Luczynski & Hanley, 2013; Reeve & Carr, 2000), suggesting that establishing alternative responses can reduce the likelihood of the development of problem behavior, even when contingencies favor problem behavior over alternative behavior. Thus, these results provide some indirect support for the utility of the PLS approach.

Future research on the prevention of problem behavior As discussed above, a small number of studies provide direct and indirect evidence for the general preventative approach inherent in PLS (e.g., Fahmie et al., 2016, 2018; Luczynski & Hanley, 2013; Reeve & Carr, 2000). This general approach can be summarized as teaching and differentially reinforcing appropriate alternative responses under conditions in which problem behavior would otherwise be likely to emerge. The available evidence suggests that this kind of intervention can indeed reduce the likelihood of the development of problem behavior in the short run. However, more research is needed to evaluate the extent PLS prevents problem behavior under different conditions, with different populations, and over longer periods of time. For example, future research could focus on the effects of teaching tolerance to delays and denials on the probability of development of problem behavior in environments in which delays to reinforcement are frequent and unpredictable. This may be a particularly important line of research with children with developmental disabilities, for whom delays and unpredictable availability of preferred items and activities are especially challenging. The friendship-skills component of PLS also needs additional empirical work, and future research could evaluate whether learning these skills is likely to reduce bullying and social isolation in preschool and elementary school.

To evaluate the preventative effects of PLS, additional short-term research similar to the study by Luczynski and Hanley (2013) is needed, along with larger scale research that spans longer periods of time. For example, researchers could employ randomized controlled trials to compare long-term performance of groups of children who did and did not receive PLS while in preschool. To achieve this, researchers would have to follow the children through the first few grades of elementary school and employ multiple measures of academic achievement and social competence, as well as direct and indirect measures of problem behavior. Finally, longitudinal follow-up through adulthood could shed light on broader outcomes of the PLS program.

Even though these studies have yet to be conducted, available evidence can guide practitioners in the meantime. As Ala'i-Rosales et al. (2019) pointed out, the literature on the functional analysis of problem behavior and FCT is large and fairly robust, which means that as a field, we know a lot about the conditions that are likely to evoke and maintain problem behavior as well as how to teach appropriate behavior to replace it. This knowledge provides a strong base on which to build programs to prevent problem behavior, as shown by the PLS program.

Other components of comprehensive prevention programs PLS and other similar programs primarily focus on building specific skills and repertoires to ward against the development of problem behavior when contingencies may favor its occurrence. However, it is likely that attention to broader aspects of behavioral repertoires, as well as the design of healthy environments, is also important to maximize the effectiveness of such programs. While a thorough discussion of these issues is outside the scope of this chapter, we will briefly mention a few components. First, it is very likely that a strong repertoire of healthy leisure skills plays an important part in preventing the development of problem behavior, in part because these skills result in enriched lives with increased opportunities for positively reinforcing experiences (Ala'i-Rosales et al., 2019). Second, a broader array of skills that encompass self-control, delay to gratification, and problem solving is likely important for long-term success in most naturalistic environments (i.e., skills that build on the tolerance component of PLS). Third, effective instructional strategies that result in acquisition of basic life and academic skills are likely to reduce the occurrence of problem behavior maintained by escape from demands (Williams et al., 2016). Fourth, various aspects of environmental design are likely to reduce the likelihood of problem behavior, such as: (a) enriched environments that include preferred items and activities, (b) healthy contingencies, in which appropriate behavior is more likely to "pay off" than problem behavior, (c) some level of noncontingent reinforcement, such as attention that is not contingent on any particular behavior, (d) multiple opportunities for making choices, and (e) proactive, clear, and fair rules and expectations (Dunlap et al., 2001, 2006; Powell et al., 2006; Williams et al., 2016).

Conclusion

For decades, behavioral researchers have focused on treating existing problem behavior (Fahmie et al., 2018). This research has not only resulted in the discovery of efficacious function-based treatment procedures, but has also revealed the conditions which reliably produce problem behavior in individuals. PLS offers parents, teachers, and clinicians a way to arrange these conditions safely and early-on in a child's life, and a procedure to teach replacement behavior—perhaps before problem behavior is ever observed. We can imagine a world in which PLS has been adopted in every early childcare setting and children entering Kindergarten are good friends, responsible citizens, and prepared to become successful scholars. There is much to be done before we get there. Some of the most critical work includes: identifying tactics to reliably produce generalization and maintenance, packaging and manualizing PLS to promote dissemination and adoption, and in recognizing the many other evidence-based prevention programs, researching how to combine them to produce a more sophisticated, comprehensive prevention curriculum that could span through the elementary years and make a meaningful difference in the lives of children and their families.

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Treating Mealtime Difficulties in Children

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Teaching Mealtime and Feeding Behavior

Eating is not only necessary for development and survival; it also plays a major role in human behavior and social interactions. Throughout history, mealtimes have occurred as meaningful social gatherings with friends and family, and most social events include the consumption of food. While most individuals often look forward to the next meal, some individuals face challenges that make eating less pleasurable.

Eating is a complex chain of behaviors and difficulties may arise at any step in the chain, leading to the potential risk of developing a feeding disorder. Eating begins with acceptance of food or liquid into the mouth and the formation of a bolus (i.e., amount of food or liquid) using the tongue. We move the tongue from side to side inside the mouth (tongue lateralization) to manipulate food to be chewed before we again form a bolus in the center of the mouth. We then propel the food or liquid to the back of the mouth, swallow it, and retain it (Arvedson & Brodsky, 2002). One may exhibit problems at different points in this chain. For example, a child may turn his or her head or cover his or her mouth when a caregiver presents a bite, preventing food from being accepted or deposited into the mouth. A child may accept bites into his or her mouth but expel (spit out) the food or have difficulty lateralizing and chewing the food and hold the food in his or her mouth (packing or pocketing bites). Persistent difficulties at any step in the behavior chain may lead to dysfunctional patterns of eating that without intervention may result in long-term eating problems.

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Diagnosis

Many children exhibit problematic mealtime behavior that resolves naturally over time, such as picky eating during the toddler years (Cermak et al., 2010). However, some children exhibit persistent feeding difficulties that warrant intervention (Mascola et al., 2010). Feeding disorders are heterogenous and encompass a wide range of dysfunctional patterns of eating. Some children exhibit selective consumption by food type, texture, brand, color, presentation format, or a combination of these factors (Bandini et al., 2010). For example, some children may eat a limited number of foods within or across food groups, refuse entire food groups (e.g., vegetables), eat only smooth foods (e.g., baby food or yogurt) or crunchy dissolvable foods (e.g., crackers and chips), or eat only a specific brand of foods (e.g., chicken nuggets only from McDonald's™).

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_39

Whereas other children may consume only limited quantities or refuse all food or liquid. Additionally, some children may lack the skills that allow them to eat or drink independently during meals. It is not uncommon for a pediatric feeding disorder to result as the manifestation of some combination of these difficulties.

Children born prematurely, with developmental or genetic disorders, or complex medical conditions are at greater risk for developing feeding difficulties (Arvedson & Brodsky, 2002; Burklow et al., 2002; Manikam & Perman, 2000). It is estimated that feeding disorders occur in 2–35% of typically developing children and up to 80% of children with developmental disabilities (Bachmeyer, 2009; Williams et al., 2005). The range in reported prevalence rates is likely due to the wide range of difficulties and clinicians and researchers using different definitions for diagnosis (Piazza, 2008). A feeding disorder is often diagnosed when these difficulties result in inadequate nutrition, failure to maintain or gain weight, and/or dependence on supplemental means of nutrition, such as enteral feeds or high calorie formulas beyond an age that is appropriate (Bachmeyer, 2009; Piazza, 2008). However, several terms have evolved to describe feeding difficulties in children including failure to thrive, infantile anorexia nervosa, and posttraumatic feeding disorder, which each encompass a different range of dysfunctional feeding. Most recently, the category of "Feeding and Eating Disorders" in the DSM-V (American Psychiatric Association, 2013) contains diagnostic criteria for Avoidant/Restrictive Food Intake Disorder (ARFID) which is diagnosed when an individual exhibits a feeding disturbance that inhibits their ability to meet their nutritional needs. A feeding disturbance may manifest as a disinterest in food or eating, avoidance of certain foods based on characteristics of the food (e.g., texture, color), or concern for aversive consequences that may be associated with eating (e.g., dysphagia). Persistent failure to meet appropriate nutritional and/or energy needs is characterized by at least one of the following: significant weight loss, significant nutritional deficiency, dependence on enteral feedings or oral nutritional supplements, and/or psychosocial functioning interference.

Etiology

Feeding disorders are as heterogeneous in the factors leading to their development as they are in their presentation. Some combination of co-occurring medical, oral-motor, and behavioral concerns often contribute to the development and maintenance of feeding disorders (Rommel et al., 2003). Medical factors that may contribute to feeding difficulties include gastrointestinal problems (e.g., gastroesophageal reflux disease [GERD], eosinophilic esophagitis (EoE), constipation, motility disorders), anatomical anomalies (e.g., cleft palate), neurological conditions (e.g., cerebral palsy), and food allergies or intolerances (Field et al., 2003; Piazza, 2008). For instance, a child with untreated GERD may experience pain following meals when the gastric contents pass from the stomach into the esophagus (Rybak et al., 2017). This painful experience may lead to the child refusing some or all foods and/or liquids in the future to avoid the painful experience he or she has after eating (classical conditioning). The child may refuse to eat or drink by exhibiting inappropriate mealtime behaviors (e.g., covering the mouth, turning away from or pushing away food or drink presentations), expelling (spitting out food or liquid), or packing (holding food or liquid in the mouth).

Oral-motor factors, such as problems with lip closure or tongue movement, delayed chewing skills, difficulty swallowing (i.e., dysphagia), or structural impairments, may also contribute to feeding difficulties (Field et al., 2003). A child with dysphagia may experience pain when swallowing certain foods or liquids or may cough and gag excessively during meals (Arvedson, 2008). Similar to a child experiencing pain from reflux after eating, a child may also begin to refuse foods and/or liquids to avoid the discomfort associated with painful swallowing (classical conditioning). Additionally, if a child has delayed skills at any point in the chain of eating, the child may refuse certain foods or liquids or refuse eating all together. For example, children with immature patterns of chewing may exhibit inappropriate mealtime behavior or expel food that is not masticated if they are unable to efficiently chew their food. Children with delayed oral motor skills often refuse to eat toward the end of meals with higher textured foods due to fatigue because the effort associated with eating becomes too high. Furthermore, children who are dependent on liquids or enteral feeds for their nutrition may miss opportunities to develop more advanced oral-motor skills, such as chewing or lateralization.

Inappropriate mealtime behavior may be maintained or worsen as a result of the consequences provided after it occurs in the natural environment (operant conditioning). That is, caregivers often deliver consequences following inappropriate mealtime behavior that may be effective for children without feeding difficulties but reinforce the inappropriate mealtime behavior exhibited by children with feeding difficulties. Caregivers may deliver attention in the form of coaxing ("Peas are so yummy"), comforting ("You're okay"), or reprimanding ("Don't push the spoon away"); provide escape by removing the food or drink or ending the meal; and/or deliver highly preferred toys or foods to try to motivate the child or ensure that they consume something. For example, a child may exhibit inappropriate mealtime behavior when the child's caregiver tries to feed him or her a nonpreferred food. If the caregiver responds by removing the nonpreferred food and providing the child with a preferred food, the child may learn that exhibiting inappropriate mealtime behavior results in removal of a nonpreferred food (negative reinforcement) and delivery of a preferred food (positive reinforcement). Relief from the child's inappropriate mealtime behavior might lead the caregiver to terminate more meals or provide preferred foods again in the future. Thus, the caregiver's behavior may become maintained by negative reinforcement (in the form of escape from the child's inappropriate mealtime behavior). These repeated interactions between the child and caregiver may ultimately contribute to the long-term maintenance of the child's feeding difficulties.

Associated Problems

Children with feeding difficulties may be at risk for associated medical conditions (Cohen et al., 2006). Dysfunctional patterns of eating can lead to medical conditions, such as lethargy, recurrent infections, constipation, compromised immune systems, high cholesterol, and obesity (Cohen et al., 2006). For example, enteral feedings or consumption of a high-calorie formula can be a good temporary solution, but children may develop infections, vomit more frequently, and undergo multiple surgeries for tube placement or re-placement if they are dependent on enteral feeds for long periods of time. Children with feeding disorders may also be at risk for delayed cognitive and social development (Piazza, 2008; Volkert & Piazza, 2012). Severe malnourishment may impair adequate brain development and lead to learning difficulties and behavior disorders. Children with feeding difficulties may not be motivated or able to participate in social events or daily activities that involve eating (e.g., school lunches or birthday parties) because the child exhibits problem behavior when food is present or requires an atypical mealtime structure. Children who receive tube-feedings may be subject to social stigma resulting in social isolation from their peers. Spending less time with peers because of these situations may lead to delayed social development.

Caregivers of children with feeding disorders are at risk for increased mental health difficulties and have often reported mental health problems associated with increased stress, depression, and anxiety (Garro et al., 2005; Greer et al., 2008). Caregivers of children who receive tube feedings may be at risk for additional stress related to tube maintenance and frequent visits with specialists (Garro et al., 2005). Feeding disorders may also create a financial burden on families if the child is dependent on tube-feedings, drinking nutritional supplements, or receiving specialized services (Franklin & Rodger, 2003; Greer et al., 2008).

Interdisciplinary Approach

Given the complex etiology, prevalence of co-occurring medical conditions, and range of feeding difficulties, an interdisciplinary approach to the assessment and treatment of feeding disorders is necessary. An interdisciplinary team should include a medical provider (physician or nurse practitioner) with expertise in pediatric gastroenterology, an oral-motor specialist (speech-language pathologist or occupational therapist) with expertise in feeding, a pediatric dietician, and a behavior analyst. All members of the interdisciplinary team play a critical role during assessment and treatment.

The medical provider's role is to rule out or identify and treat any medical conditions that might be contributing to the child's feeding difficulties. The medical provider completes a physical examination of the child and reviews the child's medical history and any test results to determine if medical treatment or additional testing/evaluation is needed. They clear the child to begin feeding therapy, monitor and treat any previously identified or new medical concerns, and coordinate care with the child's other medical providers. For example, if a child is constipated, the medical provider might order an abdominal X-ray, provide caregivers with clean out instructions, and follow-up with the child's pediatrician to provide a medication and care update. Another medical condition seen in children with feeding difficulties is eosinophilic esophagitis (EoE), which is caused by an abnormal immunologic response to specific food antigens that results in irritation of the esophagus and tissue damage (DeZoeten & Markowitz, 2008). Children with EoE often present with symptoms of GERD and dysphagia, but additional medication and dietary restrictions are needed to improve symptoms (Liacouras et al., 2005). Without ongoing medical oversight, serious conditions such as EoE can be overlooked, and when medical problems are not effectively treated, they may decrease the effectiveness of the behavioral treatments and/or worsen the feeding difficulties.

The oral-motor specialist assesses the child's oral-motor skills and safety while eating. They are trained to identify potential risks (e.g., aspiration, difficulty swallowing) and might refer for additional testing prior to treatment (e.g., modified barium swallowing study) to gather more information about the child's specific needs. They provide recommendations for appropriate food texture, liquid consistency, bolus size, and feeding apparatus based on a child's oral motor structure and skills to keep a child safe during intervention. They also identify demands of appropriate effort to ensure the effectiveness of behavioral intervention and create a plan in which oral-motor skills are developed in a systematic way. For example, if a child demonstrates aspiration, the specialist might recommend thickening foods or liquids. If a child who exhibits food selectivity has an immature pattern of chewing, the specialist may recommend an altered food texture based on the child's specific oral-motor skills. It is a common misconception that children who are selective eaters have adequate chewing skills because they consume some table texture foods. However, often, the food selective eaters consume foods that do not require mature oral motor skills, such as soft or smooth foods, starches/carbohydrates that dissolve in saliva, and even processed meats. In fact, Williams et al. (2005) showed that children with special needs had significantly more oral-motor difficulties than other children. It is important that the expertise of an oral-motor specialist also be incorporated throughout behavioral intervention to: (a) inform necessary modifications when oral motor concerns arise during intervention or current treatment plans are not effective, (b) reevaluate the child's oral motor skills when new treatment goals are developed (e.g., increasing food texture), and (c) provide guidance on teaching new oral motor skills (e.g., chewing).

The dietician assesses the child's nutritional status and growth parameters. This is often done through daily logs of the child's diet, medication, and elimination (urination and bowel movement) to help determine the child's nutritional excesses and deficits. The dietician reassesses the child's nutritional status based on their oral consumption and growth parameters throughout treatment and makes quality and quantity recommendations for food and drink items and supplements for each child's growth and health needs.

The behavior analyst conducts assessments to identify environmental variables that contribute to the child's feeding difficulties and uses empirically supported antecedent- and consequence-based treatments to increase appropriate mealtime behaviors (e.g., accepting, swallowing, chewing, self-feeding) and decrease maladaptive behaviors (e.g., inappropriate mealtime behavior, expulsion, packing).

Assessment

Indirect Assessment Methods

The interdisciplinary team gathers information regarding the child's medical, developmental, and feeding histories from the caregiver(s) via questionnaires, interviews, and the child's medical records. The medical history might include the child's medical diagnoses, current medications, growth curves, current heigh and weight, results of medical tests (e.g., swallow study, endoscopy), gastrointestinal symptoms, bowel history, allergies and intolerances, and a review of bodily systems (e.g., ear, nose, and throat; cardiovascular; endocrine; respiratory). The developmental history might include the child's birth history, developmental delays or diagnoses, developmental milestones, and general behavior concerns. The feeding history might include tube-feeding placements and schedule, oral feed schedule, typical mealtime structure (e.g., seating arrangement, average length of meals), feeding milestones (e.g., advancement through textures), current feeding skills (e.g., use of various utensils, self-feeding skills), current oral motor behaviors (e.g., biting off pieces of food, tongue control, swallowing, chewing, coughing, gagging), the variety of food types and textures and liquids consumed, the typical quantity of food and liquid consumed, and goals and results of other therapies.

Descriptive Analysis

A descriptive analysis provides an opportunity for the behavior analyst to observe a natural, unstructured meal to identify antecedent variables (e.g., food type and texture, bite size), appropriate and inappropriate child behavior, and caregiver-delivered consequences (Borrero et al., 2010; Piazza et al., 2003a). For example, Borrero et al. (2010) conducted descriptive analyses of 25 parent–child dyads with histories of feeding difficulties and calculated the conditional probability (i.e., the likelihood of one event given some other event) of the caregiver delivering escape, attention, or preferred foods or drinks and toys following inappropriate mealtime behavior. Results showed that common caregiver responses to inappropriate mealtime behavior include delivering escape from bite presentations, access to attention (in the form of coaxing, comforting, and/or reprimanding), and/or access to preferred foods or drinks and toys. A descriptive analysis also provides an opportunity for the oral-motor specialist to observe the child's oral motor skills and function.

Functional Analysis of Inappropriate Mealtime Behavior

A functional analysis of inappropriate mealtime behavior involves systematically manipulating antecedents and consequences to determine caregiver-delivered consequences that reinforce inappropriate mealtime behavior (e.g., Bachmeyer et al., 2009; Girolami & Scotti, 2001; Najdowski et al., 2008; Piazza et al., 2003a). For example, Piazza et al. (2003a) used procedures similar to those described by Iwata et al. (1982/1994) to conduct functional analyses of 15 children with feeding problems. Conditions included: escape, attention, and tangible test conditions and a control condition. The feeder delivered continuous access to preferred items and attention and did not provide differential consequences following inappropriate mealtime behavior in the control condition. The feeder removed the bite or drink following inappropriate mealtime behavior in the escape condition; provided attention following inappropriate mealtime behavior in the attention condition; and provided either preferred toys or foods following inappropriate mealtime behavior in the tangible condition. Results showed that negative reinforcement was the most common variable maintaining inappropriate mealtime behavior (i.e., 90% of the 10 children who exhibited differential responding showed a sensitivity to escape). Results also showed that the inappropriate mealtime behavior of 80% of children who exhibited differential responding was maintained by multiple functions. Not every child's behavior was maintained by the same or all functions.

The procedures described by Piazza et al. (2003a) involved prompting bites across all conditions. An alternative method involves prompting bites only in the escape condition (e.g., Najdowski et al., 2008). Bachmeyer et al. (2019) assessed the inappropriate mealtime behavior of three children with an identified feeding disorder by comparing the two procedural variations. The two methods resulted in different outcomes for two of three children. The method that prompted bites only in the escape condition identified only an escape function, and the method that prompted bites across all conditions identified multiple functions (escape from bites and attention). The researchers examined the relative effects of extinction procedures matched to both functions (individually and in combination) to determine the validity of each functional analysis method. Results suggested that the procedural variation that failed to identify an attention function for two of three children produced false negative findings. Presenting bites and prompts to eat only in the escape condition may omit the relevant discriminative stimuli or motivating operations for inappropriate mealtime behavior in the other test conditions and result in false negative findings for some children. Therefore, sources of reinforcement for inappropriate mealtime behavior are contextual. That is, an event such as attention functions as reinforcement in the presence of prompts to eat, but not in other contexts, such as when a child is left alone with a plate of food on the table or outside of the mealtime context. However, presenting bites across all conditions may result in a lack of discrimination, particularly during an alternating treatment design involving rapid alternation of more than two conditions. Therefore, functional analyses of inappropriate mealtime behavior are often conducted in a reversal design (Piazza et al., 2003a) or pairwise design (Bachmeyer et al., 2009). A pairwise design involves rapid alteration of only one test condition and the control condition and may more efficiently identify functions than a reversal design in which phases are repeated to demonstrate a functional relationship.

Researchers have shown that failure to identify all functions of inappropriate mealtime behavior could lead to an ineffective intervention (Bachmeyer et al., 2009; Kirkwood et al., 2020). For example, Bachmeyer et al. (2009) showed that a treatment that combined escape extinction and attention extinction was necessary to increase acceptance to high and stable levels and decrease inappropriate mealtime behavior maintained by escape and attention to near-zero levels for all children. Alternatively, implementing a package that addresses all potential functions could lead to a less specific intervention. For example, Kirkwood et al. (2021) observed that although caregivers of three children with feeding disorders provided escape from bites and drinks and attention following inappropriate mealtime behavior, results of functional analyses showed that inappropriate mealtime behavior was only maintained by escape from bites or drinks for all three children. They examined the effects of escape extinction when the feeder either provided or withheld attention following inappropriate mealtime behavior and found that inappropriate mealtime behavior decreased and acceptance increased when the feeder implemented escape extinction independent of whether they provided or withheld attention.

It is not uncommon for practitioners to question the utility of a functional analysis to treat pediatric feeding disorders because research has shown that escape plays a major role in the maintenance of inappropriate mealtime behavior and escape extinction is often necessary. Further, escape extinction is commonly described in the literature as being structurally similar to escape extinction combined with attention and/or tangible extinction. That is, the feeder withholds both escape and other potential reinforcers (attention or tangible items) following inappropriate mealtime behavior regardless of the procedure. In addition, practitioners often teach caregivers to implement escape and attention extinction as a treatment package. However, identifying the specific reinforcers that maintain inappropriate mealtime behavior can be important. For example, although a clinician would not typically teach a caregiver to provide attention following instances of inappropriate mealtime behavior, teaching a caregiver to withhold escape and attention for inappropriate mealtime behavior (i.e., escape and attention extinction) when only escape is identified as a reinforcer, may be unnecessary. Training a caregiver to refrain from providing reprimands for a child's problem behavior may eliminate a strategy that the caregiver has previously used to manage the child's behavior or create an additional procedure for the caregiver to follow. Clinicians might also avoid unnecessary conflict with caregivers who are adamant about not ignoring their child's behavior when their child's inappropriate mealtime behavior is not maintained by attention (Kirkwood et al., 2020). Finally, training caregivers to implement treatment packages that include unnecessary components may increase treatment complexity and could negatively impact procedural integrity (Vollmer et al., 2008).

Antecedent Assessments

Analyses of motivating operations may provide useful information about specific stimuli that can alter the efficacy of the reinforcers identified during the functional analysis, thus increasing or decreasing the likelihood of appropriate or inappropriate mealtime behavior (Michael, 1993). Within the feeding context, this may include the feeding utensil (e.g., spoon versus Nuk® brush or cup versus bottle), bolus (bite) size, food texture (e.g., puree versus wet ground), and bite placement (e.g., Munk & Repp, 1994; Patel et al., 2002; Sharp & Jaquess, 2009; Sharp et al., 2012). For example, Munk and Repp (1994) evaluated the effects of different food types at various textures (e.g., junior [50% puree and 50% wet ground], ground, and chopped texture) on bite acceptance, inappropriate mealtime behavior, and expulsion with five individuals with intellectual disabilities. Specific food types and textures were associated with different levels of appropriate or inappropriate mealtime behavior. Sharp and Jaquess (2009) compared the effects of bite size (ranging from 1 to 5 cc) and food texture (pureed, wet ground, ground, and chopped) on the inappropriate mealtime behavior, gagging, and packing exhibited by a child who presented with food selectivity. Results showed increased inappropriate mealtime behavior with larger bite sizes and increased gagging and packing with higher textures. Sharp et al. (2012) compared the effects of presentation method with a flipped versus upright spoon on expulsion and mouth clean (a product measure of swallowing). Lower levels of expulsion and higher levels of mouth clean occurred during the flipped spoon presentation for all participants.

Identification of antecedent variables (e.g., food type and texture, bite size, feeding utensils) that may influence the likelihood of appropriate and inappropriate mealtime behaviors allows the behavior analyst to individualize the child's behavioral intervention.

Intervention

Behavioral interventions have proven effective and currently have the most scientific support to decrease maladaptive mealtime behaviors and increase appropriate mealtime behaviors (e.g., Addison et al., 2012; Kerwin, 1999; Peterson et al., 2016; Volkert & Piazza, 2012). Kerwin (1999) and Volkert and Piazza (2012) conducted systematic searches of peer-reviewed studies on psychosocial or behavioral interventions for children with a feeding disorder. They identified studies with rigorous methodologies and classified the treatments as well-established, probably efficacious, or promising according to specific criteria and guidelines described by the Task Force on Promotion and Dissemination of Psychological Procedure (1995) and Society for Pediatric Psychology. Results indicated that some behavioral treatments are empirically supported and are well-established treatments for pediatric feeding disorders. Addison et al. (2012) and Peterson et al. (2016) directly compared the relative effectiveness of behavior-analytic and sensory integration therapies to treat feeding disorders. Results showed that the behavior-analytic therapy reduced inappropriate mealtime behavior and increased acceptance to stable and acceptable levels for all children, whereas inappropriate mealtime behavior remained above clinically acceptable levels and acceptance remained low or variable with the sensory integration therapy.

Consequence-Based Procedures

The most frequently researched behavioral intervention is a multi-component treatment package that combines two consequence-based procedures, escape extinction and differential reinforcement of alternative behavior (DRA) (e.g., Ahearn et al., 1996; Anderson & McMillan, 2001; Babbitt et al., 1994; Cooper et al., 1995; Hoch et al., 1994; Kerwin et al., 1995; Patel et al., 2002; Piazza et al., 2003b). In fact, Kerwin (1999) and Volkert and Piazza (2012) found that escape extinction and differential reinforcement of alternative behavior are both empirically supported and the well-established treatments for pediatric feeding disorders.

Escape Extinction

Escape extinction, which is implemented when a child's feeding behavior is presumed to be maintained by negative reinforcement (escape from food or drink), is a procedure in which escape from the demand of eating or drinking is no longer permitted. That is, the feeder no longer removes the bite or drink following inappropriate mealtime behavior. Two common escape extinction procedures are nonremoval of the spoon and physical guidance. Nonremoval of the spoon involves positioning the spoon or cup at the child's lips until he or she accepts the bite or drink, thus preventing escape from the bite presentation (e.g., Ahearn et al., 1996; Babbitt et al., 1994; Cooper et al., 1995; Piazza et al., 2003b; Reed et al., 2004). An alternative escape extinction procedure, physical guidance, consists of applying gentle pressure to the child's mandibular joint to guide the mouth open, so that the bite may then be deposited in the child's mouth (e.g., Ahearn et al., 1996). Ahearn et al. (1996) compared the relative effects of nonremoval of the spoon and physical guidance on appropriate and inappropriate mealtime behavior for three children with an identified feeding disorder. Results showed that both treatments were effective at increasing bite acceptance for all three children. Re-presentation, a procedure in which the feeder scoops up expelled food or liquid and re-deposits it in the child's mouth until it is consumed, is commonly used in combination with nonremoval and physical guidance (e.g., Piazza et al., 2003b; Reed et al., 2004).

Differential Reinforcement of Alternative Behavior

Differential reinforcement of alternative behavior (DRA) involves providing the child with access to preferred stimuli (e.g., foods/drinks, toys, activities) contingent on appropriate behaviors, such as accepting or swallowing bites of food or drinks (e.g., Brown et al., 2002; Cooper et al., 1999; Levin & Carr, 2001; Piazza et al., 2003b; Riordan et al., 1980; Riordan et al., 1984). For example, Riordan et al. (1980) treated the feeding problems of four children who exhibited limited and selective food intake. The primary treatment procedures involved delivering preferred foods contingent on acceptance of non-preferred foods, which resulted in increased food intake for all four children.

It may be possible to increase the quantity or variety of foods some children consume using DRA in the absence of escape extinction when it is possible to identify highly preferred foods or drinks (e.g., Brown et al., 2002; Cooper et al., 1999; Levin & Carr, 2001; Riordan et al., 1980; Riordan et al., 1984). However, there are factors that may influence whether preferred foods or drinks may function as positive reinforcers in the treatment of feeding difficulties, including the magnitude of the reinforcer and reinforcer deprivation. For example, Cooper et al. (1999) manipulated the quantity and/or the quality of positive reinforcement (i.e., contingent access to preferred foods or drinks) paired with acceptance of bites of nonpreferred foods in the treatment of four children who exhibited either low overall intake or highly selective food intake. Increasing the quantity of reinforcers (i.e., number of sips of Pepsi™ or bites of potato chips) provided contingent on acceptance of bites of nonpreferred foods resulted in an overall increase in food acceptance (in the absence of escape extinction) for one of four children. These results suggest that it may be necessary to increase the number of reinforcers offered for each bite of nonpreferred food consumed if treatment effects are not achieved with the initial quantity of reinforcers selected. After consumption of nonpreferred foods has been established utilizing contingent access to preferred foods, the proportion of bites of preferred and nonpreferred foods may be altered by either gradually decreasing the schedule of reinforcement or gradually increasing the demand requirement to access reinforcement. For example, Riordan et al. (1980) utilized demand fading (i.e., gradually increasing the demand requirement to access reinforcement) combined with contingent positive reinforcement to increase the proportion of nonpreferred foods to preferred foods consumed by two children who exhibited low and selective food intake.

Another factor that may influence the effectiveness of potential reinforcers, particularly preferred foods or drinks, is the relative states of deprivation associated with the preferred stimuli. For example, Levin and Carr (2001) examined the differential effects of having or not having access to preferred food items prior to meals that involved the presence versus absence of contingent positive reinforcement for acceptance of bites of nonpreferred food with four children exhibiting food selectivity by type. All four children consumed nonpreferred foods only when the positive reinforcement contingency was implemented and access to the preferred foods prior to meals was restricted.

Although DRA may not be effective without escape extinction for all children, it has been associated with beneficial effects for some children when added to escape extinction. For example, Piazza et al. (2003b) examined the effects of DRA (contingent access to preferred toys) and escape extinction, individually and in combination, to treat the feeding disorders of four children. Results showed that DRA alone did not increase food consumption, whereas escape extinction increased food consumption independent of whether DRA was present or absent. However, DRA combined with escape extinction produced lower levels of inappropriate behavior and negative vocalizations for some children.

Noncontingent Reinforcement

Noncontingent reinforcement (NCR) typically involves continuous access to preferred adult attention and/or preferred toys or leisure activities in the treatment of pediatric feeding disorders (e.g., Berth et al., 2019; Reed et al., 2004; Wilder et al., 2005). For example, Wilder et al. (2005) examined the use of NCR to decrease self-injury and increase food acceptance in a child who exhibited limited and selective food intake. Treatment involved continuous access to a video during meals without the use of escape extinction, which resulted in decreased self-injury and increased food acceptance.

Noncontingent reinforcement has also been associated with beneficial effects when added to escape extinction for some children. For example, Reed et al. (2004) examined the effects of NCR (continuous access to preferred toys) and escape extinction, individually and in combination, to treat the feeding disorders of four children. Noncontingent reinforcement alone did not increase food consumption, whereas escape extinction increased food consumption independent of whether NCR was present or absent. However, NCR combined with escape extinction produced lower levels of inappropriate behavior for some children.

Berth et al. (2019) compared the effects of DRA and NCR and the relative effects of escape extinction with and without DRA or NCR when escape extinction was necessary. Both reinforcement procedures were effective without escape extinction to treat the food refusal of one child, but only DRA was effective without escape extinction to treat the child's liquid refusal. Escape extinction was necessary for four of five children, and similar to the results of Piazza et al. (2003b) and Reed et al. (2004), the addition of positive reinforcement resulted in beneficial effects for three of four children (i.e., more stable acceptance, decreased inappropriate mealtime behavior or negative vocalizations). With escape extinction, DRA was more effective to treat food refusal for two children and NCR was more effective for one child. Thus, the results of Berth et al. suggest that the addition of positive reinforcement to escape extinction may have beneficial effects for some children, but the relative effects of DRA and NCR are idiosyncratic.

Antecedent-Based Procedures

The earliest behavioral literature on the treatment of pediatric feeding disorders focused primarily on consequence-based treatment procedures (i.e., reinforcement, extinction). A second wave of studies introduced antecedent-based treatment procedures (e.g., utensil manipulation, simultaneous presentation, stimulus fading, demand fading). Researchers have demonstrated that some of these procedures may result in desired treatment outcomes without the need for other treatment components, increase the effectiveness of other treatments, or attenuate the side effects of escape extinction for some children with feeding difficulties. It may be that these antecedent treatments enhance treatment outcomes because they decrease the aversiveness of the mealtime context and/or reduce the response effort for appropriate mealtime behavior, which may alter the value of reinforcers maintaining inappropriate mealtime behavior (motivating operations), accommodate or support oral-motor skill deficits, or a combination of both.

Utensil Manipulation

For some children, re-presenting bites does not effectively decrease expulsions and increase mouth clean. A few researchers have shown that flipping the spoon over (open bowl on the top of the tongue) when depositing the food may decrease expulsion and increase mouth clean (e.g., Dempsey et al., 2011; Rivas et al., 2011; Sharp et al., 2012; Sharp et al., 2010). For example, Sharp et al. (2012) examined the effects of bite placement with a flipped versus upright spoon on expulsion and mouth clean for three children with a feeding disorder and identified oral motor deficits. For all three children, nonremoval of the spoon resulted in decreased inappropriate mealtime behavior and increased bite acceptance; however, re-presentation did not reduce expulsion or increase mouth clean. Flipped spoon presentations and re-presentations decreased expulsions and increased mouth clean for all children. Similarly, Dempsey et al. (2011) treated the liquid refusal of a child with a feeding disorder using a flipped spoon presentation combined with a chin prompt. Mouth clean did not increase with the chin prompt alone and increased only modestly with the flipped spoon alone. The greatest increases in mouth clean resulted from the combination of two antecedent manipulations (flipped spoon and chin prompt).

Using a Nuk® brush to present bites may be an alternative option to decrease expulsion and increase mouth clean (e.g., Sharp et al., 2010; Wilkins et al., 2014). For example, Wilkins et al. (2014) compared presenting bites on a spoon or on a Nuk® brush using nonremoval and re-presentation for 12 children with feeding difficulties. Feeding behavior improved for eight children. Of those eight children, five showed lower levels of expulsions and four showed higher levels of mouth clean with presentations on the Nuk® brush than with the spoon. Similarly, Sharp et al. (2010) compared the effects of presentations on an upright spoon, flipped spoon, or Nuk® brush in the treatment of a feeding disorder for one child. The child expelled all bites presented on an upright spoon but showed decreased expulsions and increased mouth cleans with the flipped spoon and Nuk® brush presentations.

Simultaneous Presentation

Simultaneous presentation involves presenting a more preferred with a less preferred food at the same time (e.g., Ahearn, 2003; Buckley & Newchok, 2005; Piazza et al., 2002). The foods may be presented together on the same utensil in an observable format, blended together in a pureed format, or the nonpreferred food may be inside or covered by the preferred food. This strategy has been effective at increasing consumption of nonpreferred foods in the absence of escape extinction and increasing the effectiveness of escape extinction for some children. For example, Piazza et al. (2002) showed that simultaneous presentation of a more preferred food with a less preferred food may actually be a more effective method than contingent access to preferred foods to increase acceptance of less preferred foods. Piazza and colleagues compared the effects of these two methods of food presentation (simultaneous versus contingent) to increase the acceptance of less preferred foods by three children with feeding difficulties. The simultaneous presentation involved presenting preferred foods at the same time as a nonpreferred food (e.g., a piece of broccoli on a chip, salad dressing on a piece of broccoli). The contingent presentation involved presentation of a preferred food following acceptance of a nonpreferred food. Acceptance of nonpreferred foods immediately increased (without escape extinction) for two of the three children with the simultaneous presentation relative to the contingent presentation. For one child, acceptance of nonpreferred food increased with the simultaneous presentation but not the contingent presentation with the addition of escape extinction (physical guidance and re-presentation).

Results of these studies suggest that simultaneous presentation may be an effective treatment option when preferred foods can be identified. This strategy may momentarily decrease the aversive properties of the nonpreferred food and thus decrease the child's motivation to refuse the nonpreferred food. An alternative explanation is that flavor–flavor conditioning occurs (i.e., a preference for the nonpreferred is acquired as a result of pairing it with a preferred flavor; Piazza et al., 2002). However, it is possible that preference for the preferred food may be altered as a result of pairing it with nonpreferred foods; thus, this strategy may be more appropriate when a child demonstrates a strong preference for food(s) other than those that comprise the majority of the child's current nutrition.

Stimulus and Demand Fading

Food Type Researchers have shown that gradually changing the ratio or concentration of preferred and nonpreferred foods or liquids (stimulus fading) may increase acceptance of nonpreferred foods or liquids in the absence of escape extinction (e.g., Luiselli et al., 2005; Tiger & Hanley, 2006) or increase the effectiveness of escape extinction (e.g., Mueller et al., 2004; Patel & Piazza 2001). For example, Luiselli et al. (2005) gradually faded the concentration of liquid in the absence of escape extinction to establish milk consumption with a child with identified feeding difficulties. Treatment consisted of gradually increasing the concentration of milk in a beverage the child consistently consumed (Pediasure®, a supplemental nutritional beverage). After nonremoval and DRA or NCR, increased consumption of only one or two of 16 foods for two children with feeding difficulties, Mueller et al. (2004) added stimulus fading in which they blended a small portion of nonpreferred pureed foods into the pureed foods the children consistently consumed (e.g., 10% nonpreferred/90% preferred) and gradually altered the ratio until the children were consuming the nonpreferred foods alone during probes.

It may also be necessary to gradually change the ratio or concentration of paired preferred and nonpreferred foods or liquids after successfully using simultaneous presentation in order to maintain appropriate feeding behavior with nonpreferred foods or liquids alone. For example, Luiselli et al. (2005) gradually faded the concentration of liquid (without escape extinction) to establish milk consumption with a child who drank Pediasure® at full strength and at a blend of 50% Pediasure® and 50% whole milk but refused whole milk at full strength or when it was blended with Pediasure® at a concentration of less than 50% Pediasure®.

Gradually introducing the proportion of nonpreferred foods paired with preferred foods may also reduce the risk associated with pairing nonpreferred and preferred foods. Initially presenting the nonpreferred food with the preferred food at a minimal concentration or proportion may reduce the likelihood that the preferred food does not acquire the aversive properties of the nonpreferred food. A limitation to this procedure may be the length of time required for fading; however, periodic probes (of the full-strength substance) can be conducted to determine whether continuing to fade the concentration is necessary, as in the Mueller et al. (2004) study.

Food texture or liquid consistency Children with feeding disorders often display food selectivity by texture. For many of these children, consuming higher textured foods may be aversive or potentially dangerous due to delayed oral motor skills. For example, Shore et al. (1998) used texture fading in combination with nonremoval and DRA to treat the food selectivity exhibited by four children with feeding difficulties. Fading involved gradually increasing texture using various proportions of puree, junior, ground, and finely chopped food, based on results of periodic probes. Similarly, Bachmeyer et al. (2013) examined the effects of gradually altering the concentration of liquid by adding baby food to the liquid with two children who consistently consumed liquids, but not baby food, after treatment using physical guidance with re-presentation and DRA. High levels of mouth clean maintained throughout fading for both children. Mouth clean and gram intake increased and negative vocalizations decreased with 100% baby food after the fading treatment.

Utensil or feeding apparatus A few researchers have gradually altered the feeding apparatus from a utensil from which a child consistently accepts to an age-typical utensil (e.g., Babbitt et al., 2001; Groff et al., 2014; Johnson & Babbitt, 1993). For example, Babbitt et al. (2001) faded from a spoon with thickened liquids to a cup with thin liquids using nonremoval and DRA to establish cup drinking skills with two children who consistently consumed solid food but refused all liquids. Similarly, Groff et al. (2014) conducted syringe to cup and syringe to spoon fading after they established acceptance of liquids and solids with a syringe when nonremoval failed to be effective with a spoon or cup. The treatment involved using a syringe to deposit liquids and solids, increasing the volume of liquids and solids in the syringe, and conducting syringe-to-cup and syringe-to-spoon fading.

Bite size or quantity It may be beneficial to decrease the bite size and/or bite requirement at the beginning of treatment to reduce the aversive properties of the meal or response effort, and then gradually increase the bite size and/or number of bites to maintain low levels of problematic mealtime behavior and high levels of appropriate mealtime behavior (Kahng et al., 2003; Kerwin et al., 1995; Najdowski et al., 2003; Penrod et al., 2010; Sharp & Jaquess, 2009). For example, Kerwin et al. (1995) examined the role of bite amount (i.e., empty, dipped, quarter, half, and level spoon), differential reinforcement of incompatible behavior, and physical guidance or nonremoval of the spoon on feeding behaviors with three children with food refusal. Differential reinforcement of incompatible behavior and physical guidance or nonremoval of the spoon were introduced at the smallest bite amount and later introduced at the larger bite amounts with moderate to high levels of acceptance. Kahng et al. (2003) used contingent access to escape (termination of the meal) and token-based DRA to establish acceptance and consumption of food with a child with feeding difficulties, and then gradually increased the number of bites required to access reinforcement using a changing criterion design.

High-Probability Instructional Sequence

High-probability (high-*p*) instructional sequence involves presenting a series of instructions for which compliance is highly probable followed by a request for which compliance is not probable (i.e., a low-probability [low-*p*] instruction). For example, Patel et al. (2007) evaluated the effects of a high-*p* instructional sequence on food acceptance with a child who inconsistently consumed a limited variety of foods. The high-*p* sequence consisted of three presentations of an empty spoon, and the low-*p* instruction was the presentation of a spoon with food. Acceptance of food increased in the presence and not the absence of the high-*p* instructional sequence. The high-*p* instructional sequence has been effective at increasing food consumption in the absence of escape extinction (Patel et al., 2007) and associated with beneficial effects when combined with escape extinction for some children (Dawson et al., 2003; Patel et al., 2006). If a child demonstrates high levels of compliance with a request similar to eating, such as acceptance of an empty spoon, then a high-*p* instructional sequence may be effective at increasing compliance (e.g., acceptance, mouth clean) with target foods.

Advanced Skill Development

In addition to learning to consume a sufficient variety and quantity of foods and liquids to meet their nutritional needs, some children with feeding difficulties need to explicitly learn to chew because of oral motor delays or dysfunction and/or lack of opportunities to naturally develop chewing skills during critical periods. Volkert et al. (2013, 2014) described the first treatment protocols to increase chewing using least-to-most prompting combined with either a descriptive verbal prompt (of the number of times to chew) or stimulus and demand fading (i.e., the child was required to chew on an empty chew tube, a bite of food in a chew tube, a strip of food on half of a chew tube, a strip of food, a bite of food, and increased bite sizes of food). In 2013, Volkert and colleagues also developed a product measure of chewing (i.e., if the food is broken down enough to safely swallow after chewing), termed mastication, to evaluate the effects of the treatment protocols.

Even after successful intervention to increase acceptance of solids and/or liquids, children with feeding difficulties may not demonstrate the skills or motivation to begin feeding themselves (Volkert et al., 2016). Therefore, additional intervention may be necessary to teach self-feeding/drinking skills to promote independence during mealtimes. For example, Peterson et al. (2015) demonstrated that differential positive reinforcement alone (descriptive praise and preferred toys/leisure items) was effective at increasing self-drinking for two children with feeding difficulties. Collins et al. (1991) used physical guidance with a constant-time delay procedure and descriptive praise to teach self-feeding to two children with feeding difficulties. After the children mastered self-feeding with physical guidance and a 0-s time delay, a 3-s time delay was implemented, and independent self-feeding increased for both children. Alternatively, Volkert et al. (2016) examined the effects of manipulating response effort and/or food preference to increase self-feeding by three children with feeding difficulties after descriptive praise alone was not effective. That is, researchers biased the children's responding to feed themselves instead of being fed by a therapist by increasing the number of bites and/or decreasing the relative preference of the foods they had to consume if a therapist fed them.

Ethical Considerations

No behavior analyst would knowingly or intentionally harm a client. However, practicing outside of one's competency without adequate supervision (Bailey & Burch, 2016), practicing outside of an interdisciplinary approach, and failing to select and implement safe and effective treatments can result in unintentional harm.

Training and Supervision

The Professional and Ethical Compliance Code for Behavior Analysts (Behavior Analyst Certification Board, 2014), herein referred to as the "Code," specifies providing services, conducting research, and teaching only within the boundaries of one's *competence*, defined as being commensurate with education, training, and supervised experiences (Code 1.02). As Bailey and Burch (2016) discuss:

> …beyond that, practitioners will have to determine whether they are indeed competent in certain subspecialities of ABA. Examples of such subspecialties include treating feeding disorders, self-injurious behavior, aggression, and destructive behaviors. Attending a workshop or seminar on one of these specialties is not sufficient to describe oneself as competent in a subspecialty area. (p. 58)

Behavior analysts might take on a client or attempt to treat problem behaviors that are outside of their scope of competence because they want to help the child and caregiver. However, the long-term effects of behavior analysts working within the subspecialty without adequate training or supervision can be detrimental to a child's health and future success with eating and drinking.

Practitioners whose background did not involve extensive training in assessment and treatment of pediatric feeding disorders should seek comprehensive training and supervised experiences from a behavior analyst competent in this subspecialty prior to practicing or conducting research within this area. Alternatively, practitioners may be able to provide safe and effective services with ongoing consultation from a behavior analyst who is competent in this subspecialty prior to receiving additional training experiences. When behavior analysts have received some training within the subspecialty (e.g., practicum, internship, research experiences), their experience may have been limited in the number of clients and range of feeding difficulties treated, working within an interdisciplinary team, and/or the extent to which they learned to safely and effectively select, implement, and evaluate a limited variety of procedures. These behavior analysts should evaluate their competence with their supervisors or mentors to determine whether they will require additional supervision or consultation to provide safe and effective treatment. Behavior analysts practicing in this subspecialty must maintain their competence through professional development by staying current in the literature, attending conferences and workshops, and even completing additional coursework or supervised experiences (Code 1.03).

Interdisciplinary Approach

Behavior analysts protect their clients and themselves by making sure that they do not treat the behavioral manifestations of undiagnosed or unrecognized medical conditions (Copeland & Buch, 2020). Code 3.02 states that behavior analysts recommend seeking medical consultation if there is any reasonable possibility that a referred behavior is influenced by medical or biological variables. Given that approximately 86% of children diagnosed with a feeding disorder are diagnosed with a medical condition (Rommel et al., 2003), behavior analysts should assume that the child's feeding difficulties have a medical or biological component. The best way for the behavior analyst to protect his or her client and him or herself is to work within an interdisciplinary approach.

In addition, Code 2.03 states that it is always indicated and professionally appropriate to cooperate with other professionals in a manner that is consistent with the philosophical assumptions and principles of behavior analysis to effectively and appropriately serve clients. Medical providers, speech and language pathologists, and occupational therapists often have different philosophical views, but it is the behavior analyst's responsibility to collaborate with other interdisciplinary team members to ensure the best outcomes for the client.

Treatment Selection and Implementation

Code 2.09 specifies that every client has a right to an effective treatment. Many practitioners may be aware that escape extinction and reinforcement are the most commonly used evidence-based treatments for feeding difficulties, but they may not be familiar with all of the factors that should be considered to safely and effectively program and implement treatment.

For example, researchers have shown that escape extinction is highly effective to treat feeding difficulties and is often a necessary treatment component. However, extinction has been associated with numerous side effects, such as extinction bursts, emotional responding, and extinction-induced aggression (Lerman et al., 1999). Caregivers of young children with feeding disorders and often complicated medical histories may find these potential side effects unacceptable. Further, it can be discouraging for caregivers if appropriate mealtime behavior (e.g., bite acceptance) does not occur relatively quickly or if additional topographies of inappropriate mealtime behavior emerge (e.g., expulsion, packing). Consistent with Code 4.08, including a positive reinforcement component with escape extinction or other aversive procedures may attenuate the potential side effects of escape extinction for some children (e.g., Berth et al., 2019; Piazza et al., 2003b; Reed et al., 2004). Further, manipulating antecedent variables when programing escape extinction may reduce the potential side effects of extinction and increase its effectiveness, resulting in quicker acquisition of appropriate mealtime behaviors (e.g., Munk & Repp, 1994; Patel et al., 2006; Sharp & Jaquess, 2009). In addition, when developing an intervention utilizing contingent access to preferred foods or drinks, consideration needs to be given to completely restricting access to preferred foods as this could result in a decrease in overall food intake for some children. Likewise, caution should be used when simultaneously presenting preferred and nonpreferred foods because the preferred food may become aversive and result in a decrease in their overall consumption for some children. Code 4.03 requires that the behavior analyst tailor behavior-change programs to the unique behaviors, environmental variables, assessment results, and goals of each client. "One of the most difficult tasks the behavior analyst faces is extrapolating from published research methods to procedures that will work with an individual client" (Bailey & Burch, 2016). Knowing how to develop individualized antecedent assessments and interpret the results to develop the most safe and effective individualized treatment for a child with feeding difficulties requires sufficient training and experience with numerous clients with a wide range of feeding difficulties and with a variety of assessment and treatment procedures.

Considerations when implementing escape extinction should include procedural fidelity and safety of the client. Consistent with Code 4.08, escape extinction should only be implemented to treat feeding difficulties by individuals who are well-trained and receiving appropriate supervision and oversight. Forced feeding, although structurally and theoretically different than escape extinction, has been identified as a contributing factor in the development of feeding problems (Palmer et al., 1975; Riordan et al., 1980) and aspiration pneumonia (Perske et al., 1977). Escape extinction implemented by a behavior analyst without proper training and supervision can pose the same safety risks as forced feeding. Further, treatment fidelity can be greatly influenced by the child's size and strength and history with escape extinction procedures. The risks and benefits of using escape extinction with older and stronger children must be considered in terms of how likely a trained feeder can accurately and safely keep the utensil at the child's lips during high rates of intense inappropriate mealtime behavior, extinction-induced emotional responding, and aggression and/or self-injurious behavior. Further, escape extinction should only be implemented in a setting, where additional trained therapists are available to block inappropriate mealtime behavior (to ensure the feeder can keep the utensil at the child's lips to prevent escape) and where additional materials are available (e.g., appropriate adaptable seating, padding for the table and seating, protective equipment for the feeder). There are additional safety issues to consider when structuring the mealtime, particularly when implementing escape extinction, such as keeping the child in a safe, upright position; not depositing bites or drinks when the child is coughing or gagging or when the head is tilted back; appropriate bite size, food texture, and liquid consistency;

appropriate placement or deposit of the food or liquid; and appropriate pacing between bite or drink presentations. Fortunately, this knowledge and skills can be acquired with appropriate training and supervision or consultation with a behavior analyst who is competent in this specialized area of behavior analysis.

Summary

Failure to consume sufficient calories or meet nutritional needs can place a child at risk for significant delays to their growth and overall development. Children with feeding difficulties, such as ARFID, may exhibit a wide range of presenting problems, including refusal of all food or liquid, dependence on liquids, highly selective patterns of eating, and skill deficits. Behavioral interventions are effective at decreasing maladaptive behaviors (e.g., inappropriate mealtime behavior, expulsions), increasing appropriate mealtime behaviors (e.g., bite acceptance, swallowing), and teaching new skills (e.g., chewing, self-feeding). However, given the variance in presenting problems and complex etiology of feeding difficulties, an interdisciplinary approach to assessment and treatment is necessary. Further, it is important that the behavior analyst be adequately trained or receive sufficient supervision or consultation to provide an effective intervention and keep the child safe as indicated by the Professional and Ethical Compliance Code for Behavior Analysts.

Over the past two decades, behavior analysis has made great strides in the subspecialty of feeding disorders. Investigators developed new assessment methods to prescribe individualized treatments. Numerous researchers also developed a range of antecedent-based treatments that provide additional treatment options, and in some cases, may enhance existing treatments by altering motivating operations or supporting skill deficits. Further, some researchers improved our knowledge on methods to teach new skills. Although replication of some of these methods is necessary to establish additional behavioral treatments as efficacious, as we move into the next decade, there remains several other areas for investigation to further advance the effectiveness, efficiency, and specificity of our therapeutic approach. Given the complexity and heterogeneity of feeding difficulties, it is likely that multiple antecedent variables may interact to influence the value of reinforcers that maintain problem behavior in the mealtime context and/or influence feeding behavior based on response effort and acquired skills or deficits. Therefore, more comprehensive assessments evaluating potential interactions between multiple antecedent variables and research examining interactions between various antecedent manipulations and different consequence-based procedures may allow practitioners to more efficiently and specifically prescribe treatment. Further, research examining interactions between biological and behavioral variables in the treatment of feeding difficulties may also provide more effective treatments. Finally, long-term effectiveness of our treatments in the natural setting is essential to resolve feeding difficulties and achieve typical eating patterns. Therefore, future research should explore methods to program for generalization and maintenance of treatment success and prevent treatment relapse.

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40 Telehealth and Applied Behavior Analysis: An Overview and Examples of Application

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Tele-, a prefix that means at a distance ("Tele-", 2011), combines with various words indicating the distal relationship. Common examples may include instruments to transmit information, such as a television (i.e., an instrument that receives transmitted images from one location and reproduces them on a screen in a different location) or a telescope (i.e., an instrument to make distant objects appear nearer). Other examples (e.g., telephone, telegram) indicate how two or more people share information across a distance. A specific form of information sharing across a distance is telehealth.

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Many definitions of telehealth[1] exist and typically reflect nuances specific to a particular profession. The American Telemedicine Association (2013) defines telemedicine as the exchange of medical information from one site to another via electronic communication. Another example, from the American Psychological Association (2013), defines telepsychology "as the provision of psychological services using telecommunication technologies." The Health Resources and Services Administration (HRSA) defines telehealth more broadly as the "use of electronic information and telecommunication technologies to support and promote long-distance clinical health care, patient and professional health-related education, public health and health administration" (Health Information Technology, 2017). For this chapter, we utilize the HRSA definition as it does not utilize profession-specific language and the language is inclusive of appli-

[1] Telehealth is used throughout this chapter although other terms, such as telemedicine, might be applicable. Per the given definition, telehealth broadly recognizes technology utilized to enhance others' health. Additionally, it does not specify any one profession (e.g., telemedicine, telepsychology) responsible for enhancing others' health. Unless quoting or paraphrasing another source that specifically references a different term, telehealth is used exclusively.

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_40

cations beyond clinical care (i.e., education and health administration) and articulates telehealth as a modality, rather than a distinct service.

According to Bashshur and Shannon (2009), the simplest forms of telehealth (i.e., connecting those in need of care to those who provide care) arguably existed with ancient civilizations utilizing rudimentary strategies to remain connected. The same authors described transformations of technology to bridge distance and provided examples of written words, semaphore, telegrams, radio signals, and the internet. Advances in technology reinforce telehealth as a service modality to connect those in need of care with those who provide care. The Council for Autism Service Providers (CASP, 2020, 2021) has stated telehealth is not a separate or distinct healthcare, but rather a service delivery model that may be met synchronously or asynchronously.

Synchronous methods utilize technology to transmit information between two parties in "real-time" (i.e., at the same point in time) (CASP, 2020). A parent and child, seeking care for a cough, might visit with a healthcare professional via a video platform using "real-time" video and audio (e.g., Zoom or Doxy). Additionally, a direct support professional may seek care from a healthcare professional via a phone call to meet emerging medical needs for a congregate-care resident. Asynchronous methods are similar to synchronous but do not occur during the same point in time (CASP, 2020). A teenager struggling with social anxiety may email weekly with a therapist describing the number and quality of social interactions achieved during the week. An adult seeking better health may enter eating and exercise information into an application on a smartphone, later reviewed by a supporting professional.

Although technology is not new to behavior analysis (e.g., Rutherford, 2009), practicing behavior analysts have fairly recently implemented telehealth models to deliver treatment. Examples include telehealth for assessments (e.g., Barretto et al., 2006), to train others to conduct assessments (e.g., Frieder et al., 2009; Rios et al., 2020), and to deliver treatment (e.g., Peterson et al., 2017; Wacker et al., 2013b). The novel COVID-19 pandemic further created a context for discussion about and advancements in the implementation of behavior analytic services via telehealth models (e.g., Baumes et al., 2020; Crockett et al., 2020; Cox et al., 2020; LeBlanc et al., 2020; Sivaraman et al., 2020). Several resources provide an in-depth discussion of the considerations when using telehealth models (see Table 40.1); however, it is worth discussing a few of the considerations associated with telehealth models.

Understanding Differences Between Telehealth Service Delivery and Other Models

As discussed by the American Psychological Association (2013) and Quigley et al. (2019), telehealth service delivery models necessitate some modifications to traditional in-person models. Practitioners need to develop minimum competencies in these modifications to practice within the service delivery model, plan for known risks, and maintain good outcomes. Practitioners implementing telehealth should have enough awareness to tact several of the key points below.

Understanding Telehealth Service Delivery Models

Not only must a practitioner understand variables associated with modifying behavior analytic interventions delivered via telehealth, practitioners should also know the differences between telehealth models. CASP (2020) describes at least four different models for consideration during the COVID-19 pandemic: full telehealth, partial telehealth, caregiver-implemented, and caregiver consultations (see Table 40.2). Practitioners should be able to state the pros and

Table 40.1 Selective telehealth and ABA bibliography

Author	Years	Population	Summary	Technology specification
General telehealth resources				
American Psychological Association	2013	Professionals	The American Psychological Association (APA) developed a task force to review telehealth practices. The articles contain specific guidelines for developing telehealth services	No
American telemedicine association	2013	Professionals	The American telemedicine association developed a task force to review telehealth practices. The article contains specific guidelines for developing telehealth services	Yes
Alkhalifah & Aldhalaan	2018	Autism Spectrum disorder	The authors describe the implementation of a telehealth model for supporting individuals with autism Spectrum Disorder residing in the Kingdom of Saudi Arabia. The authors describe how to implement a telehealth model in rural settings and adapt for cultural variables	Yes
Council of Autism Service Providers	2020	Professionals	The Council for Autism Service Providers (CASP) developed a task force to provide guidance regarding behavior analytic telehealth. The articles contain specific guidance for practitioners to consider when developing behavior analytic telehealth services	No
Health information technology	2017	Professionals	The Health Resources and Services Administration provides a guide specific to telehealth administration. The guide contains many useful aspects, such as legal implications, example models, and technology considerations	Yes
Sutherland, Trembath, & Roberts	2018	Autism Spectrum disorder	The literature review evaluating variables related to telehealth models of service delivery for individuals with autism Spectrum disorder. The article contains useful information on the application for infants through adults, various discipline-specific services (e.g., assessment, diagnosis, treatment), and the technologies utilized	Yes
Behavior analytic telehealth resources				
Council of Autism Service Providers	2020	Professionals	The Council for Autism Service Providers (CASP) developed a task force to provide guidance regarding behavior analytic telehealth. The article contains specific guidance for practitioners to consider when developing behavior analytic telehealth services	No

(continued)

Table 40.1 (continued)

Author	Years	Population	Summary	Technology specification
Council of Autism Service Providers	2021	Organizations & Professionals	CASP developed organizational standards and guidelines to address the needs of organizations. The Telehealth chapter provides information on ethical, regulatory, and technology considerations	Yes
Ferguson, Craig, & Dounavi	2019	Autism Spectrum disorder	A literature review summarizing behavior analytic telehealth models applied with individuals with autism Spectrum disorder. The article contains useful information regarding the effectiveness of the model and technology considerations	Yes
Lee et al.	2015	Autism Spectrum disorder	The researchers describe the implementation of a behavior analytic telehealth model for assessment and treatment. The article contains technical descriptions of technology and useful troubleshooting guidance	Yes
Lindgren, et al.	2016	Autism Spectrum disorder	The authors evaluated the impact of three different service delivery models on children's challenging behavior. The research demonstrated each model successfully decreased challenging behavior. The home telehealth model had the lowest overall cost	Yes
McGarry, Vernon, & Baktha	2019	Parents	The authors evaluated the effectiveness of training parents to implement a pivotal response treatment (PRT) for children with autism Spectrum disorder. The article is an example of a parent-focused behavior analytic telehealth model	Yes
Hall, Monlux, Bujanda-Rodriguez, Jo & Pollard	2020	Fragile X syndrome	Randomized control trial evaluating a telehealth service delivery model for reducing problem behavior in boys with fragile X syndrome. The article is an example of an application of a telehealth model with a non-autism population	Yes
Pollard, Karimi, & Ficcaglia	2017	Professionals	The authors discuss the ethical considerations of behavior analytic telehealth models. The authors provide recommendations for developing clinical and business infrastructure	Yes
Pollard, LeBlanc, Griffin, & Baker	2020	Autism Spectrum disorder	The authors report outcomes on a sample of 17 patients with autism Spectrum Disorder who transitioned from in-person to telehealth technician-delivered ABA treatment at the onset of the COVID-19 pandemic	Yes

Author	Years	Population	Summary	Technology specification
Quigley et al.	2019	Professionals	The authors discuss the presence/absence of ethical considerations in telehealth research specific to individuals with autism Spectrum disorder. The authors provide recommendations for ethical considerations for research and practice	No
Rios, Kazemi, & Peterson	2018	Professionals	The authors discuss best practices for implementing behavior analytic telehealth services. The article contains useful information regarding technology considerations in relation to the best practices	Yes
Tomlinson, Gore, & McGill	2018	Professionals	A literature review summarizing training of employees delivering behavior analytic telehealth services. The article contains useful information regarding training practices and barriers to implementation	Yes

Table 40.2 Summaries of telehealth service models

Full telehealth	Services are delivered and received completely through technology
Partial telehealth	Some aspects of service delivery are delivered and received through technology. For example, a technician delivers services in-person, whereas the overseeing clinician utilizes technology for oversight
Caregiver implemented	The caregivers deliver services with oversight, training, and support from a clinician via technology. The focus is approximation of a typical model (e.g., services provided by a technician and overseen by a clinician) to support acquisition and maintenance of skills
Caregiver consultation	A clinician provides training and support to caregivers via technology. The focus is prevention of crisis and regression, and in some cases teaching of a few essential skills

Note. See Council of Autism Service Provider (2020) for additional information

cons of each model. One assumption of this competency is that it will improve the practitioner's ability to improve outcomes by choosing the correct model to fit the needs of the individual's circumstances best. Another assumption of this competency is the financial implications between models (see Funding of Services Delivered via Telehealth Model). CASP (2020) provides a tool is to assess the best-fit service delivery model for a given situation.

Regulation of Practitioners in a Telehealth Model

According to Green and Johnston (Green & Johnston, 2009; see also Carr & Nosik, 2017), regulation of professionals occurs via certification and licensure. Any practitioner with a professional certification or license must understand how the credentialing body regulates professional activities, as well as the jurisdictions of professional activities rendered. For example, the behavior analyst licensure law for Arizona regulates professionals residing in Arizona and providing services to someone in Arizona; a professional residing in Arizona providing services to someone in another state; and a professional residing in a different state and providing services to someone residing in Arizona (see https://psychboard.az.gov/statutes-rules for further information). Behavior analysts practicing using telehealth must be aware of the regulations in all states in which they practice. Additionally, different states may have overarching guidance specific to telehealth service delivery (e.g., APA, 2013; Health and Human Services, 2015). It is vital that the practitioner remains updated regarding the regulation of specific service delivery models, such as telehealth, as these rules are changing rapidly in today's society.

Funding of Services Delivered via Telehealth Model

CASP (2020, 2021) is a recommended resource for discussion of different telehealth service delivery models. These resources are unique in many ways but provide a necessary discussion of funding considerations for behavior analytic services delivered via a telehealth model. For example, CASP, 2020 contains a table indicating Current Procedural Terminology (CPT) codes and how those codes might be utilized via a telehealth service delivery model. The distinction between face-to-face and in-person services as defined by the American Medical Association (AMA) is also reviewed to aid practitioners in understanding when services can be rendered via telehealth. For example, some CPT codes require services to be delivered "face-to-face," which the AMA considers this requirement to be met when the face-to-face interaction occurs via synchronous videoconferencing.

Importantly, no practitioner should assume a service delivered via telehealth will be reimbursed and should carefully review funder guidelines. For example, some funders will approve the use of synchronous videoconferencing, but asynchronous review of patient and provider interactions is not allowed. Alternatively, some funders may have distance restrictions that only allow telehealth service delivery when a patient lives a specified distance from the provider (CASP, 2021). As recommended by CASP (2021), organizations should complete a review of each patient's health insurance coverage to determine if telehealth is a covered benefit, and if so, obtain additional information on approved modalities (i.e., synchronous and asynchronous), services (e.g., caregiver coaching, adaptive behavior treatment with protocol modification), and any restrictions that may exist.

Necessary Equipment and Expertise of a Telehealth Model

Telehealth delivery of behavior analytic services requires the use of technology. Some forms of technology might be more familiar than others (e.g., cellular phone versus a video technology platform, such as Doxy) to the practitioner. Each practitioner should be competent in the use of technology in general (e.g., needed technological support for setup, maintenance, and troubleshooting), specific technologies (e.g., difference between features associated with Zoom versus Doxy), and ethical issues that can arise specifically when using digital technology (e.g., confidentiality, privacy, consent). The American Psychological Association (2013), CASP (2021), and Pollard et al. (2017) are useful resources for general considerations associated with telehealth. Rios et al. (2018) describe a useful resource for technology considerations. Quigley et al. (2019) describe a useful resource for ethical considerations. Romani and Schieltz (2017) provide an example of determining unique telehealth considerations specific to an application area (i.e., problem behavior).

Behavior Analytic Telehealth Applications

Now that the reader understands the broad definition of telehealth and some of the considerations that the practitioner should take into account when practicing telehealth, some examples of behavior analytic practice using telehealth are provided. For each application, we provide a brief description, sample publications evaluating outcomes, and a discussion of key points, barriers, and future areas of research needed. The application areas described below are not exhaustive. The breadth of the behavior analytic applications to telehealth is, frankly, astounding. Furthermore, this is a burgeoning and continually evolving modality of service delivery. Detailed discussions of all these applications are beyond the scope of this chapter. Readers are encouraged to read the numerous citations within the chapter, information provided elsewhere in this volume, review other helpful resources (e.g., Bernstein & Chase, 2013), and continue to access professional journals, as new information is published.

Telehealth Applications for Severe and Challenging Behavior

The earliest documented application of synchronous telehealth in behavior analysis dates back to the late 1990s (Barretto et al., 2006). Using a statewide fiber-optic telecommunications system, Barretto and colleagues at the University of Iowa conducted over 75 telehealth evaluations across a 4-year period for children and adolescents who exhibited challenging behavior. Parents and school personnel at community sites (e.g., schools, Department of Human Services office) with synchronous video and audio coaching from a behavior analyst at a remote site conducted the assessments, which included descriptive and/or brief functional analyses (FAs). Despite initial demonstration of the feasibility of telehealth as a service modality for addressing challenging behavior, only three additional behavioral assessment or treatment telehealth studies with four total participants were published within the following 5 years (i.e., Frieder et al., 2009; Gibson et al., 2010; Machalicek et al., 2009).

Early feasibility studies were further validated by a series of studies conducted by Wacker and colleagues at the University of Iowa beginning in 2013. Wacker et al. (2013a) reported on 20 successful functional analyses conducted with young children with autism via telehealth and Wacker et al. (2013b) provided the FCT treatment data for 17 of those same children. The treatment data showed that substantial reductions in challenging behavior—greater than 93% reduction from baseline—could be obtained using an FA plus FCT approach via telehealth. Although still employing a single case design for data collection and analysis, the Iowa researchers published two subsequent large group studies involving FA plus FCT. However, rather than a clinic-to-clinic model, these studies employed a clinic-to-home model, whereby parents conducted all assessment and treatment sessions at home with coaching from the clinician at a remote clinic site.

Unlike previous studies, which were focused on establishing the feasibility of telehealth models to assess and treat challenging behavior, the focus of Lindgren et al. (2016) was to compare telehealth models to in-person service delivery in terms of outcomes and costs. The comparison was made between clinic-to-home, clinic-to-clinic, and in-home (on-site coaching) models. The three approaches did not differ statistically in terms of treatment outcomes related to reduction in child challenging behavior, increased child communication, or parent satisfaction. However, the clinic-to-home telehealth model cost was 67% less than the in-home model and 33% less than the clinic-to-clinic model, most of which was accounted for by travel costs. Moreover, the number of weekly visits to obtain the reduction in challenging behavior was an average of nine sessions for both the clinic and home telehealth models, whereas the average number of sessions required to reach the desired behavior reduction averaged 17 sessions for the in-person home model. Thus, not only did the clinic-to-home telehealth prove just as effective as other service delivery models, it was at a substantially reduced financial and time cost.

More recently, Lindgren et al. (2020) used telehealth to conduct a randomized controlled trial of FCT. In this study, telehealth no longer served as the independent variable, but as a method to conduct a study requiring a large sample to answer a research question. Another evaluation of FCT as a treatment approach for young children with autism who exhibit challenging behavior, a clinic-to-home telehealth model was used to coach the parents of 38 young children using FA plus FCT. Coaching parents via telehealth to implement FCT had superior results compared to treatment-as-usual with all children demonstrating substantial reductions in challenging behavior and increases in communication.

Studies from other research sites have also reported effective use of telehealth to assess and treat challenging behavior for young children with autism (e.g., Benson et al., 2018; Dimian et al., 2018; Hoffman et al., 2019; Machalicek et al., 2016; Martens et al., 2019; Simacek et al., 2017; Tsami et al., 2019). Additionally, studies have extended the use of telehealth to other diagnostic categories, such as cerebral palsy (Benson et al., 2018), Rett syndrome (Martens et al., 2019), and fragile X syndrome (Monlux et al., 2019; Hall et al., 2020); adolescents with challenging behavior (Machalicek et al., 2016; Tsami et al., 2019); international originating sites and families requiring language interpreters (Tsami et al., 2019); FBA methods other than FAs, including indirect methods (e.g., caregiver interview; Benson et al., 2018; Bice-Urbach & Kratochwill, 2016; Machalicek et al., 2016; Simacek et al., 2017; Tsami et al., 2019), descriptive assessments (Benson et al., 2018; Bice-Urbach & Kratochwill, 2016) and structured descriptive assessments leading to contingency space analyses (Martens et al., 2019), and other function-based treatments not involving FCT (Machalicek et al., 2016).

Telehealth Applications for Skill Acquisition

The COVID-19 pandemic led to a rapid expansion of telehealth service delivery and research on the direct delivery of treatment to patients via synchronous videoconferencing emerged (Ferguson et al., 2020; Pellegrino & DiGennaro Reed, 2020; Pollard et al., 2020). Pellegrino and Reed taught two adults with Intellectual and Developmental Disabilities (IDD) adaptive living skills (e.g., cook and manage a budget). All instructions and prompts were delivered via videoconference and both participants not only acquired the skills, but also expressed high satisfaction with the modality. Similarly, Ferguson et al. taught six children diagnosed with ASD tact relations via synchronous videoconferencing. All instructions, prompting, and reinforcement were delivered via videoconferencing and participants acquired and maintained the tact relations.

These initial findings are promising and beg the question of whether telehealth direct treatment is as effective as in-person delivery. Pollard and colleagues conducted an archival analysis of a sample of 17 cases who transitioned from in-person to telehealth technician-delivered applied behavior analysis (ABA) when shelter-in-place orders were issued at the onset of the COVID-19 pandemic to examine client progress pre- and post-transition to telehealth. The authors reported that 76% of participants demonstrated all of the CASP-recommended prerequisite skills (CASP, 2020) and 100% of those participants were successfully transitioned to a telehealth direct delivery model in which the participants participated in treatment with limited or no caregiver assistance. The remaining participants ($n = 4$) were transitioned to a caregiver-implemented model, in which the caregivers were the primary intervention agent responsible for delivering all components of the intervention (e.g., instructions, prompts, and reinforcement). Notably, participants continued with a similar dosage of treatment (in-person $M = 12$; telehealth $M = 11$) and maintained or improved correct independent responding (in-person $M = 75\%$; telehealth $M = 80\%$).

Based on a multitude of studies, there appears to be strong support for the delivery of behavior analytic services to assess and treat challenging behavior via telehealth. The literature base would be strengthened through studies utilizing larger participant groups, diversity of participants (e.g., age, diagnosis), generalization to other care providers (e.g., grandparents versus parents), and settings (e.g., community versus home). Additionally, research is needed to determine whether there are limiting factors for therapists (e.g., a parent who responds emotionally to child behavior) or behavior coaches (e.g., poor vocal communication). Finally, the future use of telehealth is contingent on governmental and business policies that will determine who can provide such services and where, as well as whether such services will be adequately reimbursed, if at all.

Telehealth Applications for Feeding and Nutrition

In the area of pediatric feeding, the first documented telehealth approach was conducted in 2008 by a hospital-based program that deployed a multidisciplinary team primarily consisting of Behavioral Psychology and Speech and Language Pathology (i.e., Clawson et al., 2008). In this study, the use of the telemedicine permitted the initial evaluations of 12 children and families for prospective treatment. The method in which telehealth was delivered was through the purchase of specific telehealth equipment for use at their site. Since all participants were out of state, each family was required to travel to a remote site locally that had compatible equipment to meet virtually with the clinicians who were based in Virginia. Treatment recommendations were provided for six children and admissions to their 6-week day treatment program were recommended for the other six participants. Results consisted of parent satisfaction surveys. Unfortunately, no clinical results were reported in the study. Follow-up (by phone) was also reported with three families. Thus, the overall results of the study showed that telehealth was an acceptable technology via satisfaction surveys in the initial assessment of children with pediatric feeding concerns.

Six years later, three papers were published that evaluated treatment results through telehealth technologies. The first of the three studies occurred outside the field of ABA. Malandraki et al. (2014) evaluated one participant who lived in another country (England; the researchers were based in New York City). A case study design (AB) was used to evaluate a treatment that consisted of several components, including, but limited to: (1) reduce response effort—use of a simulated spoon, (2) differential reinforcement for bite acceptance, (3) swallowing practice, and (4) muscle strengthening exercises (e.g., drinking from a straw, tucking his chin). The telehealth platform that was used for all sessions freely available (i.e., VSee). This platform also allowed the use of visual stimuli (i.e., a board game) that the participant could see, but all stimuli were manipulated by the researchers (i.e., the child could not control the objects on the screen). The experimenters primarily used this feature to deliver positive reinforcement along with sticker rewards provided on-site by the parents when the participant completed specific treatment steps. A larger reward was also delivered at the end of sessions. Intensive treatment consisted of a total of eight 1-h sessions that occurred twice, weekly. Parents were also required to implement, 30+ min of the treatment strategies on a daily basis. Treatment results that were gleaned included: (1) a decrease in the latency to bite acceptance (5 s–1 s); (2) an increase in texture of items consumed (thin liquids to purees); (3) an increase overall number of items consumed (4 in baseline to 21 by the end of treatment); (4) a decrease in swallowing latency (i.e., 89% reduction; from ~27 s to ~3 s); (5) a decrease in aerophagia (i.e., 12 liters per day to <1 liter/day); (6) improved scores on a swallowing measure checklist; and (7) positive post-treatment social validity measures indicating equal or better than face-to-face consultation. It should be noted that despite these improvements, the child remained tube dependent following treatment.

The remaining two studies were the first ones that employed ABA approaches using telehealth to address pediatric feeding (Rivas et al., 2014; Wilkins et al., 2014). Wilkins and colleagues focused primarily on a comparison of utensil usage (i.e., spoon versus nuk brush) to assess their impact on expulsions for patients who were admitted to their intensive day-treatment ($n = 11$) or intensive outpatient program ($n = 1$). The impact of the two different utensils was evaluated between two phases of treatment: (1) baseline and (2) non-removal and re-presentation of food items (i.e., escape extinction) using an ABAB design. Eight of the 12 (75%) participants achieved therapeutic effects. However, the nuk brush was associated with lower amounts of expulsions for five of the eight. Additionally, four of these five participants also demonstrated higher percentages of mouth cleans (i.e., food was swallowed within 30 s following acceptance). All seven participants demonstrated additional improvements during follow-up visits ranging from 3 months to 2 years. Pertinent to the topic of telehealth was that follow-up visits with one of the responders were entirely conducted using telehealth (via a secure web-conferencing program). Of note was that for this participant, her follow-ups at 3 and 18 months demonstrated improvements similar to patients who had in-clinic follow-up visits. However, during her 6-month follow-up, her expulsions increased back to baseline levels, acceptance decreased from 100% to 41%, and mouth cleans decreased from 100% to 20%. These trends reversed at 12-month follow-up with zero expulsions, 100% acceptance, and 73% mouth cleans. Notably, this patient was the only patient with follow-up data that showed regression of gains. However, it is unclear if these results of the 6-month follow-up were due to a utensil transition, treatment integrity concerns, or specific aspects of follow-up through telehealth. It should also be noted that at the 6-month follow-up, the transition from the nuk brush to the spoon occurred (however, this effect did not occur for the other six patients with follow-up data).

In Rivas and colleagues' study (2014), three participants were treated in an outpatient clinic during weekly 60–90-min sessions. The primary purpose of the study was to increase self-feeding behaviors for three children with a history of food refusal. Notably, one of the three participants was evaluated entirely through telehealth consultation. Treatment consisted of several components; however, the primary variable was that the child could choose to independently consume a target food (i.e., self-feed) or have one or more of those bites fed to them. Thus, the target food could not be escaped only the manner of delivery (fed or self-fed). For all participants, when the choice between being fed or self-fed one bite, all children most frequently chose to be fed. Therefore, the response effort of target foods was increased by increasing the number of required fed bites (i.e., to 2, 3, 4, and 5 fed bites) across phases until the participant probably shifted towards self-feeding. Thus, by self-feeding, they could escape or avoid the presentation of additional bites of target foods (i.e., greater effort). Treatment was successful for the two in-clinic participants when the required number of fed bites increased to two and three bites, respectively. However, the participant that was exposed to the same procedures via telehealth the probability of self-feeding remained low even when five fed target food items were presented. Therefore, an additional phase was included, in which the fed bites were switched from the same bite of the target food item to bites of a food that the participant avoided or never consumed (as identified through a stimulus preference assessment). Thus, if the participant would not consume the target food item independently, instead of additional fed bites of the same food item (same quality of food), he was then be given a prescribed number of fed bites of a different, less preferred food item (lower quality of food). This procedure was successful when the ratio of fed lower quality food items reached 4:1. That is, he biased his responding towards self-feeding 1 bite of target food to avoid being fed 4 bites of a lower quality (i.e., less preferred) food item. With respect to telehealth treatment delivery, it is interesting that the participants who received the same assessment and treatment in-person at the clinic were successful in 50% or fewer sessions (i.e., 120, 60 sessions versus 275 sessions) and with less intrusive procedures as compared to the child who received treatment through telehealth. Because only one participant was exposed to a telehealth mode of delivery, it is unclear if these results were due to modality or idiosyncratic variables associated with the participant, however.

The first study that exclusively utilized telehealth during assessment and treatment of food refusal was conducted by Peterson et al. (2015). In this study, two patients presented liquid refusal and were treated through an outpatient telehealth clinic during weekly 1-h outpatient appointments. Sessions were conducted using Adobe Connect with parents serving as the therapists. However, it should be noted that both participants had been admitted previously to an 8-week feeding program. The goals of this study were an extension of treatment goals through that program and this study occurred 1 week following the patient's discharge from day treatment. Treatment consisted of evaluation of differential reinforcement of liquid acceptance (2 cc per sip). Treatment results were demonstrated through a reversal design (ABAB) with liquid fading from 2 to 4 cc and 10 cc for the two participants. This is the first published study that completed treatment, with liquid consumption increasing for both participants to 100% of offers which was executed exclusively through a telehealth platform.

In the aforementioned studies, telehealth appeared to be of a practical matter as opposed to a programmed one to evaluate its effectiveness. Peterson et al. (2020) conducted the first study comparing in-clinic and telehealth models. The authors examined the results of three children who initially were previously admitted to an intensive feeding program and then received follow-up through a combination of in-clinic and telehealth follow-up appointments. Overall, results were similar for all measures (i.e., acceptance, mouth cleans, and inappropriate behavior) across modalities. However, for one participant, there was a significant decrease in acceptance and a concomitant increase in inappropriate behavior during the second instance of telehealth consultation. Notably, the experimenters included treatment integrity data, which showed covariation between treatment integrity problems and increases in target behaviors. Thus, the problems with effectiveness did not appear to be due to telehealth treatment delivery, but rather to poor treatment integrity. In the second part of the study, 12 patients were divided into two groups and exposed to follow-up exclusively via either telehealth or in-clinic. Rather than presenting child-specific data, the percentage of goals met during follow-up was reported. These occurred in 3-month intervals, up to 21 months of follow-up. The patients in the telehealth group met 100% of their goals and those in the in-clinic group met

92% of their goals. Thus, overall, no major differences in treatment effectiveness were found across modalities during outpatient follow-up.

The application of telehealth in pediatric feeding is still in its infancy. Research in this area has somewhat lagged behind that found in the challenging behavior literature. Most pediatric feeding programs have essentially four phases of assessment and treatment: initial evaluation and screening, outpatient treatment, intensive treatment (e.g., day treatment or inpatient treatment), and follow-up. The handful of studies in pediatric feeding that employ ABA approaches via telehealth have revealed that telehealth has been primarily used in the follow-up aspects of cases. Non-behavior analytic studies of feeding disorders have utilized telehealth in the initial evaluation and outpatient treatment phases. No studies have used telehealth during intensive treatment.

A myriad of reasons may explain the limited use of telehealth in the initial evaluation and intensive treatment phases of treatment of feeding disorders. In the initial assessment and screening phase, unique information is best obtained in-person. For example, key idiosyncratic child and parent behaviors may be missed when the only view is a front facing camera (e.g., sibling behaviors, body language of the feeder, joint attention, distractions). These could be key antecedents and consequences for specific mealtime behaviors (i.e., bite acceptance, refusals, problem behavior). How food is prepared (e.g., poorly cooked, the size of bites, brand changes) is a key variable for consideration and may be missed. In addition, for some children, medical issues (e.g., aspiration, allergic reactions, aerophagia), oral-motor concerns (e.g., lateralization, packing), and other nuances (e.g., parents pushing liquids through the tube during a meal, sibling kicks the patient under the table) might be missed or may create an unsafe situation using telehealth. In an initial evaluation, it may be useful to have a wide-angle camera lens to capture variables that could be missed through the current telehealth technology formats.

Intensive treatment also presents several significant issues that could limit the usefulness of telehealth. First, for most children admitted to these programs, they have already failed outpatient treatment or the feeding issue was so severe that a multidisciplinary team was needed. Ongoing medical issues could result in the activation of emergency medical services, which would be impractical and unsafe to implement via a telehealth model, where the child and family are at home. Another factor is that most intensive programs replace the caregivers as feeders with trained feeding staff, at least initially. Some treatment procedures such as nonremoval of the spoon require specific training to implement correctly. Moreover, inappropriate application of some procedures could result in several poor outcomes (e.g., poor integrity with intermittent reinforcement, latency to respond errors, poor technique, frustration by the caregivers, and longer need for treatment). Finally, some treatment procedures result in significant increases of other behaviors that parents may not be able to address adequately or respond to appropriately when they occur (e.g., vomiting, packing). In these situations, having trained therapists may be important for the safety of the child and positive outcomes of treatment.

The challenges presented to safety and expertise needed may be why there is limited research on intensive treatment of feeding disorders using telehealth. Telehealth may be more feasible during other phases of treatment for feeding disorders (e.g., follow-up), as evinced by the studies described here. This notion of differential viability of procedures within telehealth is also present in other professions (e.g., in-person surgery versus telehealth wellness check). The differential viability should not limit the application of telehealth models to address clinical needs (e.g., funders limiting reimbursement for outpatient telehealth services because the intensive model is not viable). It appears that after an effective treatment has been established and presumably, initial treatment effects have occurred in-person, a move to telehealth for follow-up is more feasible (e.g., Peterson et al., 2015, 2020; Rivas et al., 2014). Future research should explore the limits of telehealth applications for intensive treatment, clearly indicating when in-person treatment versus telehealth treatment can begin and end across the four phases of assessment and treatment process. A randomized control-design (e.g., Lindgren et al., 2016) would appear to be a welcomed addition to the literature to further elucidate the benefits and limitations of telehealth treatment of feeding disorders. Additionally, adding cost or social validity measures would further bolster current findings.

Telehealth Applications for Clinical Behavior Analysis

Clinical behavior analysis, a subspecialty within the field of behavior analysis, broadly focused on traditional mental health issues (Dougher, 2000), has benefitted from research supporting both synchronous and asynchronous teletherapy approaches. Technological advances have given clinical behavior analysts the opportunity to deliver a broad range of therapeutic approaches traditionally offered only in-person clinic settings through real-time remote videoconferencing and/or web-based asynchronous programs and applications. For therapeutic approaches relying heavily on oral discourse, service via telephone may be an adequate alternative or simply an adjunct to in-person or video conferencing. This section provides a brief overview of research on the use of telehealth for several common behaviorally based therapeutic approaches to mental health disorders.

Cognitive–Behavioral Therapy Cognitive–behavioral therapy (CBT), a form of psychotherapy with a focus on challenging negative thought and behavior patterns, has been one of the most researched and effective approaches to various child and adult conditions (Friedberg & Paternostro, 2019). Additionally, it was one of the earliest forms of psychotherapy delivered via telehealth (Selmi et al., 1982). Studies over nearly 30 years have provided evidence of the efficacy of telehealth-delivered CBT for a variety of conditions, including post-traumatic stress disorder (e.g., Germain et al., 2009), panic disorder (e.g., Bouchard et al., 2004), insomnia (e.g., Espie et al., 2012), depression and/or anxiety (Khatri et al., 2014), and eating disorders (e.g., Abrahamsson et al., 2018).

Perhaps, due to real and perceived barriers to accessing psychotherapy (Mohr et al., 2010), including face-to-face synchronous telehealth delivery of CBT, self-guided web-based CBT has become a popular alternative (Webb et al., 2017). Self-guided programs typically involve a combination of psychoeducation, skills instruction, homework, and at least some offer occasional remote therapist involvement (e.g., Spence et al., 2011). Research has largely shown web-based self-guided CBT approaches to be superior to no treatment for several conditions, such as depression/anxiety (e.g., Karyotaki et al., 2017) and insomnia (e.g., Holmquist et al., 2014). However, models incorporating therapist support or guidance appear to have better outcomes than those without (e.g., Baumeister et al., 2014). To better approximate the therapeutic process observed in face-to-face therapy, new forms of web-based CBT have employed artificial intelligence (AI) to serve as conversational agents mirroring face-to-face encounters (e.g., Fitzpatrick et al., 2017; Fulmer et al., 2018; Schure et al., 2020), but research comparing AI versus human support is still needed.

Habit reversal therapy and exposure with response prevention Habit reversal therapy (HRT) and exposure and response prevention (ERP) are first-line behavioral treatments for tic disorders and obsessive–compulsive disorder (OCD), respectively (Franklin et al., 2012). Both approaches depend heavily on behavioral treatment models and are oftentimes categorized as forms of CBT. There are studies to support the feasibility of telehealth-delivered models for both HRT and ERP, although there is more research dedicated to evaluate the effectiveness of ERP. Varieties of telehealth models yield positive results when treating OCD via ERP. Models include computerized (non-web-based) programs with and without therapist support (e.g., Greist et al., 2002; Kenwright et al., 2005), asynchronous web-based treatment with intermittent synchronous therapist support (e.g., Andersson et al., 2012; Kobak et al., 2015), and synchronous video-based (e.g., Comer et al., 2017; Goetter et al., 2014; Vogel et al., 2014) or telephone-based (Turner et al., 2014) therapy. In general, telehealth delivered ERP appears to be as effective as in-vivo therapy for treatment of OCD (Dèttore et al., 2015).

Only two studies have evaluated the use of telehealth to deliver HRT, both of which focused on videoconferencing for youth with tic disorders. Himle et al. (2012) conducted a small-randomized trial comparing telehealth-delivered HRT to in-vivo HRT and showed that telehealth was just as effective and acceptable as in-person therapy. While Himle and colleagues utilized a clinic-to-clinic model, Ricketts et al. (2016) conducted a randomized trial of clinic-to-home telehealth. Compared to a wait-list control, clinic-to-home telehealth resulted in significant reductions in tic severity and patient satisfaction was high.

Acceptance and commitment therapy Acceptance and commitment therapy (ACT) utilizes techniques such as mindfulness and behavior-change strategies to promote psychological flexibility (Hayes et al., 2006). Like CBT, acceptance and commitment therapy (ACT) has been heavily researched and shown effective across a broad range of conditions (Gloster et al., 2020). However, few studies have evaluated telehealth-delivered ACT and those published largely focus on delivering ACT to adults. Studies evaluating the effects of web-based ACT on anxiety and depression comprise the majority of studies, including several systematic reviews and meta-analyses. Recently, Thompson et al. (2020) conducted a systematic review and meta-analysis of research on web-based ACT, with and without therapist guidance. They reported small, but significant effect sizes for web-based ACT on depression and anxiety, and they found that therapist guidance led to greater improvements in depressive symptoms than approaches, where therapist support was not included. These findings are consistent with several other systematic reviews and meta-analyses (e.g., Brown et al., 2016; Kelson et al., 2019). Feasibility and comparative studies on web-based ACT have demonstrated successful application to a variety of other conditions, including pain (e.g., Herbert et al., 2017; Scott et al., 2018), insomnia (Chapoutot et al., 2020), and smoking (Bricker et al., 2014).

Behavioral activation therapy With a primary focus on increasing engagement in activities that result in positive reinforcement, behavioral activation (BA) therapy has been shown effective in the treatment of depression (e.g., Dimidjian et al., 2006; Ekers et al., 2014). More recently, research suggests that BA may be an effective component in the treatment of post-traumatic stress disorder (PTSD; Flint et al., 2020). Given the evidence base for BA and the common view that BA is a low intensity therapy approach, it has been suggested that BA therapy is ideal for delivery through telehealth formats (Huguet et al., 2018). Indeed, BA has been a treatment component in numerous teletherapy studies, even though few have evaluated BA as a stand-alone treatment. Studies utilizing BA to treat depression have shown success with blended models of in-person and technology (e.g., smartphone application (Ly et al., 2015); text messaging (Hart et al., 2019); clinic-to-home videoconferencing (Acierno et al., 2016); clinic-to-clinic videoconferencing (Lazzari et al., 2011); computer modules with as needed therapist support (Spates et al., 2013); email-only therapy (Eisma et al., 2015)). Satisfaction of telehealth-delivered BA therapy has generally been high (Pruitt et al., 2019) and the cost comparatively lower than in vivo delivery (Egede et al., 2018). Although numerous web-based applications utilizing BA to treat depressive symptoms are available, Huguet et al. (2016) concluded very few provide therapeutic components consistent with evidence-based BA therapy.

Contingency management Contingency management (CM) is an incentive-based intervention that can be used to promote a variety of clinically relevant, adaptive behaviors. Typically, some kind of material incentive is provided contingent upon the patient meeting some criterion for displaying a target behavior, which is objectively measured and verified (Lussier et al., 2006). One area in which contingency management has been shown to be efficacious is for promoting and maintaining drug abstinence (e.g., Benishek et al., 2014). Recently, DeFulio et al. (2021b) evaluated the use of a smartphone application and smart card (i.e., reloadable debit card that protects against risky withdrawals or debits) in participants diagnosed with opioid use disorder. The smartphone intervention was delivered in addition to ongoing, typical therapy. Participants with problem alcohol use also used the smartphones, along with a Bluetooth integrated breathalyzer device that connected to the app to remotely conduct random breathalyzer tests. The smartphone app cued participants to engage in the target behaviors, notified participants of corresponding incentives, notified participants of breathalyzer tests, and provided reminders of clinic appointments. Participants completed textual CBT modules, including comprehension questions on the modules in the app. Participants earned money on their smartcards by attending appointments, providing consistent urine tests, and completing CBT modules. Financial incentives were delivered within a couple of hours after participants met the criteria for an incentive. Participants who used the app were statistically more likely to have clean urine tests than the control group (who received the business-as-usual treatment only) in the first 30 days of treatment. They were also four times more likely to have urine tests consistent with abstinence at the end of the study. Taken together, these results suggest that ongoing use of the app produced higher maintenance of treatment effects relative to treatment without the app. The smartphone app produced impressive outcomes and had the advantages of providing participants with advanced notifications, automated accounting of their incentives, prompt delivery of the incentives, and frequent contact with the treatment. This example of telehealth treatment provides promise for an effective intervention for drug abstinence. It also has the potential to decrease clinician burden, because so much of the intervention is delivered automatically. Finally, the treatment was found to be highly acceptable to participants.

Another interesting application of CM delivered by smartphones is in promoting medication adherence. DeFulio et al. (2021a) evaluated the use of a smartphone-based incentive system on the adherence to antiretroviral therapy (ART) in patients living with HIV. ART can reduce the chance of transmission of HIV to others and can increase both the quality and length of life for those infected with HIV. However, high levels of medication adherence are required to achieve the positive effects of ART. While several interventions, such as CM, reminders, and counseling, have shown positive effects on adherence, these effects are often short-lived and do not maintain after the intervention has been discontinued. DeFulio and colleagues (under review) provided HIV-infected participants with smartphones and an app called SteadyRX, which allowed participants to take time-stamped selfie videos demonstrating ART adherence, which were checked daily and asynchronously by the researchers. The app also provided feedback on incentives earned for days with medication adherence and disbursed incentives every time participants reached \$10. Finally, the app provided listings and contact information for community resources, as well as pdf training materials. While underpowered, the study showed positive effects of the CM intervention delivered by smartphones (95% adherence), suggesting feasibility of the intervention. The intervention was easy to implement and convenient for participants to use. It was also found to be acceptable by participants, who reported improvements in understanding their own care and who reportedly felt empowered to ask more questions about their care. The long-term benefits of the intervention still need to be evaluated, and the cost of intervention implementation may be a barrier to long-term use of the intervention. Thus, the cost effectiveness of SteadyRX still needs to be analyzed. In spite of these challenges and needs for further study, SteadyRX and other smartphone applications of

CM are a very creative, interesting way of providing asynchronous telehealth treatment for clinical populations.

Additional Questions and Considerations

Despite the bevy of studies that have established the efficacy of behaviorally based telehealth therapies, there continue to be challenges and unanswered questions involving their use. For example, a great deal of research has shown that the successful development of a therapeutic alliance or connection between a therapist and patient is one predictor of positive treatment outcomes (Norcross & Lambert, 2019). However, one of the primary factors contributing to this alliance is therapeutic presence, being fully engaged with the patient in the moment (Geller, 2017), which may be challenging when therapy sessions are conducted through remote technologies. Worse yet, this therapeutic presence may not exist at all when asynchronous telehealth and online therapy without therapist support is used. Indeed, several studies have found better treatment effects when in-person therapist support is provided than when it is absent (e.g., Baumeister et al., 2014). Only a few studies have evaluated the development of the therapeutic alliance in remote therapies (Flückiger et al., 2018; Wehmann et al., 2020).

Roughly 50% of all people living with a mental health disorder in the US go without treatment, often due to a combination of limited availability and high costs of therapy (NAMI, 2017). Bolstered by a growing body of literature supporting the use of telehealth in clinical behavior analysis, telehealth may be an ideal solution that provides both a low-cost approach and the ability to reach individuals in virtually any location. Unfortunately, outside of telehealth-delivered HRT, a glaring hole in the research literature is the lack of studies involving children and adolescents. Given that nearly one in six children in the US experience a mental disorder (Whitney & Peterson, 2019) and suicide is the second leading cause of death in adolescents (Shain, 2016), it will be important for future studies to establish the efficacy and satisfaction associated with delivering behaviorally based therapies to children and adolescents via telehealth.

Finally, there seems to be no end to the number of modalities that clinical behavior analysis can be provided using telehealth. It is virtually impossible to determine what model or mixture of models is most effective and for whom. Although we have tried to focus largely on telehealth approaches involving some form of therapist–patient interaction, whether synchronous or asynchronous, there are many studies providing at least some support for self-guided approaches, with and without therapist support. Comparative studies evaluating the effectiveness of telehealth-based delivery and in-person delivery are necessary, but not sufficient for understanding optimal therapeutic benefit. Although it would be impossible to evaluate every telehealth permutation possible, it would be beneficial to directly compare the effectiveness of the different delivery models. Additionally, important people variables (e.g., conditions, ages), procedural variables (e.g., timing and dosage, integration of therapist support), perceptions (e.g., patient acceptability), accessibility, and costs should be documented and evaluated for clinicians to be fully informed of the optimal treatment options.

Telehealth Applications for Education and Professional Development

Closely related to the telehealth approaches described above, there are additional behavior analytic applications of intervention that can be applied to the education of both children and adults. One might refer to these applications as "tele-education." Historically, education, both for children and adult learners, has occurred largely in an in-person context. However, as technologies have developed, more and more learners have begun to access online platforms for their learning. For example, Driscoll et al. (2012) estimated that over 30% of college students take at least one online course. Of the 592 university programs offering a Verified Course Sequence for training in behavior analysis, 289 of them offer an online option for training and an additional 62 offer a hybrid (online combined with in-person instruction) option for training (Association for Behavior Analysis, International, November 8, 2020). Furthermore, the COVID-19 pandemic brought forth a rapid change in landscape for both learners and educators, with an almost overnight requirement to shift education for children and adult learners from traditional, in-person learning models to hybrid and fully online models. A thorough review of the literature in this area or even of examples of research in this area is well beyond the scope of this chapter. Thus, the purpose of this section is to describe a few behavior analytic applications of "tele-education." We begin with an example applications of behavior analytic tele-education for children and conclude with multiple examples of tele-education for adult learners.

Tele-education for children One of the best-known examples of asynchronous education for children that was developed from a behavioral perspective is Headsprout *Early Reading*, and later Headsprout *Reading Comprehension,* were developed as online platforms for teaching reading. The platforms address each of the areas identified by the National Reading Panel (2000) as key areas of reading proficiency: phonemic awareness, phonics, fluency, vocabulary, and comprehension. In short, these programs include a number of online "episodes" designed for young children (i.e., kindergartners through second grade). These episodes contain interesting characters, such as dinosaurs and space aliens. The episodes are "gamified," and children have to help the characters solve problems or reach a goal. Students are rewarded for correct responding by the presentation of interesting visual and auditory stimuli. High levels of correct responding (90% correct) are required for children to move on to a new skill (see Layng et al., 2004 and Twyman et al., 2004 for detailed descriptions of these programs.) Rigney et al. (2020) conducted a review of published studies evaluating the effectiveness of Headsprout. This analysis showed that there is strong evidence of Headsprout's effectiveness in teaching phonics, fluency, vocabulary, and comprehension skills. However, many of the studies conducted to date do not meet the quality standards for research based on standards established by the What Works Clearinghouse (2017). Therefore, more research needs to be conducted before strong conclusions about the efficacy of Headsprout can be made. Rigney et al. (2020) suggest that Headsprout does seem to be effective in many areas, but that it is important to continue research on this curriculum to guard against the widespread adoption and use of an intervention that may not be as effective as claimed. Regardless, Headsprout exemplifies a behavior analytic approach to education.

Headsprout is but one example of effective behavior analytic education that is presented virtually. There are many more examples available—too many to adequately address here. Furthermore, there is a vast array of very creative, non-behavior analytic applications for tele-education (e.g., Tanaka et al., 2015). Moran and Malott (2004) include several chapters describing behavior analytic approaches to education (e.g., personalized systems of instruction and precision teaching) that may be implemented in a telehealth format. An additional resource is the American Psychological Association (APA) Division Two, Society for the Teaching of Psychology (see http://teachpsych.org/about for further information). In fact, the Society for the Teaching of Psychology recently supported the Online Teaching of Psychology Conference: Using Behavior Science to Improve Online Higher Education (see https://media.wcsu.edu/channel/Online%2BTeaching%2Bof%2BPsychology%2BConference%2B%2528Nov.%2B13th%2B2020%2529/189596123?fbclid=IwAR0kvOoijW28xC1jzRjF_nCZa0iz2Ul1la1kM-p69aE6kaG_nDwG-zkGEodQ) for further information).

Tele-education for professional development Technological advances have afforded the opportunity for advanced training and continuing education opportunities for behavior analysts and behavior technicians (Gerencser et al., 2020; Tomlinson et al., 2018). Similar to those seeking treatment for problem behavior, food refusal, or clinical disorders at specialized hospitals and clinics, travel to local higher education institutions or organizations that provide advanced training is often a barrier for providers, particularly those living in rural and geographical isolated areas (Arora et al., 2007). In order to meet the training needs of providers in rural and underserved communities, researchers have developed synchronous and asynchronous training options that have been employed to disseminate Applied Behavior Analysis (ABA) teaching methodology worldwide. Technologies enable direct care technicians and behavior analysis to receive training in their local communities, thereby improving access to quality care for families in those same communities.

Effective instruction often employs behavioral skills training (BST; Reid & Parsons, 1995), which consists of a slow release of responsibility from the teacher to the learner in displaying the desired skill. Typically, this consists of the instructor telling students who to perform the skill, then showing students how to perform the skill, having students practice performing the skill with close supervision for feedback, and then having students perform the skill independently and in the natural context of where the skill is needed. BST is an established teaching method that used to teach a variety of ABA methodologies to staff, caregivers, and teachers (e.g., Lavie & Sturmey, 2002; Sarokoff & Sturmey, 2004). Under traditional in-person training model, instructions are provided orally or in written format and modeling of the skill may be provided live with the instructor demonstrating the skills. Role-play opportunities are typically provided with the instructor and/or another trainee serving as role-play partner and instructor feedback is provided during role-plays or immediately following role-plays. Staff training delivered via telehealth often follows the same BST model implemented during in-person training, with some modifications to the delivery format. For example, instructions might be provided via asynchronous online modules (Gerencser et al., 2020; Higbee et al., 2016; Pollard et al., 2014) or via synchronous videoconferencing platforms (e.g., Fisher et al., 2014). Skill modeling may also be provided asynchronously using video models to demonstrate the skill or might include synchronous, real-time viewing via screen sharing features in the video conference platform. Role-play and feedback opportunities often require some modifications. For example, the trainee may be required to identify an on-site role-play partner with whom to rehearse the skills in-person. Similar to live training, the trainer might observe the trainee rehearse the skills via live videoconferencing and provide real-time coaching and feedback (e.g., Buzhardt & Heitzman-Powell, 2005). Using a combination of these procedures, individuals have been successfully trained to implement a variety of ABA teaching methods, including mand training, discrete trial teaching, preference assessments, functional communication training, and functional analysis implementation.

Rios et al. (2020) used remote BST to train practitioners to implement functional analysis conditions using a nonconcurrent multiple baseline to evaluate the effects of training. Ten behavior analytic clinicians participated in training delivered remotely using video conferencing software. Participants were provided with written descriptions for how to implement functional analysis conditions. Then, they watched video models synchronously with the researchers. Next, they were provided opportunities to practice the skills remotely with a confederate serving as a child with problem behavior. The confederate was at the site with the trainers, while the practitioners were located at their center. Practitioners practiced the skills with live feedback through video conferencing until they reached mastery. After participants had reached mastery on all functional analysis conditions, maintenance probes were conducted regularly until they needed to implement conditions with an actual client. Practitioners were observed as they implemented conditions with actual clients to determine if their skills generalized. These probes were also conducted remotely. All participants improved their skills with functional analysis implementation. Eight of ten participants' performance maintained at or above mastery during maintenance probes and with actual clients. Only two needed further training and support. In addition, training took very little time—time required for training averaged 50 min across participants (range 36–75 min). This study demonstrated that BST could be implemented efficiently and effectively through synchronous remote training.

Asynchronous training methods also have been employed to teach caregivers, providers, and teachers about the principles of behavior analysis, as well as specific teaching methodologies (e.g., discrete trial teaching, mand training) (Gerencser et al., 2020; Higbee et al., 2016; Pollard et al., 2014). Asynchronous trainings are typically delivered in a self-paced format, in which individuals may view recorded webinars. Sometimes referred to as e-learning or online learning, the instructions might be provided orally via asynchronous web-based platforms and/or written instructions may be delivered via electronic format (e.g., email, website, or smartphone application) (e.g., Granpeesheh et al., 2010; Hamad et al., 2010). Asynchronous learning often incorporates components that are similar to behavioral skills training, as described above. For example, trainees may receive access to audio and written instructions as well as video models remotely and asynchronously. Such asynchronous lessons may also include rehearsal exercises, during which the trainee practices implementing specific skills on their own. One drawback of asynchronous rehearsal exercises is that the trainee may rehearse incorrect implementation of skills with little immediate feedback due to the lack of an expert available during practice. However, despite this limitation, research has suggested asynchronous training can have a positive impact on skills development, especially when it is followed by coaching and feedback (Gerencser et al., 2020; Granpeesheh et al., 2010; Higbee et al., 2016; Pollard et al., 2014; Vismara et al., 2009).

A vital component in the delivery of quality services is continuing education. Typically delivered in a workshop or didactic format, continuing education opportunities can provide limited results, particularly for the management of complex cases. Combining in-person with synchronous and asynchronous tele-education can provide a comprehensive, effective, long-term solution to the need for ongoing mentoring and staff development. To help address the limitations of the traditional continuing education model, the Extension for Community Healthcare Outcomes (ECHO) was developed as a new model of healthcare training. Project ECHO combines brief didactic training with case mentoring that is designed to create on-going learning opportunities for participants through a virtual learning network. Using synchronous videoconferencing, experts provide shared case management and consultation on complex cases to providers. Providers are able to enhance their clinical knowledge using their own cases for training and may present their cases multiple times for on-going, case-specific mentorship.

Project ECHO is not intended to replace the continuing education system. Rather, it is a technology-supported, supplemental continuing education and mentoring program designed to increase provider competence and confidence in treating patients. Leveraging the strengths of multiple training formats, Project ECHO not only has been effective in disseminating information quickly, but also in reducing the barriers related to provider isolation and burnout, both of which are common among rural providers (Arora et al., 2007). Rural providers who participated in these programs reported increased knowledge, empathy, comfort, and self-efficacy in dealing with chronic conditions. Project ECHO has been replicated across various complex disorders, including ASD, mental health, epilepsy, dementia, palliative care, and chronic pain internationally (Zhou et al., 2016).

Pollard et al. (2021) adapted the Project ECHO model with behavior analysts to promote advanced care coordination with multidisciplinary professionals, as well as mentoring behavior analysts to implement telehealth service delivery models for ABA services. ECHO Autism for Enhancing Coordination of Care for Autism was successfully piloted with the behavior analytic community. ECHO clinics were delivered via synchronous videoconferencing twice per month for 2 h each time. A multidisciplinary panel consisting of a developmental pediatrician, a doctoral level Board Certified Behavior Analyst, a Licensed Clinical Social Worker, a masters level Healthcare Administrator, and a parent of a child with ASD led each ECHO clinic. Each clinic began with a 30-min didactic presentation from multidisciplinary team members and followed with a 90-min interactive case presentation that was designed to expand the behavior analyst's knowledge of coordination of care. All panelist and participants participated using real-time video and audio technology (i.e., Zoom). Case presenters received oral and written recommendations for their case in real-time during the ECHO clinic, and supplemental resources were emailed following each clinic to support clinical recommendations (e.g., research, tool kits, programs and other resources). Providers reported high levels of satisfaction with the mentoring model, as well as increased confidence in coordinating care. Applications of Project ECHO are widespread, and due to the benefits, we are beginning to see emerging programs and research within the field of behavior analysis.

As technology continues to advance, new technologies will continue to emerge to meet the training needs of providers, caregivers, and staff, as well as provide continuing education opportunities. For example, podcasts have emerged as another avenue to disseminate behavior analytic information, and while there is not any research to date on this avenue for providing continuing education to staff, researchers should consider exploring this modality for supplemental staff training. Virtual reality has been used in healthcare education and training, including telesurgical applications, emergency response training, and 3D environments for treating mental health disorders (Mantovani et al., 2003). Virtual reality training and training using robotics also will likely emerge in future behavior analytic research for staff training. These applications may provide additional opportunities to enhance provider training, particularly in rural areas, where limited training opportunities exist (Mantovani et al.). Often, providers acquire training experience with already existing patients; however, when ABA services are delivered in-home, this can often be obtrusive and uncomfortable for a family to have trainees in their home working with their child (e.g., Karst & Van Hecke, 2012). Advances across multiple technology platforms will continue to provide additional avenues to standardize training and better prepare the ABA workforce.

Conclusion

Telehealth is a service delivery model utilized by many different professions, including behavior analysts. As with all service delivery models, professionals should be aware of pros and cons to ensure implementation meets the needs of those served. We have provided several resources for behavior analysts to evaluate fit of a telehealth service delivery model within their practice. Additionally, we have described and discussed how telehealth has been applied in several behavior analytic service programs. The information provided here should not be considered exhaustive, as the breadth and depth of application are vast within the field. Furthermore, technology evolves extremely rapidly, and thus, applications rapidly change and improve. This is an important and ever-evolving area in the field of behavior analysis. The reader must stay current with contemporary research to stay abreast of developments in this area. This is true across the field of behavior analysis, but perhaps especially true, where computer technologies are concerned.

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41 Smoking Cessation

Jesse Dallery, Lesleigh Stinson, and Andrea Villegas

Smoking Cessation

Cigarette smoking continues to take an enormous toll on society. Since the first Surgeon General's report on the health consequences of smoking in 1964, more than 20 million Americans have died prematurely from tobacco-related diseases (U.S. Department of Health and Human Services, 2014). An estimated 34.2 million people still smoke combustible cigarettes in the United States, and smoking remains the leading cause of premature death and preventable disease (Creamer et al., 2019). At least 70 chemicals in cigarette smoke are known carcinogens including arsenic, benzene, formaldehyde, lead, nitrosamines, and polonium 210 (Prochaska & Benowitz, 2019). Most adult smokers, 88%, smoked their first cigarette before the age of 18 (U.S. Department of Health and Human Services, 2012). Quitting cigarette smoking produces health benefits regardless of age (U.S. Department of Health and Human Services, 2014), and novel regulatory and treatment options continue to emerge to promote cessation (Bricker et al., 2018; Donny et al., 2014).

In this chapter, we review a behavior analytic approach to conceptualizing, assessing, and treating cigarette smoking. A behavior analytic perspective views cigarette smoking as operant behavior, or behavior that is selected and maintained by consequences (Thompson & Johanson, 1981; Silverman, 2004). Viewing cigarette smoking as operant behavior is tremendously useful in assessment and treatment (Henningfield & Higgins, 1989). The acquisition and maintenance of smoking can include social and non-social primary reinforcers, conditioned reinforcers, observational learning, the influence of advertising, social media, rules, and negative reinforcement. A behavior analytic account also entails contextual factors such as the availability of alternative sources of reinforcement and environmental stressors. It is also compatible with other biological and psychosocial theories to account for cigarette smoking. For example, genetic or acquired characteristics (e.g., family history of cigarette smoking or substance dependence, other psychiatric disorders) can affect the probability of cigarette smoking (Hatsukami et al., 2008). These characteristics may produce individual differences in sensitivity to reinforcement (to drug and/or social reinforcers), punishment, and delay to reinforcement that may contribute to cigarette smoking (Thompson, 2007). The operant view also incorporates private events such as craving and anxiety, as well as verbally mediated processes as part of a comprehensive account of the determinants and outcomes of smoking (DeGrandpre, 2000; Wilson & Hayes, 2000). Finally, a behavior analytic perspective also pro-

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_41

vides a useful framework to account for the effects of conventional treatments for smoking such as nicotine replacement, behavioral treatments focused on providing incentives contingent on abstinence, and novel regulatory and intervention efforts to prevent smoking and promote long-term cessation (Cassidy & Kurti, 2018).

Conceptual Framework: The Four-Term Operant Unit

Most of the biological and environmental variables associated with the acquisition, maintenance, and successful treatment of cigarette smoking can be captured by the four-term operant unit (Dallery et al., 2013; Thompson, 2007). The four-term operant unit consists of motivating operations, discriminative stimuli, the target behavior of cigarette smoking, and consequent stimuli. Figure 41.1 presents a schematic of these units and some of their interactions. We have included examples of each term in the operant unit, but these nominal examples are not meant to apply universally across individuals. Also, the static nature of the figure belies the dynamic nature of how these units emerge over time, and how the influence of different variables may vary over time and across individuals.

Upon inhalation, nicotine rapidly enters the lungs, undergoes dissolution in pulmonary fluid, and is transported to the heart and then to the brain (Hatsukami et al., 2008). It takes about 10 s for nicotine to enter the brain (Rupprecht et al., 2015). Daily smokers may smoke consistently throughout the day to maintain nicotine levels in a particular range (Benowitz, 1991). Cigarette smoke contains over 7000 chemicals, some of which may enhance the psychoactive effects of nicotine and some of which have independent psychoactive properties (Rupprecht et al., 2015). Evidence suggests that nicotine can serve as a positive reinforcer in non-humans and humans (Henningfield & Goldberg, 1983; Perkins et al., 2001). Laboratory research with non-human animals, however, suggests that nicotine serves as a weak primary reinforcer (Caggiula et al., 2009), and self-administration is increased by the presence of sensory stimuli such as illuminated cue lights during nicotine delivery (Palmatier et al., 2007). In humans, reinforcing consequences associated with smoking may include the physiological effects of nicotine, such as the arousal, increased energy, or appetite-suppressing effects of tobacco use (Hatsukami et al., 2008). Smoking

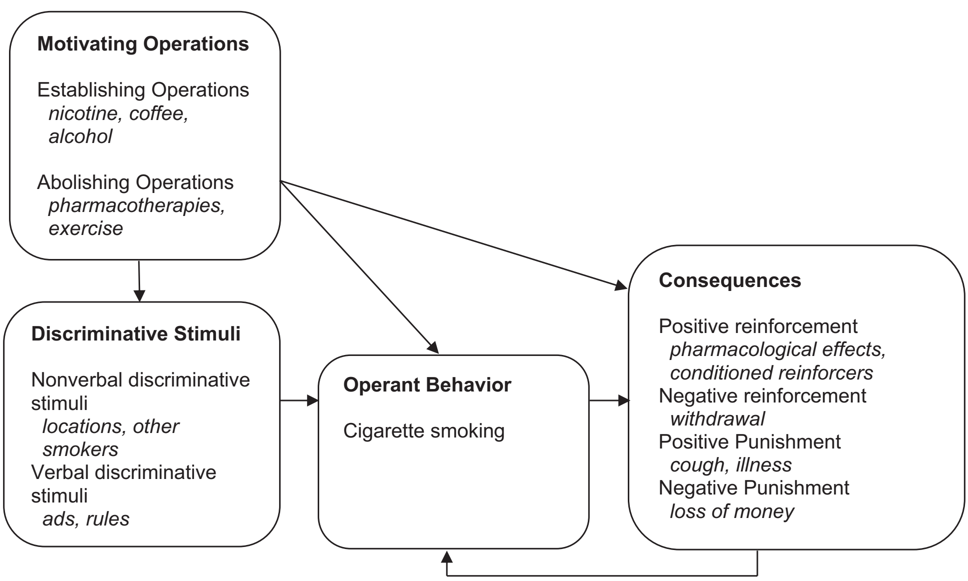

Fig. 41.1 The four-term functional unit of analysis

can be acquired and maintained through other sources of positive reinforcement, such as social interaction (Friedman et al., 1985). Although nicotine may serve as a weak primary reinforcer, it may still confer conditioned reinforcing properties to stimuli associated with smoking such as the taste, smell, airway stimulation, and other sensory stimuli (Rose, 2006; Russel et al., 1974).

Negative reinforcement can also contribute to the origin and maintenance of smoking behavior (Eissenberg, 2004). Nicotine withdrawal is characterized by negative affect such as irritability, anger, cravings, and depression, and physiological symptoms such as constipation, coughing, dizziness, and even mouth sores (American Medical Association, 1994; Hughes et al., 1990). These symptoms peak in the first week of abstinence, but several studies have reported their persistence several months into abstinence (Gilbert et al., 2002; Piasecki et al., 2002). Although alleviation of negative affect is often endorsed by smokers, human laboratory research suggests that smoking relieves negative affect under limited conditions (Lerman & Audrain-McGovern, 2010; Perkins et al., 2010). For example, in the human laboratory, Perkins et al. found that smoking only reduced negative affect induced by abstinence, but not after other procedures to induce negative affect and anxiety (e.g., preparing for a speech, viewing negative mood slides). Interestingly, such effects were independent of nicotine: smoking denicotinized cigarettes had similar negative affect-reducing effects. Following smoking cessation in clinical contexts, negative affect has been found to characterize over 50% of all smoking lapses (Shiffman et al., 1996; Robinson et al., 2017). The role of negative affect on smoking is complicated, and may depend on factors such as nicotine content, stages of smoking (e.g., maintenance versus relapse), and other factors (see Kassel et al., 2003, for a review). Negative reinforcement associated with smoking can also occur when a smoker takes a break from work to smoke (Dunbar et al., 2018).

Establishing operations momentarily increase the value of a reinforcer and increase the likelihood of the response that produces that reinforcer (Laraway et al., 2003). In addition to serving as a reinforcer, nicotine may also function as an establishing operation. In laboratory animals, systemic injections or infusions of nicotine increase responding maintained by conditioned reinforcers such as an illuminated cue light (Charntikov et al., 2020; Donny et al., 2003; Chaudhri et al., 2006; Raiff & Dallery 2006; Palmatier et al., 2007; Liu et al., 2007). These findings, along with the findings that nicotine serves as a primary reinforcer, led to the dual reinforcement model of nicotine self-administration, which posits that nicotine has reinforcing and enhancement (establishing operation) effects on behavior (Caggiula et al., 2009). In humans, administration of nicotine has been shown to increase responding (e.g., under a progressive ratio schedule) maintained by access to music and video, and their self-reported pleasantness (Perkins & Karelitz, 2014; Perkins et al., 2017). Using electronic daily diaries, Piasecki et al. (2011) found that tobacco use increases the pleasure and subjective effects (e.g., "buzzed") of alcohol use, and vice versa. In addition, a review by Martin and Sayette (2018) found that nicotine enhanced social behavior, meaning that it increased positive features of social functioning and decreased negative features. For example, participants exposed to nicotine were faster at identifying facial expressions than after abstinence and were less likely to engage in aggressive behavior after being provoked. Nicotine enhancement may be selective to certain types of reinforcing consequences such as sensory and social stimuli. Nicotine does not appear to enhance responding maintained by food reinforcers in animals (Raiff & Dallery, 2008) and monetary reinforcers in humans (Perkins et al., 2017). More work is needed to identify the generality of the establishing operation functions of nicotine across different types of reinforcers, and the extent of individual differences in these effects.

Antecedent events and stimuli are also associated with cigarette smoking (Niaura et al., 1988; Shiffman et al., 2004, 2014). For example, smoking may occur in the presence of specific people (peer smokers), places (outside, in car), and things (smoking paraphernalia). These stimuli may function as discriminative stimuli within the four-term unit, and they may also have additional Pavlovian effects (Thompson, 2007). The presence of certain peers may be associated with smoking-related reinforcement, and thus increase the probability of smoking. The presence of the same peers may also elicit physiological conditioned responses, and the same is true for other stimuli associated with smoking such as cigarettes, smoke, smoking paraphernalia, coffee, and so on (Conklin et al., 2013; Winkler et al., 2011). These physiological conditioned responses may set the occasion for the verbal responses characterized by "craving" (a full account of the origins and the multiple functions of verbal craving responses is beyond the scope of this paper). Nicotine itself can serve as a discriminative stimulus and increase responding maintained by ethanol in the animal laboratory (Ginsburg et al., 2018). Other environmental events may function as discriminative stimuli and alter the probability of smoking. For example, rules concerning the health consequences presented by parents, teachers, or the US Surgeon General may decrease smoking (Cerutti, 1989). Advertising may have discriminative stimulus effects (and establishing operation effects), as ads may signal the availability of social reinforcement for smoking. The role of advertising is particularly pernicious in light of the 26 million dollars per day spent on advertising cigarettes by tobacco companies in the United States (Centers for Disease Control, 2020).

Aversive consequences following smoking may also occur. Unless these consequences reduce the likelihood of smoking behavior, they cannot be termed "punishers." Some aversive physiological stimuli may occur immediately following smoking, such as throat irritation, mouth dryness, shortness of breath, and cough (Şanli et al., 2016). Other consequences such as the increased likelihood of cancers and cardiovascular disease may be delayed and probabilistic (U.S. Department of Health and Human Services, 2010). Delaying the presentation of aversive stimuli reduces their punishing effects, as does reducing the certainty that they will occur (Green et al., 2014). Even when increased disease risk is communicated based on genomic information tailored for the individual, it does not appear to increase cessation (Ramsey et al., 2018).

The four-term unit comprising the operant determinants of smoking is also situated in the context of other biological vulnerabilities, previous operant learning, and current circumstances. Some of these will require consideration in assessment and treatment. Gene variation may increase the risk of dependence and treatment failure. Recent research suggests that individuals with genetically slow nicotine metabolism have higher cessation success with behavioral counseling and nicotine patch treatment (Chenoweth & Tyndale, 2017). In addition, the presence of comorbidities like depression, anxiety, posttraumatic stress, and schizophrenia requires effective management to increase the probability of cessation (Prochaska & Benowitz, 2019). The same is true with respect to the presence of other smokers and non-smokers in the individual's environment, such as parents, partners, and friends (vanDellen et al., 2016). Additionally, individuals from lower socioeconomic classes and with lower educational attainment have been shown to smoke at higher rates and be less successful when they attempt to quit smoking (Garrett et al., 2019; Jarvis, 2004).

The availability of alternative sources of reinforcement may also influence smoking. Dallery and Raiff (2007) found that choice to smoke in the human laboratory decreased with the magnitude of the monetary alternative (see also Johnson & Bickel, 2003; Stoops et al., 2011), and Cassidy et al. (2015) found a similar pattern of decreasing smoking choices with increasing magnitude of an alternative monetary reinforcer in adolescents. In a non-lab, naturalistic setting, Audrain-McGovern et al. (2004) showed that school involvement, physical activity, academic performance, and sports team participation were associated with decreased risk of smoking. In a human laboratory choice arrangement, concurrent access to money and food decreased choice for cigarette puffs under some conditions (Epstein et al., 1991). In addition, Schnoll et al. (2016) found that the extent of alternative reinforcers predicted long-term abstinence following treatment. These findings suggest that enriched environments with a variety of opportunities to obtain alternative reinforcers may decrease smoking (Acuff et al., 2019; Correia et al., 2002; Vuchinich & Tucker, 1988).

Lastly, other behavioral tendencies or processes have also shown to be correlated with smoking status, such as the degree of delay discounting and distress tolerance (MacKillop & Munafò, 2017; Veilleux, 2019). For example, individual differences in delay discounting, or the rate at which a future outcome loses value with increasing delays, have been reliably associated with smoking status and severity (Bickel et al., 1999; DeHart et al., 2020). Research suggests that rapid discounting increases the later propensity to smoke compared to those who discount at lower rates (Audrain-McGovern et al., 2009; Dallery & Raiff, 2007), and nicotine and other drugs of abuse may increase impulsive and risky choice (Dallery & Locey, 2005; Locey & Dallery, 2011; Perry & Carroll, 2008).

Assessment

Assessment of smoking includes consideration of reliable and valid methods to assess cigarette smoking, the functional assessment of the variables associated with the four-term unit, and characteristics such as degree of nicotine dependence and self-reported motivation that may be used to guide treatment decisions.

Cigarette Smoking

Self-report of smoking, as operant verbal behavior, is influenced by a variety of social contingencies. The self-report may vary depending on the contingencies associated with the age of the smoker (adolescent versus adult), the reasons for quitting (pressure from spouse or personal health reasons), and whether quitting may result in a positive consequence such as a monetary incentive. As such, no unitary statement about the validity of self-report is possible. Clinicians must assess and possibly attenuate the influence of social and non-social contingencies operating on the form of the self-report (Critchfield et al., 1998). One method to increase the accuracy of self-report is to count smoking episodes within a time period (Frederiksen et al., 1979; McFall & Hammen, 1971). These self-monitoring methods can vary in precision from simply counting the number of cigarettes smoked in one day to recording the number, time, and behaviors or environments relevant to each smoking episode. These methods involve discrimination of the smoking episode and recording of that episode. As such, measurement error can occur in both of these steps. Another method involves counting the permanent product of a smoking episode, that is, the smoked cigarette (Schwartz, 1992). Similarly, Timeline Follow-Back (TLFB) procedures may be used to increase accuracy. These methods are also well-suited to collect information about smoking over longer periods (e.g., 30 days) and with non-daily smokers (Harris et al., 2009). Briefly, the TLFB procedure uses key events (such as birthdays) to prompt respondents to provide daily retrospective estimates over a specified time period (Lewis-Esquerre et al., 2005). The TLFB procedure may have limits in terms of accuracy, particularly for heavy smokers (Griffith et al., 2009; Shiffman, 2009).

More objective methods include biochemical assessments of the metabolites of nicotine in saliva or urine, or exhaled breath carbon monoxide (CO; Benowitz et al., 2020). Benowitz et al. reported that up to one in ten who self-report abstinence do not meet biochemical abstinence criteria in research settings. Not only are biochemical methods often more accurate than self-report, but also they may be useful in populations in which smoking may occur surreptitiously such as with adolescents. Cotinine is the primary result of the metabolization of nicotine in the body and is most easily measured via saliva or urine. One consideration for the use of cotinine as an objective measure for smoking is that cotinine may also be present in the body if the individual is using other nicotine-containing products, such as electronic cigarettes (ECs) or nicotine replacement. Commercially available products such as NicAlert® for salivary testing may be useful in clinical settings. NicAlert® is advantageous in that it is inexpensive, and results are available within minutes of collecting the (urine or saliva) sample. In addition, cotinine's long half-life (10–30 h) permits detection for several days after cessation (Benowitz et al., 2020).

An alternative objective method is the measurement of breath carbon monoxide (CO). Commercially available devices (e.g., Pico Smokerlyzer®; Bedfont Scientific Ltd) measure the rate of conversion of CO to carbon dioxide when the smoker exhales air over a catalytically active electrode. Breath CO measurement is highly correlated with blood nicotine levels (Jaffe et al., 1981). Optimal cutpoints for abstinence range between 4 and 6 ppm and will depend on the manufacturer of the CO meter (Perkins et al., 2013). Another consideration is the short half-life of CO, which is about 4 h, which may necessitate twice-daily measurements to provide an index of daily abstinence. Breath CO may reach a "non-smoking" cutpoint in a regular smoker in 6–24 h, and can depend on other factors such as activity level, sleep, and ambient sources of CO (Benowitz et al., 2020). Recently available CO monitors, such as the Smokerlyzer®, can be connected directly to a smoker's smartphone. For detailed consideration of biochemical confirmation procedures and cutpoints for CO and cotinine, the reader is directed to Benowitz et al. (2020).

Functional Assessment

In contrast to the ubiquity of functional assessment methods in other areas of Applied Behavior Analysis (Hanley, 2012), there are relatively few examples of functional assessment methods in the area of cigarette smoking (Cole & Bonem, 2000; Epstein & Collins, 1977; Pomerleau et al., 2003). Many treatment guidelines recommend assessment of "triggers" for smoking, but they do not assess the full range of functions as exemplified in modern assessment methods. Axelrod (1991) reported on one of the first approximations to a functional assessment that included both antecedents and consequences. It was not developed by behavior analysts but rather by physicians and published in a medically oriented encyclopedia. The questionnaire asked smokers their reasons for smoking (e.g., to relax, deal with anger, to get a lift), and then various activities were recommended based on the responses (e.g., deep breathing, going for a walk).

Burrows et al. (2020) developed the Functional Assessment for Smoking Treatment Recommendations (FASTR). The FASTR is a 30-item questionnaire designed to identify 5 potential functions of smoking derived from the four-term unit: automatic positive reinforcement, automatic negative reinforcement, social positive reinforcement, social negative reinforcement, and antecedent stimuli. The questionnaire is divided into five subscales, one for each function, and each item was rated on a 5-point Likert scale, from strongly disagree to strongly agree. Although Burrows et al. found that the measure has good psychometric properties, it has not been evaluated as a method to improve cessation treatment.

Ecological Momentary Assessment (EMA) is a common self-report method to assess smoking behavior along with its antecedents, and less commonly its consequences (Shiffman et al., 2008). EMAs involve the delivery of short questionnaires throughout the day, directly to an individual's smart phone or other mobile device. These questionnaires typically include measures of the individuals' covert behaviors and states, overt behaviors, and environmental conditions (e.g., location, social context). As such, EMAs provide a way to sample behavior over long periods of time in a way that reduces recall bias and maximizes ecological validity (Shiffman et al., 2008). They are particularly useful in identifying social and situational factors that contribute to smoking, and thus may offer a functional approach to the assessment of smoking. Lag analyses between antecedents and smoking behavior found that the presence of cigarettes significantly predicted smoking both before and after a quit date, while the presence of other smokers predicted a smoking lapse, with the likelihood increasing with days after the quit date, though non-significantly (Koslovsky et al., 2018). Using a similar analysis with recently abstinent smokers, alcohol use (within 15 min) predicted smoking lapses for low-nicotine-dependent smokers up to 25 days after quitting (Dermody & Shiffman, 2020). Although EMA represents an improvement over global retrospective self-reports, there is a dearth of work comparing EMA to direct observation (Dallery et al., 2013; Shiffman et al., 2008).

Assessing Nicotine Dependence and Motivation

Assessing nicotine dependence may suggest different kinds or levels of treatment. The most common method to assess dependence is the Fagerström Test for Nicotine Dependence (FTND) (Heatherton et al., 1991). The FTND is comprised of six yes/no items, and higher scores reflect a greater degree of dependence. Physical dependence is the result of chronic smoking, with the individual showing signs of withdrawal that are ameliorated by smoking. Two questions seem to be particularly important indicators of dependence: cigarettes per day and time to first cigarette of the day (West, 2004). The FTND has been shown to predict treatment outcomes. Results may also indicate different intensities or doses of behavior therapy or pharmacotherapy, respectively (Fiore et al., 2008; West, 2004).

Finally, assessing self-reported motivation may be used to select treatment approaches. West (2004) recommends simple direct questioning about a smoker's interest and intent to quit in clinical contexts. More structured, brief questionnaires are also available (Hall et al., 1990). For behavior analytic clinicians, assessing motivation may be a precursor to assessing the contingencies that lead to the different responses. For example, high motivation to quit smoking may be a result of threat of divorce and health problems. These factors could also be addressed or harnessed in treatment. In addition, if a smoker reports low motivation to quit smoking, strategies such as motivational interviewing may be warranted before (or in addition to) recommending other treatments. However, evidence is inconclusive about the effects of motivational interviewing on smoking (Lindson et al., 2019b). Furthermore, as West (2004) notes, the degree of nicotine dependence is a much better predictor of treatment outcome than motivation once treatment has commenced.

Treatment

Although over 70% of smokers express some desire to stop smoking and 45% actually make a quit attempt per year, only about 5% are successful (Hatsukami et al., 2008). The United States Public Health Service endorses a variety of pharmacological and counseling therapies for smoking cessation (Fiore et al., 2008). Most patients, however, relapse within six months, even when various treatments are used together (Cahill et al., 2014, 2016; Hartmann-Boyce et al., 2014; Hughes et al., 2014; Stead et al., 2015, 2016). Although smoking cessation rates are higher following these treatments compared to placebo, the high relapse rate, in absolute numbers, presents a formidable challenge for smoking reduction efforts. A review of smoking cessation interventions designed to prevent relapse found that no psychosocial interventions were effective in preventing relapse (Hajek et al., 2013). Treatment of cigarette smoking should not be viewed as a behavior problem treated acutely, but rather as a chronic, relapsing condition that is likely to require long-term behavior management. Most smokers try to quit several times, and thus repeated intervention may be necessary to support this dynamic process (Hughes, 2003; Niaura, 2008).

Accessible, effective smoking cessation programs are needed. Stitzer (1999) argued that increasing the acceptability and accessibility of behavior therapy in particular is critical: "Greater use of behavior therapy is especially important in view of the research findings that support its dose-related ability to improve cessation" (p. 186). The goal of treatment is cessation. Smoking reductions may increase the probability of later cessation, but there is no evidence that smoking reduction leads to decreases in health risks (Hughes & Carpenter, 2006). In addition, smokers who reduce their smoking engage in compensatory smoking (e.g., deeper inhalation per cigarette). A reduction in cigarette consumption of 50% or more results only in a 30% decrease in biomarkers for toxicant exposure (Hatsukami et al., 2008). In this section, we discuss briefly pharmacotherapy, behavior therapy, and technology-based platforms to deliver behavior therapy. The focus will be on contingency management (CM).

Pharmacological Therapy

The most common pharmacological therapy is nicotine replacement therapy (NRT). NRT can be administered transdermally with a patch, orally (gum, lozenge or sublingual tablets, inhaler), or nasally (Hatsukami et al., 2008). As the name implies, NRT replaces nicotine in tobacco to maintain some of its effects while also reducing its abuse liability (i.e., by reducing the amount and speed of nicotine delivery). Evidence suggests that all forms of NRT are equally effective, and approximately doubles the probability of cessation relative to placebo control conditions (Lindson et al., 2019a, b). In addition, a recent systematic review indicates that combination NRT versus single-form NRT, and 4 mg versus 2 mg nicotine gum, can increase the chances of cessation (Lindson et al., 2019a, b). A common combination is a fast-acting NRT such as gum with a nicotine patch. There is also some evidence for more success with higher-dose nicotine patches, such as 21 mg patches relative to 14 mg patches. The review also suggested that there is some evidence that using NRT prior to quitting may improve quit rates when compared to starting on the quit date.

Other common pharmacological treatments include bupropion and varenicline. Both are non-nicotine-based drugs. Bupropion is also used as an anti-depressant, but its effects appear to be similar in depressed and non-depressed smokers (Hughes et al., 2014). Varenicline targets a specific nicotinic receptor subtype (technically, varenicline is a potent α4 β2 partial agonist). Overall, bupropion produces similar rates of cessation compared to NRT (Cahill et al., 2016), while varenicline increases cessation relative to NRT and bupropion. Cahill et al. concluded that compared to those not treated with varenicline, the use varenicline produces one extra successful quitter for every 11 people treated. Some side-effects associated with varenicline may be of concern (e.g., nausea). More significant side-effects associated with all forms of pharmacotherapy (e.g., cardiovascular events) have not been supported in large, systematic studies (Benowitz et al., 2018)

Pharmacological interventions influence the effects of positive and negative reinforcement associated with smoking. For example, NRT leads to a decrease in withdrawal symptoms. Research also suggests that medicinal nicotine, particularly transdermal patches, results in reduced reinforcement from cigarette smoking, at least as measured by ad libitum cigarette smoking and self-reports of satisfaction derived from smoking (Hatsukami et al., 2008). As such, NRT may function as an abolishing operation to the extent it attenuates the reinforcing value of smoking cigarettes (Laraway et al., 2003). Interestingly, recent research also suggests that adhering to NRT may prevent the loss of the establishing operation effects of nicotine on sensory stimuli (Perkins et al., 2019). Varenicline also has effects that can be understood within the four-term unit. It provides relief from tobacco withdrawal (via its agonist action) and it also attenuates the reinforcing effects of nicotine (via its antagonist action; Hatsukami et al., 2008).

Electronic cigarettes (ECs) have also emerged as a potential pharmacological treatment for cigarette smoking (Glasser et al., 2017; Martner & Dallery, 2019). ECs are battery-operated devices that contain a liquid consisting mainly of water, propylene glycol, vegetable glycerin, nicotine, and flavorings. ECs can deliver nicotine at doses and rates that are similar to what is observed with combustible cigarettes. In addition, they both involve similar patterns of inhaling, exhaling, and hand-to-mouth gestures (Farsalinos, et al., 2013), and as such may substitute for the conditioned reinforcing stimuli associated with smoking. Several studies suggest that ECs may function as a substitute for cigarettes in laboratory settings (Grace et al., 2015; Johnson et al., 2017; Pope et al., 2019; Quisenberry et al., 2016, 2017; Snider et al., 2017; Stein et al., 2018), and a small number of randomized controlled studies suggest that vaping may promote smoking cessation (Adriaens et al., 2014; Bullen et al., 2013; Caponnetto et al., 2013). Although the use of cigarettes among youth has declined over the past decade, the use of electronic cigarettes in this population is increasing (Singh et al., 2016). EC use in youth may increase the chances of initiation of cigarette smoking and affect brain development (U.S. Department of Health and Human Services, 2016).

Behavior Therapy

A plethora of counseling and talk-therapies exist to treat cigarette smoking. These range from brief counseling such as the 5 As (Ask, Advise, Assess, Assist, Arrange) that can be used by clinicians mostly in a primary care setting (Fiore et al., 2008), to individual and group cognitive-behavioral therapy (Niaura, 2008). Cognitive-behavioral approaches include components such as learning to cope with craving and withdrawal induced by nicotine deprivation, learning and avoiding antecedent “triggers” for smoking, stress management, social support, and motivational enhancement (e.g., listing reasons for quitting) techniques. There is good evidence of a dose–response increase in efficacy, at least as measured by total minutes in contact (Fiore et al., 2008; Niaura, 2008). Overall, according to systematic reviews and expert panels, there is moderate evidence for efficacy of these treatment approaches.

Technology-based platforms also deliver cognitive-behavioral approaches along with social support and other components (Taylor et al., 2017). For example, BecomeAnEx.org focuses on teaching strategies to identify and cope with smoking cues, along with providing social support and pharmacotherapy resources. The website contains an online forum for smokers to communicate with one another, videos, interactive content, and a personalized quit plan. The social network component has been found to increase cessation, but only for those who actively participate in the forum. In a large sample (n = 2657), Graham et al. (2017) found abstinence rates of 7.7% in non-users of the forum, 10.7% in passive users, and 20.7% in active users. A theme in research on technology-based platforms is that although they provide access to evidence-based treatment components, users generally do not engage with relevant content and adherence is poor (Eysenbach, 2005). Recent research has explored how specific intervention components may increase engagement. For example, Graham et al. found that increasing engagement in the social network component of BecomeAnEx and provision of free NRT increased adherence across all three recommended components of an evidence-based smoking cessation program (skills training, social support, and pharmacotherapy use).

Bricker and colleagues developed a web-based Acceptance and Commitment Therapy (ACT) called WebQuit (Bricker et al., 2014, 2018). ACT for smoking focuses on acknowledging and accepting emotions, thoughts, and other antecedents for smoking without allowing them to control subsequent behavior. ACT uses six core processes to develop such “psychological flexibility”: acceptance, cognitive diffusion, being present, self as context, values, and committed action. Without going into detail, these processes focus on two main activities: mindfulness and acceptance of thoughts and feelings, and identifying values and behavior change procedures to commit to these values (e.g., smoking cessation). Core processes of ACT were embedded in the website by using personalized quit plans along with videos of former smokers sharing success stories and modeling acceptance. A pilot randomized controlled trial indicated that WebQuit outperformed the Department of Health and Human Services’ website, Smokefree.gov. Cessation rates were higher for the web-based ACT intervention than the Smokefree (23% versus 10%) at a 3-month follow-up (Bricker et al., 2014). However, in a larger randomized controlled trial involving 2637 smokers (Bricker et al., 2018), there were no differences in abstinence at a 12-month follow-up: 24% (278 of

1141) for WebQuit.org and 26% (305 of 1168) for Smokefree.gov. The authors point out the increase in the Smokefree.gov group relative to the previous trial, and they suggest that several new elements of the site may have bolstered efficacy (e.g., new content and front-page placement of coping with depression, an interactive feature to select pharmacotherapy). In addition, in both trials, participants in the ACT group reported increased acceptance of internal experiences (e.g., cravings), and this acceptance was also related to the impact of ACT on smoking. Despite the lack of group differences in the second study, both platforms resulted in positive outcomes. The public health impact of both sites can be estimated based on the product of reach and efficacy. As such, for every 1 million smokers reached, approximately 250,000 would stop smoking (Bricker et al., 2018).

Contingency Management

Contingency management (CM) interventions emerged from basic research on operant behavior and drug reinforcement (Silverman, 2004; Silverman et al., Chap. 65, this volume). Specifically, CM incorporated the finding that linking the absence of a problem behavior with contingent delivery of a reinforcer can lead to decreases in or elimination of problem behavior (Hunt & Azrin, 1973; Miller, 1975; Stitzer et al., 1977). Under contingency management procedures for cigarette smoking, smokers receive desirable consequences contingent on objective evidence (CO or cotinine) of smoking reductions and abstinence. Several early studies provided the initial evidence of the feasibility of using CM to reduce smoking (Tighe & Elliot, 1968; Paxton, 1980, 1981, 1983; Winett, 1973). These studies generally offered rewards, such as the return of monetary deposits, contingent upon self-reports of smoking abstinence and showed that CM could reduce levels of smoking. These studies suffered from several limitations, however, including reliance upon self-reports of abstinence (versus biochemical verification of abstinence) for implementing the contingencies or insufficient monitoring of smoking status. Subsequent studies, using more rigorous experimental methods, provided persuasive demonstrations that CM could reduce smoking (Sigmon & Patrick, 2012; Stitzer & Bigelow, 1982, 1983, 1985; Stitzer et al., 1986; Rand et al., 1989). For example, Stitzer and Bigelow (1982) delivered $5 payments to participants who submitted CO samples with at least a 50% decrease from the average baseline readings. This contingency effectively decreased CO levels, decreased number of self-reported cigarettes per day, and increased the latency to the first cigarette of the day.

A 2019 Cochrane review of CM for cigarette smoking concluded that incentives improve smoking cessation rates at long-term follow-up (i.e., at least six months from treatment onset) in mixed population studies (Notley et al., 2019). The review also highlighted that effects were sustained even after withdrawal of incentives. There was considerable diversity across studies, which included 33 studies and more than 21,600 participants. Settings included workplaces, clinics, hospitals, and community programs, and monetary consequences ranged from 0 (under deposit contract procedures, which are discussed below) to $1185. Interestingly, the review found no discernable effect of reward magnitude on outcomes. Notley et al. also examined CM targeting pregnant women who continue to smoke and found higher cessation rates compared to control groups both at the end of the pregnancy and after the birth of the baby. Smoking during pregnancy is the leading cause of infant morbidity and mortality (U.S. Department of Health and Human Services, 2001). Another major review of extant interventions revealed that incentive-based CM interventions were the most efficacious in promoting cessation among pregnant women (Chamberlain et al., 2013; see also Higgins et al., 2012; Ierfino et al., 2015; Tappin et al., 2015). Furthermore, the benefits of incentive-based interventions extend beyond smoking outcomes. Higgins et al. (2012) found incentive-based interventions improved estimated fetal growth, average birth weight, percentage of low-birth-weight deliveries, and breastfeeding duration. In several recent studies, Higgins et al. (2014) found that

CM increased estimated fetal weight and abdominal circumference, and Lopez et al. (2015) revealed a reduction in the severity of postpartum depression.

Technology-Based Contingency Management

Despite the well-established efficacy of CM to promote cessation, there remain several challenges in adopting, implementing, and ensuring the fidelity of CM interventions (Dallery & Raiff, 2011). Making weekly or daily visits to a clinic to provide evidence of smoking status may also represent a substantial burden to various patient populations. To address these challenges, Dallery and colleagues developed a smoking cessation intervention that employed remote, web-based technology to allow for frequent (twice daily) and convenient breath CO collection (Dallery et al., 2008, 2013, 2017; Dallery & Glenn, 2005; Jarvis & Dallery, 2017; Reynolds et al., 2015; Stoops et al., 2009). Individuals provided CO samples in front of a video camera connected to the Internet. The video was time stamped, sent across the Internet, and evaluated by staff. An incentive was delivered electronically if the sample was valid and if the CO level displayed on the CO meter met the criterion for incentive delivery. This intervention has been effective in promoting smoking cessation (Dallery et al., 2015a, b), including in a nationwide study of smokers (n = 94) from around the United States (Dallery et al., 2017). In the nationwide study, the treatment lasted seven weeks, and there were significant differences in negative COs between the treatment group and a group that received incentives for submitting CO samples: 54% versus 25%, respectively. Although group differences persisted at the three- and six-month follow-ups, these differences were not statistically significant.

Technology-based CM has also been used to arrange group contingencies, where small groups of smokers must collectively achieve cessation goals to receive consequences (Dallery et al., 2015a, b; Meredith et al., 2011; Meredith & Dallery, 2013). Participants also provided and/or received encouragement, feedback, and support via a discussion board. Some evidence suggests that social networks influence smoking abstinence (Christakis & Fowler, 2008; Mermelstein et al., 1986; Mermelstein & Turner, 2006). Moreover, research suggests that practitioners are more willing to adopt treatments that use social components relative to those that use only tangible reinforcers (Kirby et al., 2006). Overall, group-based and individual CM appear to generate similar rates of abstinence, but there are individual differences in preferences for individual or group arrangements. One advantage of technology is that one size need not fit all: a variety of group or individual contingency arrangements could be delivered in a single platform.

To facilitate dissemination, basic cell phones and smartphones have been used to implement similar incentive-based interventions in adults (Alessi et al., 2017; Carpenter et al., 2015; Dallery et al., in press; Dan et al., 2016; Hertzberg et al., 2013; Kendzor et al., 2020; Kurti et al., 2020) and adolescents (Kong et al., 2017). For example, Alessi et al. used a CM procedure and basic cell phones to obtain visual evidence of the CO sampling procedure. CM plus usual care (n = 45) was compared to usual care alone (n = 45), which consisted of pharmacotherapy (i.e., nicotine patch) and twice-weekly counseling sessions conducted remotely via telephone. Results indicated that 82% of mobile CM versus 41% of usual care participants were abstinent at 4 weeks, and 21% versus 16% at 24 weeks. Smartphones have even greater reach relative to Internet-based methods. Compared to white Americans in the United States, black and Hispanic groups report equivalent rates of smartphone ownerships: 77% for whites, 72% for blacks, and 75% for Hispanics (Perrin, 2017). African Americans and Hispanics use their smartphones more often for health-related activities like searching for health information compared to whites (Perrin, 2017). As such, mobile technology could further reduce the "access gap" to the receipt of evidence-based interventions to promote cessation.

Monetary consequences may limit the application of CM interventions. To address this limitation, Dallery et al. (2008) used a deposit contract method that we introduced in the early CM studies noted above. Smoking status was verified via CO and Internet-based procedures. The procedure required an up-front deposit of $50 by the participant, which could be recouped based on evidence of abstinence. The deposit contract procedure produced equivalent rates of abstinence relative to a no-deposit group, and it resulted in cost savings. Jarvis and Dallery (2017) also investigated self-selected deposits rather than a fixed deposit. In Experiment 1 of their study, 47% of the CO samples met the criterion for abstinence, compared to 1% during baseline. Experiment 2 evaluated the impact of an additional clinic "match" of the participant's deposit. No samples met the criterion during baseline but 41.5% met it during treatment. The average deposit was $82 in Experiment 1 and $49 in Experiment 2. Participants rated the intervention favorably, and sample submission rates were high. The deposit arrangements completely eliminated voucher costs, even when incorporating a clinic-match. After payments to 19 participants, $332.66 was left in surplus and donated to charity.

Halpern et al. (2015) evaluated incentive treatments for smoking cessation, including deposit contracting, in a large (N = 2538) randomized six-month intervention. Sustained abstinence for those who accepted the programs (i.e., participants could refuse the group assignment) was 52.3% in the deposit groups compared to 17.1% in the reward groups. However, the rate at which participants selected the deposit was low: only 13.7% accepted the deposit. The acceptability of a deposit—or the number of individuals who actually make a deposit—will depend on a host of factors (Halpern et al., 2012; Stedman-Falls et al., 2018). More research is needed to assess variables that influence acceptability. A technology-based method to enable a deposit (e.g., via PayPal) may lower the response effort associated with making deposits and therefore increase acceptability for some individuals (Stedman-Falls & Dallery, 2020). Deposit contracts may not only offset voucher costs, but also they may mitigate a public policy concern with paying people to change behavior (Madison et al., 2011). A deposit contract method may be acceptable and efficacious for a sizeable enough portion of smokers and stakeholders to deliver a public health impact, and it could be used in individual treatment in clinical settings.

There is certainly more work to be done to further promote cessation. Qualitative data from a recent mobile phone CM study revealed that participants wanted help learning personally relevant new skills or information about smoking cessation, and several reported significant life stressors (Dallery et al., in press). Multi-component technology-based interventions hold promise. Several mobile phone CM interventions have included skills building, stress management, and/or motivational enhancement treatment components (Carpenter et al., 2015; Hertzberg et al., 2013). For example, Carpenter et al. (2015) included weekly cognitive-behavioral therapy and pharmacotherapy, and they found smoking abstinence rates of 65% and 60% at 3 and 6 months after the mobile CM intervention, respectively. Mobile interventions have also been designed to provide intervention components such as stress management on demand based on participant input (Heron & Smyth, 2010). Such "ecological momentary interventions" may be useful adjuncts to CM (Businelle et al., 2016). In addition, methods to assess the functions of cigarette smoking should be explored to tailor intervention components to promote cessation (Burrows et al., 2020).

Considerations in the Delivery of CM in Clinical Settings

CM interventions are comprised of several components that can be implemented in a variety of ways (Meredith et al., 2014; Petry, 2000). Once a reliable and valid monitoring system is selected, either CO or cotinine in saliva or urine, the clinician must select a CM intervention (e.g., voucher or prize-based in which reinforcers are available intermittently). In addition, several specific parameters of the CM intervention must be selected to maximize cost-effectiveness and access to treatment. For example, the clinician must select parameters of reinforcement (e.g., delay, magnitude) to maximize the probability of successful outcomes (Lussier et al., 2006; Stitzer & Bigelow, 1983). As noted above, however, a major Cochrane review found little evidence of magnitude effects across smoking cessation studies. It may have been the case that the magnitudes were all sufficiently high, which means that care should be taken to ensure that the magnitude selected is above an empirically informed threshold. In clinical practice, the parameters of a specific CM program may need to be modified iteratively, using experimental methods, to reveal the optimal program for a specific individual (Dallery & Raiff, 2014).

Another consideration in designing a CM intervention in a clinical setting is the schedule of reinforcement. The most common schedule of reinforcement used in CM interventions is the ascending schedule of reinforcer delivery with resets of the voucher value for evidence of lapses or missed samples (Roll & Higgins, 2000; McPherson et al., 2018). One study found that a schedule that included ascending values plus resets resulted in greater rates of smoking abstinence than an ascending schedule without resets, and greater rates of abstinence compared to a fixed schedule in which the same amount was available for each negative sample (Roll & Higgins, 2000). Prize-based procedures also involve escalation (Petry, 2000), but because rewards are available intermittently, they may represent a lower-cost method to deliver incentives.

One potential problem with an ascending schedule of reinforcement is the low initial value of the consequence for abstinence. Several researchers have noted that some participants never contact the monetary reinforcers for abstinence (Correia et al., 2005). One reason some participants do not achieve abstinence is that most CM interventions require an abrupt transition to complete abstinence. Gradual reductions in drug use may permit greater contact with monetary reinforcers for changing drug use behavior. Several studies suggest that gradual reductions, or shaping procedures, can generate high initial rates of abstinence in nicotine-dependent individuals (Lamb et al., 2004, 2010). Shaping procedures are only possible if some quantitative or semi-quantitative monitoring of drug status is available, which is the case for CO- and several cotinine-based measures.

Conclusions

Cigarette smoking remains a vexing problem, or what some have called a wicked problem (Wallace et al., 2015). Although smoking rates overall have declined, there remain substantial disparities in smoking prevalence. Smoking remains high among people who have less education, American Indians/Alaska Natives, those who experience serious psychological distress, those experiencing socioeconomic disadvantage, people with a disability, and those who are lesbian, gay, or bisexual, to name a few examples. Population-level interventions are responsible for most of the reductions in smoking such as increased taxes, smoking bans, and mass media campaigns, especially those interventions targeting youth initiation. Nevertheless, a role still exists for treatments focused on individuals, and as such behavior analytically derived interventions are justified and require further development. This development will need to be sensitive to the changing landscape of tobacco control policies. For example, in 2017, the U.S. Food and Drug Administration announced a focus on reducing nicotine in cigarettes to levels low enough that cigarettes would be minimally or non-addictive (Gottlieb & Zeller, 2017). If new policy is implemented, it would mean that only very low nicotine content (VLNC) cigarettes would be sold in the United States. Research has found that VLNC cigarettes lead to lower dependence, fewer cigarettes smoked per day, and increased quit attempts compared to standard nicotine level cigarettes (Donny et al., 2015; Hatsukami et al., 2010), and that VLNC reduced abuse liability compared to higher nicotine content cigarettes in adolescent smokers (Cassidy et al., 2018).

As we have reviewed in this chapter, a behavior analytic framework of the etiology, maintenance, and treatment of smoking has proven to be robust and pragmatic. Many researchers and clinicians have lamented the limited scope of behavioral interventions, despite their potential to address a wide range of socially relevant behavior (e.g., Friman, 2010; Normand & Kohn, 2013). Cigarette smoking is a case example of how behavior analysis has been broadened to inform understanding and treatment of the leading preventable cause of death in the developed world. Indeed, Henningfield and Higgins (1989) noted the important contributions of behavior analysis to the 1988 Annual Report of the Surgeon General on the Health Consequences of Smoking (U.S. Department of Health and Human Services, 1988). Specifically, the contributions included research on the cross-species similarities in drug taking behavior, research showing drug taking follows the same general laws as other operant behavior, and research on behavioral treatments for cigarette smoking. We hope that the current chapter provides further evidence for the continued vitality and social relevance of behavior analytic research on cigarette smoking.

Acknowledgment We thank Lindsey Ives and Alexandra Knerr for comments on a previous draft of this chapter.

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Safety Training

42

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Worldwide 4.9 million people died in 2016 from injuries that could have been prevented. Of those deaths 644,855 were children under the age of 15 (World Health Organization, 2018). Deaths from unintentional injuries disproportionately occur in developing nations and affect children in disadvantaged socioeconomic areas (Laflamme et al., 2010). In the United States unintentional injuries are the leading cause of death for children, and 9.2 million children under the age of 19 are treated in the emergency room (ER) for non-fatal injuries (Borse et al., 2008). These deaths could be prevented if children and caregivers were provided with evidence-based comprehensive safety instruction.

Chapter Overview

The purpose of this chapter is to provide an overview of behavior analytic evidence-based methods for assessing, designing, and implementing safety instruction. The chapter will focus on child and adolescent safety. The procedures that will be discussed are applicable to both children and adolescents who are neurotypical and those with developmental disabilities. This chapter is divided into three main sections. Section one introduces safety instruction and discusses limitations of education-based methods and the contributions of a behavior-analytic approach. Section two describes the process of assessing safety behaviors and designing instruction. Section three discusses evidence-based interventions, design considerations, and suggestions for generalization and maintenance. For ease of reading, the term *learner* is used in lieu of *children and adolescents*.

An Overview of Safety Instruction: The Need for a Behavior Analytic Approach

Safety instruction addresses safety on two fronts: prevention strategies and safety responses. These two fronts are each an essential part of safety instruction. Prevention seeks to eliminate potential dangers from the environment and teaching safety responses seeks to provide learners with behaviors they can engage in when they encounter a danger. Current mainstream safety instruction attempts to address prevention and teaching safety responses through education-based instruction. Education-based instruction is a passive learning methodology that targets the

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_42

acquisition of safety knowledge to promote safety behaviors (Miltenberger et al., 2020).

Education-Based Prevention Instruction

Mainstream safety instruction, focused on prevention, targets caregivers as their behaviors can directly affect the safety of the children in their charge (Krenzelok, 1995). The typical method of intervention is to provide caregivers with a set of rules on how to remove dangers from the environment. The rules are usually disseminated through pamphlets, commercials, ad campaigns, and online recourses (Krenzelok, 1995). A characteristic example of prevention-based safety instruction is the State of Texas's *Keep 'Em Safe Texas* safe gun storage program. *Keep 'Em Safe Texas* is a program launched in 2020 in response to Centers for Disease Control and Prevention (CDC) data that indicated annually Texas is among the top three states in the United States for unintentional shootings by children (Centers for Disease Control and Prevention, 2020). The program targets safe storage of firearms and its message comprises three rules: "Safely store fire-arms, safely store ammunition, and restrict access." Like many of its predecessors this program attempts to change behavior through education. However, research suggests that the effectiveness of education-based prevention programs is limited. Despite the existence of education-based safe gun storage programs in the United States, only about 55% of gun owners with children under the age of 18 report storing all their guns safely (Crifasi et al., 2018).

These data are not presented to suggest prevention initiatives are completely ineffective. Preventative environmental manipulations, such as mandated four-sided pool fencing, smoke alarms, firearm storage programs, and bike helmets, have reduced the number of injuries and deaths, but the reduction is not substantial enough (Centers for Disease Control and Prevention, 2012). Even if caregivers employ preventative measures, learners may still encounter dangers. A learner may encounter a dangerous item or situation at school, in the community, or when at the home of a peer. Therefore, safety instruction also seeks to teach a variety of responses that learners can use to stay safe.

Education-Based Safety Instruction

Concerningly, most mainstream safety programs approach safety instruction by using the same education-based methodology just discussed. Education-based safety instruction uses a variety of age-appropriate activities, such as games, reciting slogans, illustrative anecdotes, and art activities to disseminate safety information (Kennedy & Mason, 2015; Mondozzi & Harper, 2001). For instance, Kennedy and Mason (2015) evaluated the effectiveness of a fire safety program on increasing student knowledge and awareness of the risks of fires and false calls to emergency services. The participants in the study were 226 10- and 11-year-olds at four public middle schools in the United Kingdom. The *Facing up to Fire* program used was implemented by staff at each school and used a series of CDs, DVDs, VHS tapes, and worksheets that described fire-related situations. The participant's knowledge was assessed through a survey that was administered before training, after training, and three months after the end of the program. A comparison of pre-program and post-program data indicated a statistically significant increase in fire safety knowledge and the results of the three-month follow-up survey indicated participants could still recall the information taught. Although Kennedy and Mason (2015) demonstrated the effectiveness of the *Facing up to Fire* program at increasing safety knowledge, the authors acknowledge that it is unknown if there was a subsequent increase in safe behavior.

A potential flaw of education-based safety instruction is that it operates on the assumption that acquisition of verbal-safety behavior will lead to non-verbal safety behaviors. Research evaluating if education-based instruction is effective at increasing safe behaviors has found that this verbal behavior to non-verbal behavior transfer does not consistently occur (Beck &

Miltenberger, 2009; Carroll et al., 1992; Gatheridge et al., 2004; Schwebel & McClure, 2014).

Schwebel and McClure (2014) evaluated correspondence between gains in verbal statements of safety behavior and the related non-verbal safety behaviors. Safe street crossing behavior was taught to 240 participants ages 7 to 8. Participants were assigned to one of four conditions: An education-based instruction condition, a virtual reality (VR) instruction condition, an individualized street side instruction condition, or a no-treatment control condition. Following intervention participants in the education-based instruction group engaged in verbal behaviors regarding safe street crossing, but not the non-verbal safe street crossing behaviors. Participants in the virtual reality condition engaged in the non-verbal safety behaviors, but not the corresponding verbal behaviors and participants in the individualized street side instruction condition acquired both verbal and non-verbal behaviors.

Himle et al. (2004) evaluated the effectiveness of the National Rifle Associations' *Eddie Eagle GunSafe Program*, an education-based instructional program used in the United States to teach learners about gun safety. The *Eddie Eagle GunSafe Program* uses a series of activities to teach participants that when they encounter a firearm they should "Stop. Don't touch. Leave the area. Tell an adult." The activities include reviewing the safety message, responding to "what would you do if…" anecdotes, and art activities such as slogan coloring sheets. After the participants in the study completed the *Eddie Eagle Gun Safe Program*, they were exposed to a simulated situation in which they came across an unattended firearm. The participants were naive to the assessment and were not aware they were being observed. The results of the assessment indicated that although all the participants demonstrated acquisition of the safety message, they did not subsequently engage in the safety response.

Beck and Miltenberger (2009) evaluated the effectiveness of *The Safe Side* program, a training program that purportedly teaches learners 5-to-10-years-old abduction prevention responses. The program comprised a training DVD entitled "Stranger Safety" and its goal is to teach learners through instructions and modeling to respond to various abduction situations. The authors showed the training DVD to six participants, 6-to-8-years-old. After exposure to the training DVD, the participants were exposed to a series of simulated situations such as a stranger knocking on the door and a stranger approaching and violating the participants' space. Beck and Miltenberger found that despite having watched *The Safe Side* DVD none of the participants engaged in the safety responses explained and demonstrated in the video.

The results of these studies identify an expected flaw with education-based instruction. Learners receiving education-based safety instruction fail to demonstrate the safety responses taught because instruction alone is insufficient to establish stimulus control over the safety behavior.

A Behavior-Analytic Approach to Safety Instruction

Although a behavior-analytic approach to safety instruction is similar in focus on prevention and teaching safety responses to an education-based approach, several features distinguish these approaches. First is the addition of an active learning component. The term active learning refers to the addition of components that require the learner to practice the steps of the safety response while receiving feedback on and correction of their performance (Miltenberger et al., 2020). As demonstrated above, numerous behavior analytic studies have demonstrated that skill acquisition is better achieved when an active learning component is included in intervention as opposed to instruction alone.

A second key component of behavior analytic safety instruction is the incorporation of procedures to increase the likelihood that an established safety response will generalize to the natural environment and be emitted under appropriate stimulus conditions. Behavior analytic safety instruction incorporates methods such as programming common stimuli, teaching mediating responses, and multiple exemplar training to facilitate transfer of safety behaviors to the natural environment (Stokes & Baer, 1977).

Behavior analytic researchers have recognized the limitations of an education-based approach and have evaluated interventions to teach safety responses across an impressive array of areas over a span of almost 45 years (Giannakakos et al. 2020a; Mechling, 2008). The safety literature in behavior analytic research has particularly focused on abduction and sexual abuse prevention (Dixon et al., 2010; Doughty & Kane, 2010; Lumley & Miltenberger, 1997), fire safety (Bertsch et al., 1984), and firearm safety (Jostad & Miltenberger, 2004; Miltenberger, 2008).

The remainder of this section briefly discusses each safety category and the types of behaviors that have been taught. Table 42.1 contains a breakdown of each safety area, the safety responses taught within that area, and references for several representative studies in each area.

Transportation Safety Transportation safety involves teaching responses that keep adults, children, and infants safe when using bicycles and motor vehicles. Research on bicycle safety has focused exclusively on increasing helmet wearing behavior (e.g., Ludwig et al., 2005; Van Houten et al., 2007). Research on motor vehicle safety has focused on increased seat belt use (e.g., Geller et al., 1982, 1989), correct installation of child passenger safety restraints (e.g., Giannakakos et al., 2018; Himle & Wright, 2014), and reducing cell phone use while driving (Clayton et al., 2006).

Personal Safety Personal safety is focused on three main areas: responding to emergency situations, abduction prevention, and sexual abuse prevention. Safety training on emergency situations has focused on determining emergency situations and dialing 911 (e.g., Jones & Kazdin, 1980; Spooner et al., 1989). Abduction prevention targets teach learners to resist lures from strangers (e.g., Beck & Miltenberger, 2009;

Table 42.1 Overview of responses addressed in the behavior analytic literature

Safety area	Response taught	Select references
Transportation safety		
Bicycle safety	Increasing correct helmet use	Ludwig et al. (2005), Van Houten et al. (2007)
Motor vehicle safety	Increasing seat belt use	Geller et al. (1982, 1989)
	Decreasing cell phone use while driving	Clayton et al. (2006)
	Increasing correct installation of child car seats	Giannakakos et al. (2018), Himle and Wright (2014)
Personal safety		
Abduction prevention	Responding to a lure from a stranger by saying "no," leaving the area, and telling an adult	Ledbetter-Cho et al. (2019)
	Responding to the doorbell ringing, by not answering the door and telling a parent	Beck and Miltenberger (2009), Summers et al. (2011)
Abuse prevention	Discriminating good and bad touch	
	Responding to a potential violation by saying "no," leaving the area and telling an adult	Egemo-Helm et al. (2007), Miltenberger et al. (1999)
Emergency response	Calling 911	Spooner et al. (1989), Ozkan et al. (2013)
	Discriminating emergency situations	Rosenbaum et al. (1981)
Home safety		
Fire safety	Responding to a fire alarm	
	Exiting during a fire	Garcia et al. (2016), Haney and Jones (1982)
	Responding to an unattended lighter	Houvouras and Harvey (2014), Rossi et al. (2017)
	Extinguishing cooking fires	Mechling et al. (2009)
Gun safety	Responding to an unattended firearm	

(continued)

Table 42.1 (continued)

Safety area	Response taught	Select references
Sharp object safety	Disposing broken items	Winterling et al. (1992)
Suffocation prevention	Identification and removal of household hazards	Barone et al. (1986), Metchikian et al. (1999)
Poison prevention	Responding to household poisons	Dancho et al. (2008), Collins and Griffen (1996)
	Responding to medications	Giannakakos et al. (2018), King and Miltenberger (2017)
Infant safety	Arranging a safe sleep environment	Austin et al. (2018), Carrow et al. (2020)
Community safety		
Social safety	Refusing requests for money and personal information	Spivey and Mechling (2016)
Pedestrian safety	Crossing the street	Harriage et al. (2016), Wright & Wolery (2014)
Seeking help when lost	Making and answering calls from parents	Carlile et al. (2018)
	Exchanging an ID card	Taylor et al. (2004)
	Making a vocal request for help	
Water safety		
	Basic swimming and flotation skills	Alaniz et al. (2017)
	Holing on to the pool side to reach the stairs and throwing and catching a lifeline	Turgut et al. (2015)

Note: The references provided in this table are illustrative of the research in each area. Additional studies have been published that are not listed on the table

Ledbetter-Cho et al., 2019) use a safe word (Rodriguez & Jackson, 2020), and respond to a stranger at their door (Summers et al., 2011). Sexual abuse prevention teaches individuals to identify private body parts (Boyle & Lutzker, 2005; Miltenberger & Thiesse-Duffy, 1988), and discriminating and responding to abuse situations (e.g., Egemo-Helm et al., 2007; Miltenberger et al. 1999).

Home Safety Home safety is one of the largest areas of focus within the behavior analytic literature and includes the widest range of safety responses. Interventions have targeted both preventative methods and safety responses. Researchers have evaluated procedures for teaching children and young adults fire-related safety (e.g., Haney & Jones, 1982; Houvouras & Harvey, 2014), responding to an unattended firearm (e.g., Himle et al., 2004; Rossi et al., 2017), cleaning up sharp and broken objects (Winterling et al., 1992), and poison prevention responses (e.g., Collins & Griffen, 1996; Dancho et al., 2008). Studies targeting caregiver prevention strategies have trained safe arrangements of infant sleep environments (Austin et al., 2018; Carrow et al., 2020; Vladescu et al., 2020) and removing potential hazards from the home environments (e.g., Barone et al., 1986).

Community Safety Community safety covers skills related to safely navigating community locations such as public transportation, stores, and streets. Research has been conducted evaluating procedures for teaching safe street crossing (e.g., Harriage et al., 2016; Wright & Wolery, 2014), seeking help when lost in public (e.g., Carlile et al., 2018; Taylor et al., 2004), and refusing inquiries from strangers for money and personal information (Spivey & Mechling, 2016).

Water Safety Water safety is an area of research that has garnered limited attention within the behavior analytic literature. The responses taught in this area comprise basic swimming, flotation, and water awareness skills (Alaniz et al., 2017), water recovery and deck behavior, and throwing and catching of a lifeline (Turgut et al., 2015).

Assessment and Design

Assessment

The first step to comprehensive safety instruction is assessment. Safety assessments can be separated into two categories: assessing the environment and assessing behavior. There are two types of assessments indirect and direct. Indirect assessment can provide useful information on a learner's safety repertoire or lack thereof. Direct assessment allows direct observation of the learner's behavior and can identify if a learner will engage in a safety response under the appropriate conditions. Research supports the use of indirect assessment methods if they are followed up with direct assessment of the behavior (e.g., Lutzker et al., 1998; Mandel et al., 1998). Comprehensive assessment is essential to identifying deficits in prevention and responsive behaviors and should inform subsequent intervention.

Assessing the Environment The purpose of assessing the environment is to identify potential hazards that may interfere with safe behavior. To date, the behavior analytic literature has paid little attention to methods of environmental assessment as they pertain to safety. The recommendations provided in this section are behavior analytic in nature; however, the supporting literature is largely derived from safety research in other fields.

One environmental assessment commonly used in research on child neglect and family services, that may be of use to behavior analysts, is the Home Accident Prevention Inventory-Revised (HAPI-R; Mandel et al., 1998). The HAPI-R is a validated checklist that assesses safety hazards across 10 categories (i.e., poison, choke, suffocation, drowning, fire/electrical, fall, sharp object, firearm, crush, and allergen/organic). The HAPI-R is administered using an assessment form (available in Lutzker & Bigelow, 2002). The person assessing the environment uses the form to collect information on the learners in the home, including their eye level and how far and high they can reach. This information is subsequently used to determine if dangerous items are placed safely out of reach. The assessor then goes through each room of the home and indicates the number of hazards present across each category. One assessment form is filled out per room. The total number of hazards within and across the 10 categories is calculated and used as a measure of safety.

Jabaley et al. (2011) provided a characteristic example for how the HAPI-R is used as an assessment tool. The authors used the HAPI-R to assess the existence of safety hazards in the homes of three families living in a large metropolitan area in the United States. During the initial assessment, the experimenters first established the eye level and reach of the oldest child in the home (up to age 5). These data were used to determine at what height hazards would need to be placed to be considered inaccessible. The experimenters then went through each of the three rooms and collected data on the number of hazards in each room. The number of hazards recorded provided a baseline measure of safety within the home.

The existing research using the HAPI-R assessment has emphasized in-person consultation. However, in-person assessment of the home environment may not always be possible. One solution may be to incorporate videoconferencing software, wherein a researcher or practitioner could score the HAPI-R, as a caregiver virtually navigates their home.

The HAPI-R provides a comprehensive assessment of household dangers; however, there are some home safety areas not included in the assessment. One such absent area is home pool safety. CDC (2012) data indicate 74% of fatal pool accidents occur at residential locations and the highest drowning rates are in children 1-to-4-years-old. Drowning prevention research has identified several environmental manipulations that are effective in decreasing pool-related drownings, including four-sided pool fencing, pool alarms, automated covers, and restricting access by keeping the pool area locked when appropriate supervision is not available (Coffman, 1991). Researchers might consider developing a checklist that could be used to identify potential safety risks and subsequently inform safety instruction targeting responsible caregivers.

Finally, for individuals with disabilities an additional prevention assessment may be needed. It is estimated that 49% of learners with autism spectrum disorder (ASD) engage in elopement behavior (Anderson et al., 2012). Elopement can be potentially life threatening as learners may encounter dangers outside the home (e.g., traffic, drowning, suffocation). To date, no experimentally validated elopement prevention checklist for individuals with ASD or developmental disabilities exists. The National Autism Association developed an elopement prevention checklist that caregivers can use to evaluate their home (https://nationalautismassociation.org/docs/BigRedSafetyToolkit.pdf). Used in a research or clinical context this checklist may present an assessment option to identify preventative measures already in place and guide caregivers through implementing the remaining safety precautions.

Indirect Safety Response Assessment Indirect assessments can be a useful tool for identifying deficits in a learner's safety repertoire. To our knowledge, there is only one commercially available standardized assessment that evaluates safety responses, the Assessment of Functional Living Skills (AFLS; Partington & Mueller, 2012). The AFLS assesses several areas including safety responses related to independent living, basic health safety and first aid, and workplace safety.

There are also several checklists specific to a variety of common safety areas available from national and international organizations such as Safe Kids Worldwide. Researchers and practitioners might consider using these checklists to collect information from caregivers or guide interviews about safety. Checklists on a variety of areas including fire safety, water safety, and pedestrian safety are available of the Safe Kids Worldwide website (https://www.safekids.org/).

Direct Safety Response Assessment The most reliable method of determining a learner's safety repertoire is to directly observe whether the learner engages in safety responses when they are required. Two methods of assessment have been well researched in the behavior analytic safety literature, in situ, and role-play assessments (Giannakakos et al. 2020a; Miltenberger et al., 2020). These assessments simulate a dangerous situation the learner might encounter without placing them at risk.

In Situ Assessment In situ assessment has been used to assess safety behavior across numerous areas including firearm safety (e.g., Hanratty et al., 2016; Jostad et al., 2008), abduction prevention (e.g., Beck & Miltenberger, 2009), fire safety (e.g., Houvouras & Harvey, 2014; Vanslow & Hanley, 2014), help-seeking behavior (Pan-Skadden et al., 2009), and poison prevention (Dancho et al., 2008). In situ assessment involves arranging a simulated situation in which the safety response can occur without exposing the learner to actual danger. In situ assessment is often conducted in the natural environment with precautions in place to ensure the learner's safety (Carlile et al., 2018; Summers et al., 2011). During in situ assessment, the learner is observed remotely or covertly and is unaware they are being assessed. Covert observation during in situ assessment is essential so that the observer's perceived presence does not exert control over the safety response (Miltenberger et al., 2005). There are several ways to arrange covert observation during in situ assessment. For instance, Dancho et al. (2008) observed participants during in situ assessment through a one-way mirror in an observation area attached to the assessment area. Giannakakos et al. (2020b) used video streaming software installed on a tablet device placed in the assessment room and streamed to the instructors' smart phone and Hanratty et al. (2016) placed a baby monitor with video capability in the assessment area.

Another consideration during in situ assessment is the inclusion of a termination criterion to ensure the learner does not practice, or inadvertently contact reinforcement, by engaging in a dangerous behavior. For example, Ledbetter-Cho et al. (2016) taught four learners with ASD an abduction prevention response. During the in situ assessment, the participant was brought to the assessment area by a known adult who then gave an excuse to leave the participant unattended. A confederate unknown to the participant approached and presented a lure such as "Come play with my iPad." If the participant began to leave with the confederate, the confederate made an excuse such as "I forgot I have to meet a friend" and disengages from the interaction. Thereby eliminating the possibility that the participant's behavior might contact reinforcement by leaving with the confederate. Although in situ assessment provides the closest indication of how a learner might respond to an actual danger, the covert and simulated aspects of the procedure may not be appropriate to all safety responses.

Role-Play Assessment In the case of some safety responses such as exiting a house fire (Rosenbaum et al., 1981) or sexual abuse prevention (e.g., Egemo-Helm et al., 2007; Katz & Singh, 1986; Miltenberger et al., 1999), it may be unethical or infeasible to conduct an in situ assessment. Unlike in situ assessments, during role-play assessments the learner is aware that their behavior is being assessed. During role-play assessments, the learner is presented with a scenario and asked to demonstrate how they should respond.

Egemo-Helm et al. (2007) used a role-play assessment to evaluate the sexual abuse prevention skills of four women with developmental disabilities. During the role-play assessment, the participants were aware of the assessment condition. Abuse lures were presented by the experimenter and the participant was asked what they would do if it were a real situation.

Rosenbaum et al. (1981) used a role-play assessment to evaluate 27 preschoolers' ability to differentially respond to emergencies and dial 911 when required. During the role-play assessment, participants were shown videotaped scenes. For each scene, the participant was told to pretend they were at home and then asked if the situation required them to call someone and why. The participant was then asked to act out the response they described.

Designing Safety Instruction

After deficits in a learner's safety repertoire has been identified, it is necessary to select target safety responses, instructional settings, and instructional materials.

Expert Consultation Expert consultation can be an integral tool when designing safety instruction (Jones et al., 1981; Katz & Singh, 1986). Experts such as firefighters, police officers, and physicians can provide useful information on how a certain safety response will keep a learner out of danger. Because safety recommendations may change over time as further research is conducted, recommendations should not be taken directly from the published literature without verifying their current accuracy from experts. Researchers and practitioners are encouraged to collaborate with local agencies and consult official websites such as the Centers for Disease Control and Prevention, the American Medical Association, and the National Fire Protection Association for up-to-date information that can assist in the selection of the most effective safety recommendations. One example of changes in safety recommendations is exemplified by a study that taught participants to extinguish cooking fires (Mechling et al., 2009). One of the extinguishing materials used in the study was flour. Although flour was a recommended extinguishing method at the time of publication, the National Fire Protection Associations has since recommended against the use of flour to extinguish cooking fires, as flour is flammable and particles suspended in the air may catch fire and can cause an explosion (Ahrens, 2017). Therefore, it is imperative to include qualified experts into the process of designing safe and effective safety interventions.

Selecting the Safety Response

General Safety Response Learners may come across a variety of dangers: comply with a lure from a stranger, play with an unattended lighter, mistake a bottle of pills left out on the counter for candy, or gain access to an unsupervised pool area. With such a wide variety of possible situations, numerous studies have targeted a safety response that is applicable to most dangerous situations. In a systematic review of the literature, Giannakakos et al. (2020a) reported that nearly half of the studies taught a general three component safety response. The general safety response comprises three components and is appropriate to a wide range of potential dangers, including abduction prevention, abuse prevention, and dangerous object safety (e.g., Giannakakos et al., 2020b; Houvouras & Harvey, 2014; Johnson et al., 2005; Rossi et al., 2017; Summers et al., 2011; Vanslow & Hanley, 2014). First, the learner is taught to identify that a danger is present in their environment. As part of this component intervention should include teaching the learner to identify the names of any stimuli that will be involved in safety training. For learners with appropriate skill sets, tact training (i.e., expressive identification; Sundberg et al., 2000) and listener training (i.e., receptive identification; Grow & LeBlanc, 2013) can be used to ensure learners can identify dangers and other stimuli associated with safety training.

Second, the learner is taught that after identifying a danger they should immediately avoid interaction with the danger. Depending on the nature of the danger being addressed, avoidance may be leaving the area or not entering an unsafe one (e.g., unattended pool) or it may comprise refraining from handling an item (e.g., lighter or prescription medication). Any level of interaction with a dangerous item could lead to injury or death; therefore, learners should be taught that no level of interaction with a dangerous item is acceptable. For instance, a learner putting their foot in an unattended pool may fall in, or a learner who verifies if a firearm is real by picking it up may accidentally discharge the weapon.

Finally, the learner must locate and notify a responsible adult of the danger. This final component is essential as it allows a caregiver to remove the danger and establish a safe environment.

Specific Safety Responses The general safety responses discussed above are applicable across multiple dangers, but situation-specific safety responses are sometimes required.

Several studies on fire prevention responses have taught participants to exit their home or school in response to a fire alarm (e.g., Bigelow et al., 1993; Garcia et al., 2016; Jones et al., 1981). The complexity of the exiting response varies greatly across studies as is dictated by the skill repertoire of the learners targeted for intervention. Some studies have taught learners to stop what they are doing and walk out the nearest exit in response to a fire alarm (Bigelow et al., 1993). Others have taught learners to exit their homes via multiple routes and to make decisions when pathways are blocked by fire or smoke (Jones et al., 1984).

In the area of pedestrian safety learners are taught safe street crossing behaviors. These behaviors are similar across studies and include stopping at the edge of the roadway, checking for oncoming vehicles, and crossing when the way is clear. Some studies have taught learners to cross only simple one- or two-lane road ways (e.g., Steinborn & Knapp, 1982), while other have taught learners to navigate more complex environments such as four-way roadways with a center island (e.g., Wright & Wolery, 2014).

While most of the abduction prevention literature has taught learners to engage in the general safety response described above, one study is a notable exception. Rodriquez and Jackson (2020) taught learners a safe word response applicable to abduction attempts by familiar adults. When approached by a familiar adult, the learner was required to ask for the safe word and provide an appropriate response to the adult's knowledge of the word. If the adult said the safe word, the participant would say "ok" and comply with the adults' request. If the adult did not know the safe work, the participant would say "no" and run away (Dowshen, 2018).

Modifications for Individuals with Developmental Disabilities Individuals with developmental disabilities may have skill deficits that necessitate modifications to safety responses described above.

First, safety responses with vocal components may present a barrier for learners with limited vocal verbal behavior repertoires. Modifications to common safety responses are required to ensure the topography of the safety response is appropriate to the vocal repertoire of the learner. One example of this type of modification is demonstrated in Taylor et al. (2004). The study taught three teenagers with ASD who had limited vocal repertoire to seek help when lost. As a complex vocal request for help was not possible, the participants were taught that if separated from a caregiver, they should approach an adult, say "excuse me" and produce a communication card. The communication card contained the participant name, a statement that they were lost, and instructions to call their parent or caregiver. Although this study was conducted with teenagers, the response topography is appropriate to younger learners as well.

Second, some learners may not have the skills necessary to respond differentially to safe and unsafe stimuli and situations that share common features. When an undeveloped discriminative repertoire poses a barrier to safety-skills acquisition, stimulus prompts can be used to facilitate differential responding (Maglieri et al., 2000). For example, a learner could be taught that if a certain sticker, such as the Mr. Yuk sticker (Fergusson et al., 1982; i.e., green stickers emblazoned with a disgusted face and the national poison control number) appears on an item, they should not touch it and, when skill sets allow, should report the item to a caregiver. Then stickers are placed on all dangerous items or access points (e.g., pool gate). Reinforcement in the form of praise is provided for avoiding and reporting stickered items left unattended in the environment. The primary advantage of this discrimination method is that it does not require the learner to respond differentially based on physical features, which vary widely across different types of dangers. The stimulus control exerted by the stickers serves to control the safety response and can be extended to novel dangers as needed. In the context of generalization, the stickers may be conceptualized as common stimuli (Stokes & Baer, 1977). A response trained in their presence is likely to generalize to untrained stimuli that are labeled with that same sticker.

Selecting the Instructional Setting(s) Research recommends teaching in the natural environment to promote generalization and increase the likelihood the safety response will occur when needed (Miltenberger, 2008; Miltenberger et al., 2020). For instance, Johnson et al. (2005) taught thirteen 4-and-5-year-olds to engage in an abduction prevention response. Behavioral skills training sessions occurred at each participant's day-care program, in a classroom, various hallways, and outside on the playground. Following behavioral skills training (BST), in situ assessments were conducted on the playground, in the school building, and at each participant's home. The results of this study indicated that the inclusion of BST and in situ training (IST) components was effective at establishing the abduction prevention response for all participants.

However, if teaching in the natural environment is not possible or not feasible, practitioners should attempt to create an analog instructional setting that contains stimuli common to the natural environment (i.e., program common stimuli; Stokes & Baer, 1977). The inclusion of common stimuli promotes generalization by pairing the targeted safety response with stimuli which may be present in the natural environment or may share a sufficient number of stimulus features (e.g., signs, store employee regalia, locations of customer service markings) Several studies have incorporated stimuli common to the natural environment into controlled teaching settings. Page et al. (1976) arranged a simulated street model complete with houses, cars, trees, and people to teach individuals with disabilities to discriminate safe conditions for crossing the street. Carlile et al. (2018) taught participants in a public school setting how to respond when lost in public through simulated commercial stores using large color photos of store interiors and instructors dressed in employee uniforms. Jones et al. (1984) taught four individuals with congenital blindness to exit their school dormitories during a night-time fire. The experimenters simulated the features of an actual fire using a taped recording of the school's fire alarm, a recording of the sound of flames, and a hair dryer to provide the sensation of nearby flames.

Selecting Instructional Materials When selecting instructional materials, the practitioner should ensure training exemplars are physically representative of actual dangers the learner might encounter. One method that has been used to identify representational stimuli is a psychometric sort (Giannakakos et al., 2020b; Lee et al., 2019, Rosch, 1975), in which the instructor identifies a pool of exemplars of a danger and has relevant stakeholders (e.g., caregivers, individuals in the local community) order the exemplars from most representative to least representative by assigning each exemplar a number from one (most representative) to 10 (least representative). An average score is calculated for each exemplar and these averages can be used to establish a representation gradient from which exemplars can be chosen. An example of a representation gradient is displayed in Fig. 42.1. A psychometric sort could also be used to select non-dangerous exemplars. Non-dangerous exemplars could be selected based on having non-relevant shared characteristics with the dangerous exemplars, then a psychometric sort could be conducted to establish a gradient of most representative to the least representative exemplars (i.e., boundary stimuli).

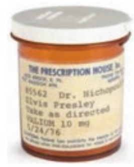
For ethical and safety purposes, actual dangerous materials are never used in safety instruction unless they have been rendered inoperable (e.g., lighters emptied of fluid and refilled with water, firearm with cemented barrel). The literature provides several innovative methods for the creation of realistic instructional materials, including lighters (e.g., Houvouras & Harvey, 2014; Rossi et al., 2017), firearms (Jostad et al., 2008; Lee et al., 2019), medications (Dancho et al., 2008; Giannakakos et al., 2020b), and cleaning products (Rossi et al., 2017; Summers et al., 2011). There are several ways to simulate dangerous items. Table 42.2 provides suggestions for safe alternatives for use in research and instruction.

Safety Response Interventions

Antecedent Interventions

Antecedent interventions as they pertain to safety are focused on manipulating a dangerous environment to eliminate or reduce learner exposure to danger. The section on assessment discussed using the HAPI-R and publicly available checklists to assess the home environment and identify potential dangers. This section describes how to use the results of these checklists might be used provide instruction on preventative safety measures to caregivers.

The results of the HAPI-R provide information on the locations and number of hazards in the home and are used to identify specific training targets for caregivers (Barone et al., 1986). For example, Metchikian et al. (1999) used the HAPI-R to assess the homes of three families referred from their county's child protective services. The HAPI-R was used to identify the presence of hazards in at least four rooms including the living room, kitchen, bathroom, and the child's bedroom. The rooms were target for treatment based on the number of hazards recorded during baseline, whereas the room with the highest number of hazards was targeted first. During training, the instructor informed the caregivers of the types of hazards that could posed a threat and provided three suggestions on how to eliminate such hazards, such as, placing it out of reach, locking it up, or fastening drawers with child locks. Then the instructor asked the parents to identify other hazards and demonstrate how they could be made inaccessible. Positive and corrective feedback were delivered and parents were

Exemplar	Average rating	Exemplar	Average rating
	1.4		2.2
	3.6		4.4
	4.5		6.6
	7.4		7.6
	8.4		8.9

Note: Unpublished data from Giannakakos, A. R., Vladescu, J. C., Reeve, K. F., Kisamore, A. N., Fienup, D. M., & Carrow, J. (2020b). Using behavioral skills training and equivalence-based instruction to teach children safe responding to dangerous stimuli: A proof of concept. *Psychological Record*. Advanced online publication. https://doi.org/10.1007/s40732-020-00380-8

Fig. 42.1 Example of psychometric sort of prescription medications. (Note: Unpublished data from Giannakakos et al. (2020b)

asked to make the target room safe before the next session. The intervention was successful at training parents to reduce the number of hazards in all target rooms.

After completing the elopement checklist like the one described intervention might focus on training caregivers putting missing preventative measures in place. Here we describe some useful prevention strategies that can be targeted for intervention. First, installation of secondary locks should be considered if a learner is able to independently exit their home (e.g., unlock doors, reach door handles). Secondary locks are installed out of the learner's reach or require a key to

Table 42.2 Recommendations for simulations of dangerous objects

Dangerous object	Safe preparations	Average cost
Firearm	Movie prop replicas can be obtained from online movie prop warehouse	$100–$200 per replica
	Real firearm disabled by pouring cement down the barrel	Sometimes available through police departments
Lighter	Empty one time use lighter of fluid, refilled with water, and remove flint. Lighting mechanism should be tested to ensure it no longer produces a flame	$2–$4 per lighter
	Reusable lighters can be purchased online and filled with water. Flint should be removed	$15–$30 per lighter
Prescription medications	Pharmacies may donate empty l prescription bottles. Simulated prescription labels can be printed online. Lids should be sealed with super glue	Free
	Empty prescription bottles can be obtained from online sellers. Simulated prescription labels can be printed online. Lids should be sealed with super glue	$0.20–$0.50 per bottle
Cleaning chemicals	Bottles can be obtained online and filled with water. Food coloring can be used to replicate color as needed. Lids and spouts should be rendered inoperable by sealing them with glue	$1.50–$30 per bottle
Broken objects	Breakaway glass also known as sugar glass, is a transparent form of sugar. It is available from theater production companies. It breaks similar to glass, and although it can still cause a cut is generally less dangerous	$20–$50 per item

which the learner does not have access. Second, contact sensors on exterior doorways can act as an alert if a door is opened unexpectedly. A contact sensor is a small two-piece device that attaches to the door and door frame. When a door is opened, the contact between the sensors is broken and an alarm is triggered.

Direct Intervention Procedures

Behavioral Skills Training A recent review of the literature found that the majority of studies used behavioral skills training (BST) in isolation or in combination with other methods to teach a wide range of safety responses (Giannakakos et al., 2020a). BST is a treatment package comprising instructions, modeling, role-play, and feedback. In the context of safety training, the instructor first provides the learner with information on the nature of the danger and the safety response. The type and complexity of this information are appropriate to the learner's age and skill level can be written, vocal, or both. Next, the safety behaviors are modeled. The model is presented so that the learner can observe every component of the response. Then the instructor gives the learner the opportunity to practice the response and provides feedback, both positive and corrective on their performance. The cycle of modeling, role-play, and feedback is repeated until the learner completes the target behavior correctly and independently. The termination criteria for BST vary across studies. One commonality is the requirement that learners emit all steps of the target safety responses independently and without error; however, the number of times a learner emits the response before BST is considered complete varies. Some studies required only one instance of criterion responding (e.g., Ledbetter-Cho et al., 2016) and others required as many as five instances (e.g., Carrow et al., 2020; Sanchez & Miltenberger, 2015).

One example of how BST may be used to teach an appropriate safety response is exemplified by Summers et al. (2011) who used BST to teach six young children with ASD how to respond to the ringing of the doorbell in their home. First, the instructor provided the participant with a clear rule, "when the doorbell rings, do not open the door, you need to go tell mom." Next, the instructor gave the participant the opportunity to engage in the safety response. The instructor observed the participant as they completed the response and provided praise contingent on a correct response. If the participant did not engage in the safety response a series of partial physical prompts were provided to complete the response and another opportunity to engage in the response was presented. Rehearsal and feedback were repeated until the participant independently engaged in the safety response for three consecutive opportunities across three separate days.

Another example of how BST has been used to teach safety responses is a study conducted by Vladescu et al. (2020) who used BST to teach 31 new or expectant caregivers to arrange a safe infant sleep environment. During BST, the instruction and modeling portion was conducted in a group format. The instructor reviewed an educational brochure called Safe Sleep for Babies (Consumer Product Survey Commission, n.d.) with the participants and reviewed the importance and rationale for arranging a safe sleep environment. Next, the instructor modeled the steps of setting up the safe sleep environment. Participants questions were answered throughout this group training. Rehearsal and feedback were conducted with participants individuals. The participant was given an opportunity to arrange the sleep environment independently. If the participant completed a response correctly, they received behavior-specific praise. If the participant engaged in an error, corrective feedback was immediately provided. BST continued until the participant demonstrated 100% correct responding for two consecutive role-play opportunities.

Variations on Behavioral Skills Training Several effective variations of the standard BST format have been evaluated in the literature. One variation of BST that can be useful in settings with low trainer-to-client ratios, such as public schools is to replace the in-person instruction and modeling portion of the treatment with a video model (e.g., Giannakakos et al., 2018; Gunby et al., 2010). There are several important factors to consider when using video modeling. Video lengths vary within the literature, but research supports that the video should be long enough to demonstrate the skill (Karsten et al., 2015). Video models can be shot from the point-of-view of the person engaging in the behavior (i.e., first-person perspective) or that of an observer (i.e., third-person perspective). Studies comparing first-person and third-person perspective suggest both perspectives are equally effective as models for target behaviors (Ayers & Langone, 2007). Although video models can be time intensive to create and require some technical knowledge (e.g., using video editing software, using a device with a sufficient camera quality), they have the advantage of providing a standardized model and set of instructions that can be used across multiple learners (Karsten et al., 2015). For instance, Giannakakos et al. (2018) taught three adults to correctly install and use child passenger safety restraints (CPSR; i.e., car seats). The instruction and modeling portion of BST was provided via video. During the first session of BST, participants watched a short video which provided information on motor vehicle-related infant and child mortality rates and the role correctly installed and used CPSRs serve in reducing deaths and injuries. Next, the participants were brought out to a vehicle and given a tablet containing the video model of correct installation and use of the CPSR. Participants watched the video and followed a checklist as they completed the steps of the installation. Following completion of the installation they were provided with behavior specific positive and corrective feedback on their performance. This was repeated until the participants installed the CPSR 100% correct for three consecutive sessions.

A second variation of BST is computer-based BST. Vanslow and Hanley (2014) evaluated computerized BST and in-person IST to teach abduction prevention and responses to dangerous items. Computer-based BST consisted of a computer game approximately 20 min in length. In the first part of the game a narrator described the dangers and steps of the safety response. Video models of children responding to the dangers were shown. Then the participants completed a series of mini games that required them to practice the order of the steps of the safety response, discriminate safe and unsafe objects, and act out the steps of the response with a cardboard cutout that was placed in the room. In study one computerized BST was used to teach an abduction prevention response. However, in a subsequent in situ assessments only one participant demonstrated the entire safety response. IST was added to establish the abduction prevention response.

A third variation is parent implemented BST. Parent implemented BST has the advantage of reducing the need for a behavior analyst to be present for sessions and may be an attractive option in remote areas or areas with few behavior analysts. In a recent study, Novotny et al. (2020) used a web-based manual to guide parents through the steps of using BST to teach their children to respond to the presence of an unattended firearm. The website created for the study provided parents with all the materials needed to conduct BST, instructions and checklists on how to conduct each component, and video models of the rehearsal and feedback components of the safety response. Experimenters conducted in situ assessments before and after the parent training to measure its effectiveness. Results indicated parent implemented BST was effective for three of the six child participants. For the other three participants experimenter implemented IST was required before they mastered the safety response. The findings of this study are preliminary support for parent implemented web-based BST.

In Situ Training Giannakakos et al. (2020a) reviewed the safety literature and found that in almost half of the studies, BST alone was insufficient to establish the target safety response for all learners. The subsequent inclusion of in situ training (IST) was effective at increasing responding to mastery levels (Giannakakos et al., 2020a). Once a safety response has been established it is then necessary to ensure that response will occur under the control of the danger rather than irrelevant aspects of the environmental arrangement present during training. Including IST as a component of safety instruction serves to assess and facilitate the establishment of appropriate stimulus control (e.g., Beck & Miltenberger, 2009; Giannakakos et al., 2020b; Lee et al., 2019; Miltenberger et al., 2005.) During IST, the practitioner sets up a simulated situation in which the learner will have an opportunity to demonstrate the safety response. The learner is then introduced to the situation while the instructor observes covertly. If the learner completes a step of the safety response incorrectly the instructor interrupts the situation in a natural way and provides corrective feedback, models the correct response, and has the learner practice.

Sanchez and Miltenberger (2015) taught four young adults with intellectual disabilities the general abduction prevention response described earlier in the chapter using BST. Then participants were exposed to an IST condition. The participants were placed in a simulated situation like the one described above. If the participant failed to engage in the abduction prevention response the instructor interrupted the session and demonstrated the correct behaviors. The participant was then required to rehearse the behaviors until they completed the response correctly. Training was considered complete once the participant engaged in the abduction prevention response independently and correctly during an IST probe.

Virtual Reality Virtual reality is an intervention tool that has been garnering increased attention in the safety literature recently. Virtual reality technology is used to create a realistic simulated learning in which the learner can practice the target safety skills. Virtual reality technology has been incorporated into safety instruction to teach fire safety (Çakiroğlu & Gökoğlu, 2019; Padgett et al., 2006) and safe street crossing (e.g., Josman et al., 2008; McComas et al., 2002). One consideration when seeking to use virtual reality as a training mode is to ensure that sufficient hardware is available to run the simulations. As with any relatively new technology, the advancements in this area are constant and become more affordable over time. A recommendation is therefore made to thoroughly research the hardware capability needed to run the targeted simulations and determine if the investment is financially reasonable. Another consideration is that some VR immersive simulations carry the risk that some individuals might experience simulator sickness. In a study evaluating VR software to teach pedestrian safety 11% of participants dropped out due to simulator sickness. A final consideration for using virtual reality is that simulations may not be available for all intended safety responses and finding qualified programmers may be challenging.

Çakiroğlu and Gökoğlu (2019) used VR-based BST to teach 10 adolescents fire safety responses. Participants were taught a variation of the general safety response, if they see a fire they should not interact with it, get away, and tell an adult. During VR training participants wore a virtual reality headset that created a 360 view of a simulated home. The instruction, modeling, rehearsal, and feedback components of BST were provided using avatars in the VR environment. Three participants mastered the safety response following VR BST, for the other seven participants one to four subsequent IST sessions were required to reach mastery. As we discussed earlier in the chapter, research recommends teaching in the natural environment whenever possible; however, it may not always be possible to do so. Virtual reality technology may provide an alternative method in which a realistic instructional setting can be simulated. The simulated environmental stimuli created would have the potential to produce strong stimulus control over the safety response and increase the likelihood of generalization to the natural environment.

Important Intervention Elements

Establishing a Mastery Criterion Mastery criterion is an important consideration when teaching safety responses. In all cases a safety response should be taught to a mastery criterion of 100% or all components completed correctly. Incorrect completion of even a single step of a safety response could result injury or death.

Discrimination Training Just as it is important to establish an appropriate safety response, it is equally important that learners be taught the conditions under which the safety response is not required (Lee et al., 2019; Giannakakos et al., 2020b). Research suggests that safety instruction without discrimination training may lead to overgeneralization of the safety response (Ledbetter-Cho et al., 2019). We therefore recommend that discrimination training be incorporated into all safety instruction. In the context of safety training an individual is taught to emit one response in the presence of a dangerous stimulus and an alternative response in similar situations that do not contain the dangerous component.

Procedures used by Giannakakos et al. (2020b) provide an illustrative example. Two typically developing preschoolers were taught to engage in a safety response when they encountered a variety of dangerous items (i.e., firearm, medications, lighters). Discriminated responding was obtained by also teaching the participants to stay and play when physically similar non-dangerous items (i.e., hair dryer, containers, flash drives) were present in the same environment.

Rossi et al. (2017) also evaluated responding in the presence and absence of the dangerous items in their study to demonstrate appropriate stimulus control. Rossi et al. taught three 5- and 6-year-olds diagnosed with ASD to engage in the general safety response in the presence of an unattended firearm, lighter, or cleaning product and to continue to play if those items were absent in the environment.

Ledbetter-Cho et al. (2019) also used discrimination training to establish correct stimulus control over a safety response. The instructors used BST to teach four learners with ASD to engage in an abduction prevention response following lures from strangers. All participants acquired the abduction prevention response, but when an overgeneralization probe was conducted in which participants were approached by a police officer all participant engaged in some portion of the safety response. Discrimination training was provided in the form of BST and participants were taught to differentially respond to civilian strangers and police officers, and to go with the police officer if asked. Following discrimination training participants successfully engaged in differentiated responding.

Instructional Context The conditions under which a learner encounters a danger may be multifaceted. Most of the studies that have established a safety response in the presence of dangerous stimuli such as poisons, firearms, and fire-starting devices have used only one instructional context. The instructional context typically is a simplistic one, a learner is left in, or told to go to a room that is baited with a dangerous stimulus. Although this is a realistic context a learner may come across a dangerous stimulus in other more complex situations. For example, a learner may see prescription medications left on a table after viewing their parent consume them. A learner may be enticed to touch a firearm by a friend or sibling or a learner who sees birthday candles left out and knows the location of matches may attempt to access them. One study to date has evaluated procedures for teaching a response to a dangerous item under more varied contexts. Lee et al. (2019) evaluated the extent to which a safety response taught in the presence of a firearm under one context would generalize to a representative sample of additional contexts. BST and IST with discrimination training were used to teach participants to engage in the three-step safety response in the presence of an unattended firearm or to stay and play in the presence of a hair dryer. Participants were taught that in the context of finding a firearm placed on a piece of furniture among their toys they should engage in the three-step response—don't touch, leave the area, and tell an adult. Generalization was then assessed to four other contexts. In general, the contexts varied by who was present in the setting, the placement of the gun, and in what way it was left unattended. More specifically, these contexts included, the participant's parent being present in the room, the firearm placed on a piece of furniture, the experimenter asking the participant to retrieve an item from a location where the firearm is placed, a firearm left unattended after a parent finishes interacting with it in view of the participant, and a peer or sibling holding the firearm and attempting to induce the participant to play with it. Following BST and IST in the first context all participants demonstrated generalization of the safety response to the remaining untrained contexts. The results of this study provide preliminary evidence that BST and IST may be effective in establishing a safety response with generality to a variety of related contexts. Additional replications of Lee et al.'s (2019) procedures are needed to establish the generality of this outcome.

Modified Reinforcement Contingencies It is sometimes necessary to modify the reinforcement contingencies surrounding the safety response (Hanratty et al., 2016; Miltenberger et al., 2004). If the natural reinforcing contingency for the safety response (i.e., caregiver praise) is not sufficient to establish and maintain responding additional reinforcement contingencies may be required. In their study evaluating the effects of BST and IST on teaching a firearm safety response to 5 preschool children, Hanratty et al. (2016) found that following BST and IST participants failed to acquire the safety response. To address this issue the experimenter added both a positive and negative reinforcement contingency to the IST procedure. If during an IST session the participant did not engage in the correct response within one minute or if they touched the firearm the experimenter interrupted the session, reviewed the safety response and had the participant practice the skills for 10 min instead of attending their class playtime. If the participant correctly engaged in the safety response during the IST session, they were given the option to go outside and play or complete an activity of their choice. These modifications were effective in increasing correct responding for four of the five participants.

Generalization and Maintenance Establishing a safety response is only a fraction of comprehensive safety instruction. It is unknown when, if ever, a learner will need to demonstrate a safety response. Therefore, it is imperative that established responses generalize to novel stimulus conditions and maintain over time (Miltenberger, 2008). Careful consideration should be given to programming for generalization and maintenance. This section breaks down the procedures described above and identifies those elements that promote generalization and long-term maintenance.

First, several of the studies discussed used realistic simulations of dangerous stimuli during training. This procedural element serves to establish a common stimulus (dangerous item) that is shared by both the training setting and any future dangerous situation. Subsequently, the common stimulus serves to control the safety response regardless of how other stimulus conditions might vary. If appropriate stimulus control of the response is established during training it will increase the likelihood the learner will engage in the safety response if they encounter that dangerous stimulus.

Second, because we cannot predict the exact stimulus conditions surrounding a dangerous situation, the practitioner should incorporate multiple exemplar training into their safety instruction (e.g., Lee et al., 2019; Rossi et al., 2017). Depending on the safety response being taught this may include multiple exemplars of dangerous stimuli, discrimination stimuli, or teaching the response in a variety of different scenarios. For example, a learner being taught not to touch fire starting devices might be exposed to multiple exemplars of fire-starting devices (e.g., matches, butane lighter, Bic lighter) and variations in appearance for each one (e.g., different colors and sizes). If designing an intervention to teach a learner not to approach an unattended pool, multiple scenarios could be used such as, being outside when the pool gate is left open, or a sibling suggests jumping in the pool when caregivers are inside. Including varied materials and scenarios in training increases the likelihood that generalization of the response will occur to similar untrained conditions and therefore be more likely to maintain over time.

The unpredictable nature of dangerous situations makes it imperative that behavior analysts conduct regular maintenance checks. Whenever possible maintenance probes should be conducted using an IST format (Miltenberger, 2008). Regular assessments to evaluate in the target safety response are still present in a learner's repertoire can in themselves be a type of preventative measure as they allow parents and practitioners to identify if a response needs to be retrained. Few studies in the safety literature have evaluated the long-term maintenance of the responses they established (Giannakakos et al., 2020a). It is essential therefore that established responses maintain long term. There is a need in the field of behavior analysis for follow-up studies that evaluate if safety responses have maintained at mastery levels. It is concerning that it remains largely unknown how safety responses established using behavior-analytic methodology maintain over time.

Giannakakos et al. (2020b) evaluated the effectiveness of a treatment package consisting of BST, IST, and equivalence-based instruction (EBI) at establishing a concept of danger that was not limited by the physical features of the dangerous stimuli and a collateral safety response. The authors first determined their exemplars of dangerous stimuli through a psychometric sort. Ten individuals were asked to sort 10 pictures each of handguns, medication, and lighters. The results of the psychometric sort generated a gradient of stimuli for each dangerous item. The most representative and least representative exemplars were used during training, while the exemplar with the median score in each gradient was reserved for generalization. Non-dangerous items were then selected for use in discrimination training based on shared physical features with the non-dangerous items (i.e., hair dryers, flash drives, and containers filled with small objects or liquid). BST and IST were used to teach participants a safety response—don't touch, leave the area, tell an adult—in the presence of one type of dangerous stimulus, and to stay and play in the presence of the corresponding non-dangerous stimulus. Then participants were exposed to EBI to establish classes of dangerous (i.e., handguns, lighters, and medications) and non-dangerous (i.e., hair dryers, flash drives, and containers) stimuli. After participants demonstrated acquisition of the classes, their response in the presence of the two remaining types of dangerous and non-dangerous stimuli was probed. Both participants demonstrated transfer of the safety response taught during BST to untrained types of dangers and novel exemplars following EBI and engaged in discriminated responding in the presence of the related non-dangerous stimuli. Several aspects of this study provide examples of generalization strategies. First, generalization of the safety and play responses to untrained exemplars was likely facilitated by the responses having been trained in the presence of the most and least representative exemplars during BST and IST. The most and least representative exemplars of each stimulus served as boundary stimuli for each of their respective classes, making generalization to examples with physical characteristics between these boundaries highly likely. Second, the authors demonstrated that EBI could be used to establish classes of stimuli that were related to each other not by their physical characteristics, but by a conceptual property (i.e., dangerous of non-dangerous). The inclusion of the dangerous and non-dangerous stimuli used during BST and IST in the class formation during EBI facilitated transfer of the safety and play responses to the untrained stimuli without the need for BST and IST.

Future Directions

There are several areas of the safety literature that could be strengthened. One such area is environmental assessment. The HAPI-R assessment discussed in this chapter is a useful tool but does not cover all the areas that might need to be evaluated. To date no assessment of environmental manipulations related to safety exists that reflects the unique needs of individuals with developmental disabilities. Environmental assessment plays an important role in subsequent antecedent interventions targeting creating a safe environment. Researchers should consider developing and evaluating assessments that could assist practitioners in identifying safety response deficits.

A second area for future research is discrimination training. Several studies have found that safety training is enhanced by the inclusion of discrimination training. Ledbetter-Cho et al. (2019) demonstrated the risk for overgeneralization that occurs when a safety response is not established under appropriate stimulus control. Future studies should seek to incorporate discrimination training into different areas of safety instruction. For instance, the area of emergency responses seems a prime candidate for teaching discriminated responses. Information provided by Arizona State University Center for Problem-Oriented Policing (Sampson, 2004) suggests that in some United States counties close to 50% of monthly calls are non-emergencies. These findings suggest a vast majority of people fail to discriminate the conditions under which they should *not* call emergency services. Discrimination training could be employed to teach learners at a young age to respond differentially to emergency and serious, but non-emergency situations.

A final area of safety instruction that has received limited attention within the behavioral literature is water safety, particularly regarding preventative methods and responses that could help a learner should they begin to drown. Researchers and practitioners should look to the prominent water-safety courses by organizations such as the American Red Cross and seek expert consultation from credentialed Water-Safety Instructors (https://www.redcross.org/take-a-class/swimming/water-safety) when designing safety responses around water safety. A general safety repertoire for water-safety instruction should minimally address treading water, identifying life guards, walking while on the pool deck, identifying prominent pool signs (e.g., no diving) as well as gauging the depth of water by referencing the numbers marked around the pool deck. Other behaviors which may help a learner in a pool setting may also include recognizing the signs of active drowning so that they can alert a lifeguard or adult if they witness an individual in distress

Chapter Summary: Key Points

- Education-based instruction is insufficient to establish safety behaviors due to the lack of an active learning component. To effectively establish a safety response instruction must include a rehearsal and feedback component.
- The first step in comprehensive safety instruction is to use identify potential dangers in a learner's environment and deficits in safety responses. Subsequent instruction should be comprised of both antecedent and direct intervention procedures.
- Expert consultation is an important component of safety research and instruction. Researchers and practitioners should collaborate with local agencies and consult official websites such as the Centers for Disease Control and Prevention, the American Medical Association, and the National Fire Protection Association for up-to-date information during the intervention planning process.
- BST in isolation and in combination with IST are the most evidence-based methods for establishing safety responses.
- All learners regardless of skill level should have a repertoire of safety responses. Research has identified procedures that are effective for both neurotypical learners and learners with developmental disabilities.
- Programming for generalization of the safety response to the natural environment should be incorporated into safety instruction. Evidence-based methods of programming for generalization may include programming common stimuli, multiple exemplar training, and discrimination training.
- The most important area for future research in behavior analytic safety instruction is response maintenance. It is unknown when, if ever, a learner will need to demonstrate a safety response. Therefore, it is imperative that established responses maintain over time.

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Part VII

Leisure and Social Behavior

43 Mobile Devices in the Context of Applied Behavior Analysis: A Multipurpose Tool

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History of Mobile Device Usage

Mobile devices, specifically cellular phones, have rapidly revolutionized society's use of technology over the last century and significantly shaped how we communicate with each other. Beginning in the early 1900s, the first mobile devices possessed limited radio capabilities and were mainly utilized for ship-to-shore and police communication (Satia, 2010). By 1964, a limited number of non-cellular car phones were installed, which utilized ineffective radio bandwidth. The first cell phone tower was installed in 1969, and the first cellular call devices were prototyped 4 years later. Popularized car phone usage did not occur until the late 1980s with the use of large, bulky devices that consumed great amounts of energy (Smith, 2010). It was not until the mid-1990s that the Blackberry® and Nokia® "Communicator" devices were popularized for sending and receiving emails and fax messages. Despite these technological advances, the devices were still ineffective for the use of voice calls. In 2004, Cingular® became the first carrier of the mobile phone. The first iPhone or "smartphone" was released in 2007 (Pothios, 2016) marking a significant step in mobile cellular technology. These "smartphones" increased the usage abilities of the phone beyond calling, texting, and email to a variety of uses (e.g., Internet access, maps, music, games).

Over the past three decades, mobile device usage radically increased in the United States and has become integrated into everyday life. By 2008, the number of individuals who owned a mobile device rose to 262 million (Shelton et al., 2009) and continued to escalate to 318 million users by 2019 (Pew Research Center, 2019). This growth has resulted in 75% of Americans accessing the Internet from their smartphone an average of 5 hours per day (Mendoza et al., 2018).

Social media usage on platforms such as Facebook, YouTube, Instagram, Twitter, Pinterest, and LinkedIn have also expanded in a diminutive timeframe (Mendoza et al., 2018; Pew Research Center, 2019). Pew Research Center (2019) noted that the number of Americans using one of these social media sites increased from 5% in 2005 to 72% in 2019. This has resulted in social media being integrated into the daily routine as 75% of Facebook users and 60% of Instagram users claimed to access the site at least once per day (Pew Research Mobile, 2019).

Among this substantive growth in mobile device use have been users who are teens and young adults, who are considered "digital natives" in today's society (O'Bannon & Thomas, 2014), meaning they have not known a

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_43

world without mobile cellular technology or smartphones. Teen users have disclosed that they access the Internet at least daily (Sibley et al., 2017). It has been reported that young people receive or send an average of nearly 109 texts per day (Mendoza et al., 2018), as teens and youth oftentimes associate mobile usage with social connection. According to Tulane et al. (2017), the devices provide (a) connection with friends and family, (b) peer attention and acceptance, and (c) levels of regulation and autonomy. These devices have led many to create and maintain relationships through interaction of social media platforms, texting, sending pictures, and scheduling events (Carels, 2019; Nesi et al., 2018; Thomas & McGee, 2012; Tulane et al., 2017).

Within the past few years, mobile technology has morphed into portable tablets and wearable smartwatches that synch with another mobile device. These smartwatches have increased in their usability as there have been increases in app development (BusinessWire.com, 2020). As these technologies have once again broadened the communicative abilities of mobile devices, the smartwatch has also bridged into a tool to assist with documentation of health conditions (e.g., heart attack detection; Tison et al., 2018).

A thorough history of mobile technology is outside the purview of this chapter; however, the previous paragraphs provide a brief overview of the rapid spread of these technologies and how they have become intertwined in the social and health-related facets of modern society. Throughout this chapter, we will discuss mobile devices as a general term that encompasses cellular phones, smartphones, smartwatches, and tablets (e.g., iPad®, Kindle, Amazon Fire®). If needed, we will specify which type of device has been referenced in the literature. The remaining sections of this chapter will address these technologies in relation to the human behavior change, specifically applied behavior analysis (ABA). Understanding some basic tenets of how these technologies have and can be used for ABA practitioners can assist in furthering the quality of services provided in the field.

Mobile Devices as Agents of Behavior Change

There are numerous studies that have shown the effects of mobile devices on human behavior. These studies have varied across the spectrum of academic research and have shown both the benefits and detriments of these technological advancements. Hypotheses related to mobile device effects on human behavior have been posited related to medical sciences (Thomas et al., 2019), business (Thusi & Maduku, 2020), education (Clemons et al., 2016), and the arts (Tyak et al., 2017). This breadth of research has encompassed a wide swath of human behaviors ranging from taking medication as prescribed (Armitage et al., 2020) to encouraging social interaction among children with autism spectrum disorder (ASD; Grosberg & Charlop, 2017). A cursory search of the literature reveals a multitude of studies aimed at utilizing mobile devices to assist in behavior change.

Each of these studies suggests that technology has the power to reinforce and shape human behavior in manners that have previously been unavailable. Throughout most of human existence, there needed to be an actual person present to develop social interaction skills, and there needed to be additional people present to encourage the generalization of these skills. With mobile devices, the need for a person to be physically present to teach, reinforce, and generalize a social interaction behavior is not required. The device provides multiple platforms that involve voice and video with live or recorded interactions that can shape the social interaction behaviors. Additionally, throughout the Coronavirus Disease-2019 (COVID-19) pandemic, mobile devices became an important way for individuals to stay socially connected to one another. While many were quarantined, many individuals were only able to connect with family through voice calls, text messaging, and video-based communication (Banskota et al., 2020).

Additionally, even niche behaviors that require specialized skill and information have become simpler as a result of the mobile device utility. For example, if a person is trying to engage in a specific behavior (e.g., rebuild an engine from an antique car), they have access to a device that can provide them with multiple means to assist in engaging in the behavior accurately: (1) vocal communication through a call to an expert on the subject; (2) using a live, video-based communication (e.g., FaceTime, Zoom, or Skype) to be shown what to do in real time; (3) using mobile data to download an owner's manual for the specific model of automobile; (4) using a video-based platform (e.g., YouTube) to watch the specific skill multiple times via a video model of how to specifically perform the task; and so on. Prior to the invention of the mobile device, a person would have to either have experience with engine repair or have a person physically present with them to show them how to perform the tasks needed.

Although there have been many positive aspects to the behavior change associated with mobile devices, we would be remiss to not address some of the detrimental side effects. Mobile devices have caused people to engage in distracted behaviors that have led to accidents, injury, and death (National Safety Council, 2012). For example, distracted driving causes thousands of deaths each year (National Center for Statistics and Analysis, 2021). This is when the driver of the automobile is focused on talking or texting on their mobile device, as opposed to observing the road for warning signs (e.g., brake lights) or hazards. Distracted pedestrians using their mobile device are also a growing problem. This problem has required a behavioral intervention to cue the pedestrians that they are about to enter a dangerous area (e.g., intersection; Larue & Watling, 2021). A common sign when at many crosswalks now is "Phone Down and Head Up" to remind pedestrians to look before crossing the road (Barin et al., 2018).

Perhaps one of the most challenging aspects of behavior changes has been the problematic nature in which people have engaged with these devices. Nomophobia is a term that has been used to describe the fear that a person has when they are unable to access their phone or mobile device (Tams et al., 2018). Addictive mobile phone behaviors have been associated with more stress (Khalili-Mahani et al., 2019). Stressors surrounding mobile devices have sparked a growing call for additional research regarding "screen addiction" (World Health Organization, 2015) and development of tools to evaluate this phenomenon (Domoff et al., 2019). Any addiction suggests that the mechanism (i.e., chemical substances, gambling, Internet browsing) the individual is addicted to is providing some form of reinforcement that maintains the behavior (Alavi et al., 2012; Dixon et al., 2015). In the case of "screen addiction," the reinforcer maintaining the behavior(s) is a device that has a screen (e.g., mobile device). The emergence of this industry shows the reinforcing power of the mobile device to catch and hold a person's attention to the point that they are unable to function within their daily lives.

Contingency Analyses of Mobile Devices

As technology continues to improve, the use of mobile devices in our everyday lives does not seem to be slowing. It is for this reason we should consider how mobile devices function within a basic ABA framework. As noted above, addressing "screen addiction" is an emerging field that suggests that there are many reinforcing qualities surrounding mobile devices. When considering these qualities, it is important to note that mobile devices may serve several potential behavioral functions.

Considering that mobile devices are by definition tangible, handheld tools, it is clear that they may serve as a positive reinforcer (S^{R+}) in the form of a tangible reinforcer. In addition to being tangible, the mobile device offers a variety of activities in which the user can engage. According to estimates in late 2020, there were almost one million gaming apps available on Apple® App Store, while Google Play® had almost 500,000 available gaming apps (Statista, 2021b). It was reported in the same timeframe that there were over 3.4 million non-gaming apps on Apple® App Store and almost 2.5 million non-gaming apps on Google Play® (Statista, 2021a). With apps being created that serve a myriad of purposes, it is clear that the one tangible device provides access to almost endless activities. Although there are always idiosyncratic variables that may affect tangible or activity reinforcer effectiveness (Cooper et al., 2020; Schlichenmeyer et al., 2013), an individual's particular fixation to one type of activity may be able to be met in a variety of ways through the available apps. Having access to all of these apps that may contain a reinforcing activity further emphasizes the premise that mobile devices can serve as a tangible reinforcer. Refer to Tables 43.1 and 43.2 for example contingencies for mobile devices.

A second way in which mobile devices can serve as S^{R+} is in the form of social attention. Many of these devices provide direct access to other people through text, voice, video communication, or through social media platforms. Historically, phone calls have served to provide social attention for the caller and receiver of the call. As telecommunications have improved, phone calls have been used as social attention reinforcers that aimed to help with follow-through on interventions (Laforest et al., 2012), counseling (Lash et al., 2001), as well as reinforcing parents for their child's school attendance (Copeland et al., 1972). Some mobile devices do not have a phone function; however, through various apps (e.g., WhatsApp®), a phone call can still be made using mobile or Internet data. Additionally, mobile devices allow individuals to have conversations with multiple people simultaneously, thus increasing the potential potency of the reinforcement. Social media is designed to provide social attention to users in such a manner that users will increase the amount of time spent on the app (Guedes et al., 2016). In addition, gaming apps provide access to social attention through online gaming (Thomas & Martin, 2010). Based on this limited discussion, it is evident that reinforcement in the form of social attention is built into the fabric of mobile devices.

Negative reinforcement (S^{R-}) is the removal of an aversive stimulus following a behavior that increases the likelihood the behavior will recur (Cooper et al., 2020). When considering functioning, behaviors that are reinforced using S^{R-} are often considered "escape-maintained behaviors" (Allday, 2019). Mobile devices have the potential to provide escape in a few different ways. First, users can "escape" from social interactions (i.e., attention). This is accomplished by focusing on the device screen as opposed to

Table 43.1 Example attention contingencies related to mobile device use

	Motivating Operation	Antecedent	Behavior	Consequence	Potential reinforcement
Phone call 1	Desire to avoid contact with individual	See individual	Look at caller ID	ID shows a known caller	S^{R-} Attention
		ID shows a known caller	Silence ringing and ignore	Avoid conversation with unknown caller	
Phone call 2	No contact	Device rings	Look at caller ID (known caller)	ID shows a known caller	S^{R+} Attention
		ID shows a known caller	Touch green button and say "hello"	Person on other end says, "hi"	
Text message	No contact	Device "dings"	Look at phone	Notification shows "message from mom"	S^{R+} Attention
		Notification shows "message from mom"	Unlock phone to read message	Read message from mom	
		Read message from mom	Type a message to mom	Phone "dings" with heart emoji	

Table 43.2 Example activity contingencies related to mobile device use

	Motivating Operation	Antecedent	Behavior	Consequence	Potential reinforcement
Map app	Desire to meet friends	Voice prompts that church St. is the next left	Initiate turn signal to go left onto church St.	Arrive at destination	S^{R+} Attention/ activity
Reading app	Desire to read	Find the "book" icon on the screen	Touch the "book" icon	Book opens on screen to allow reading	S^{R+} Activity
Gaming app	Tired of working	Find the "game" icon on the screen	Touch the "game" icon	Game begins	S^{R-} Activity

looking or talking to the person that is being avoided. Second, users can escape from non-preferred tasks. When tiring from non-preferred tasks (i.e., activity), the user can engage the mobile device to play a preferred app. This type of escape is moving from a non-mobile device activity to an activity that can be completed on the device. Another means of escape can be achieved with the device, when the user stops working in one application to engage in a more preferred application. Please refer to Tables 43.1 and 43.2 for example contingencies related to mobile device use.

We have considered S^{R+} in the form of gaining access to attention and a tangible/activity reinforcer as well as S^{R-} in the form of escape. The only other primary behavioral function is related to automatic reinforcement. When considering how a mobile device can be used within a contingency that results in automatic reinforcement, it is not as clearly identifiable. Definitions of automatic reinforcement posit that a behavior must occur when there is not another person mediating the behavior (Vaughan & Michael, 1982). Furthermore, automatic reinforcement suggests the potential for non-social interactions or an environment without socialization (Falcomata et al., 2004; Patel et al., 2000) where the behavior continues without another person being involved (Cooper et al., 2020). The mobile device is a tangible tool that can be manipulated in isolation without socialization or another person mediating the behavior. The reason it would be difficult to identify an automatic reinforcement contingency for mobile devices is the fact that it always provides access to activities through its tangible existence; however, it is possible through these devices that an individual could engage in a variety of behaviors with the device without other socially mediated contingencies.

Mobile devices can also serve as a discriminative stimulus (S^D). An S^D is the antecedent stimulus that signals that reinforcement is available for engaging in a specific behavior (Cooper et al., 2020). With mobile devices, there may be several discriminative stimuli based on the specific audible sound that emits from the device. For example, a text message may make one sound ("beep"), while the phone ringing may make another sound ("rrrrring"), while a game notification may make another sound ("bim bam"). The user engages in a non-systematic form of stimulus discrimination training to determine which sound is associated with each function of the device. In this regard, the audible sound serves as a discriminative stimulus for engaging in specific behaviors associated with the device. For example, when a "beep" is heard, the user learns to read activate the screen to read the text versus if a "rrrring" is heard the user knows to press the "green button" to answer the phone. The user quickly learns which sound represents which information is being delivered. Research is emerging in how to better use these devices within the context of discriminative stimulus training (Lorah et al., 2014; Mitteer et al., 2020).

A unique observation of mobile device users is that there are many times that they will pick up the device and activate it without a clear audible sound to prompt them. This may be observed as a user pressing a button to check the time, then placing the device back on the table. As noted earlier, the ever-expanding utility of the mobile device makes it difficult to know how motivating operations impact device use.

As shown in this section, the mobile device has been a powerful agent of behavior change among people from a variety of demographic and social backgrounds. Although these examples are not directly related to the field of ABA, it is vital to reflect on how the wider professional and social communities have studied and focused on these technologies. Understanding how they can be an agent of behavior change requires us to focus on the potential reinforcing properties of the devices, as well as how they can serve as antecedent stimuli to engage in certain behaviors.

Mobile Devices in the Field of ABA Research

As mobile device use in the larger society has grown so has their use within research studies in ABA. As noted in the previous sections, it is clear how these devices can function to prompt and reinforce specific behaviors. It is in this utility that ABA researchers have considered the value of the mobile device in relation to their ability to be used within various components of single case designs. A cursory scan of behavior analytic literature reinforces the breadth of how mobile technology has been used to change human behavior systematically. It is outside the purview of this chapter to provide an in-depth analysis of research in ABA using mobile devices; however, we will address some of the studies that have used these devices.

Utilizing the full range of innovations that mobile devices may provide has shown how they can help to improve a variety of skills. Carlile et al. (2018) taught individuals with autism spectrum disorder (ASD), within a multiple probe design, to use a communication app (i.e., FaceTime®) on a device to seek help when lost. The researchers were able to produce generalized responses to novel situations among the participants. Bicard et al. (2012) utilized text messaging to improve the class attendance and reduce tardiness among college-aged student athletes. This was evaluated within a multiple baseline with embedded reversal design and found that the text messaging helped the student athletes regarding their classes. Also, there have been multiple studies that have utilized single case designs to evaluate mobile devices' ability to improve geometry skills of students with learning disabilities (Cihak, 2009), transition behaviors in school for students with ASD (Cihak et al., 2010), and self-monitoring skills for students with emotional and behavioral disorders (Gulchak, 2008). These studies show how mobile devices can help with a variety of behaviors across ages and settings.

Driving while distracted on a mobile device is one example that has a practical application to an issue addressed earlier, and has the potential to result in an accident, injury, or death (National Center for Statistics and Analysis, 2021). With this in mind, Clayton et al. (2006) used a sign at the exit of a parking lot to prompt motorists to put their phone down while driving, as well as put on their seat belt. Using a multiple baseline with reversal design, the authors found that the sign prompting motorists to put their phone down prompted many drivers to comply. Unfortunately, the authors noted that approximately 33% of drivers were on their phone again within one block.

Another example from the literature shows how an interdependent group contingency was used to reduce cell phone usage in schools (Jones et al., 2019). Within the context of a reversal design, students at an alternative high school had an interdependent group contingency (i.e., all students can access the reinforcer if all students meet a specific, predetermined criterion (Litow & Pumroy, 1975)) implemented to decrease mobile device use. Results showed a functional relation between the interdependent group contingency and reduced use of mobile devices for a specific student and for the entire class. In these two examples, mobile device use was considered unacceptable at the moment. These two studies showed ways in which to reduce mobile device usage.

There are numerous studies that focus on the use of mobile devices in changing health-related behaviors. The most common use of mobile devices to change health behaviors is when using some form of a contingency management (CM) intervention. CM interventions focus on providing access to reinforcers following exhibition of a targeted, desired behavior (Petry, 2011). There are many examples of using CM including a mobile device to change a specific health-related behavior. For example, Raiff et al. (2016) used a multiple baseline design to implement a package intervention (i.e., text-message reminder and monetary incentive) to increase the adherence to taking medication for participants with diabetes. Results showed that the intervention improved participant adherence to their medication regimen. Dallery et al. (2021) used a mobile app that included CM to decrease smoking behaviors among adults. Results suggested that this type of app was user friendly and encouraged participants to complete the required activities. Stedman-Falls and Dallery (2020) examined a mobile device-based and in-person deposit contract to increase physical activity (i.e., steps taken per day). The authors noted that both interventions were successful, yet participants preferred to use the mobile device-based system over the in-person.

It is evident that there are many uses of mobile devices within the research protocols of single case designs. The preceding citations reflect a small portion of the literature that has been produced showing how mobile devices can be used to promote behaviors as well as reduce behaviors. As a field, ABA researchers should continue to pursue the use of mobile devices within their research and discover the most efficient manners in which they can assist in improving socially significant behaviors.

Mobile Devices in ABA Practice

The field of ABA has grown exponentially over the past two decades with the advent of the Board Certified Behavior Analyst® (BCBA®) credentialing. The BCBA has helped the field to grow and organize in a manner that has greatly expanded practice opportunities (Behavior Analyst Certification Board, 2019). Behavior analysts have been able to incorporate mobile devices to streamline the manner in which the science is being delivered to consumers. The range of applications of the mobile devices has the potential to impact every facet of ABA practice including, but not limited to, assessment, intervention, data collection, and communication.

Assessment Using Mobile Devices

Prior to beginning any behavioral intervention, there are assessments that must be conducted to determine which skills need to be taught and reinforced or behavior to be changed. There are several popular forms of pen and paper assessments that have been used over the past decade that have been digitized and made available on mobile platforms.

The *Assessment of Basic Language and Learning Skills—Revised* (ABLLS-R; Partington, 2010) is a commonly used assessment that informs curricular decisions related to language instruction. The digitized version (i.e., WebABLLS-R) provides digital tools to collect and analyze data related to ABLLS-R programming, as well as serve as a communication tool to share the data with other practitioners.

Another common tool used by practitioners in ABA is the *Verbal Behavior Milestones Assessment and Placement Program* (VB-MAPP; Sundberg, 2008). The VB-MAPP is another tool that is used to evaluate verbal behavior. The program also provides a guide to instruction based on identified deficits. The mobile platform version of the VB-MAPP allows for practitioners to enter and analyze data via visual analysis. In addition, the mobile VB-MAPP provides a communication tool that allows immediate sharing of progress data.

Within the realm of functional living skills, the *Assessment of Functional Living Skills* (AFLS; Partington & Mueller, 2012) has also created an online system that is compatible with mobile devices that allow practitioners to organize and communicate results quickly and easily. Each of the AFLS® domains (i.e., Basic, Home, School, Community, Vocational, and Independent Living) is available to complete the evaluation of these skills for an individual. As with the other apps, the AFLSonline™ allows for quick scoring and tracking of skills, as well as a mechanism to create and share reports with stakeholders quickly.

Assessments designed to evaluate challenging behaviors are perhaps one of the most difficult assessments to fully digitize. One reason for this challenge is that there are numerous variations of data needed for these evaluations. For example, to complete a functional behavioral assessment (FBA), the practitioner may need to assess using interview, record review, behavior rating scales, and direct observation (Sugai et al., 2000). The process a practitioner would follow may depend on the individual and the severity/topography of the problem behavior. Therefore, there are a number of apps that can capture different pieces of the FBA process. For instance, mobile devices can record and digitize the interview. Hopper and associates (2021) have suggested that such interviews can be recorded and transcribed utilizing mobile devices and cloud-based tools. This would allow the practitioner to easily refer back to information from the interview after the direct observation. Additionally, programs such as the multi-option observation system for experimental studies (MOOSES; Tapp et al., 1995) or Countee (Peić & Hernández, 2016) can be used to collect and analyze direct observational data. ABA clinicians can use these applications on mobile devices to collect an array of assessment data in either full or partial capacities depending on the functionality of the app and the needs of the clinician.

Data Collection Applications in ABA

One of the primary tenets of behavior analysis as a field is the collection of direct observation data to drive intervention and to evaluate outcomes to determine if changes need to be made. There are many dimensions of behavior (e.g., frequency, rate, duration, latency, topography, force, locus) that can be collected by the behavior analyst (Alberto & Troutman, 2017). Additionally, some behaviors lend themselves to being collected using time-based interval systems such as whole- or partial-interval recording or momentary time sampling (Alberto & Troutman, 2017). Apps developed on mobile devices have increased the ease with which practitioners and researchers can reliably collect these data. Apps such as MOOSES and Countee have been designed to collect almost all of these types of data. Furthermore, other apps such as Intervals ABA (Mays, 2019), Behavior Tracker Pro (Marz Consulting, 2019), and Nulite Behavior Tracker for Special Education® (Moy, 2015) are also designed to collect a variety of types of data. See Figs. 43.1, 43.2, 43.3, and 43.4 for example screenshots from these apps. As with other general use apps, the number of data collection and integration apps, as well as ABA specific apps, continues to grow and be developed.

Some dimensions of behavior may be best measured using permanent product. Mobile device cameras allow practitioners to take pictures to produce a permanent product. This may be used by practitioners working with clients who engage in property destruction. Prior to the easy use of photographs, the level of the property destruction was typically recorded through notes, or some sample of the property destruction was kept (e.g., a torn worksheet). Now, practitioners can photograph the classroom or clinic via a mobile device and use it as a point of comparison when determining whether an intervention is working.

Mobile devices can also make the measurement of descriptive data easier. For example, Antecedent–Behavior–Consequence (ABC) data are often collected as a way to evaluate the environmental variables that maintain a behavior (Tarbox et al., 2009). Given the importance of ABC data to practitioners of ABA, there are a number of structured (i.e., predetermined choices) data collection forms and narrative (i.e., open response) data collection forms meant to prompt and aid the practitioner to record the important environmental variables. The use of mobile technology allows practitioners to record this information easily. As noted in Fig. 43.2, this app allows users to collect ABC data as one of the option of data collection. This feature allows for both structured and narrative forms of data collection. There are apps that will then graph these data to help the practitioner identify trends

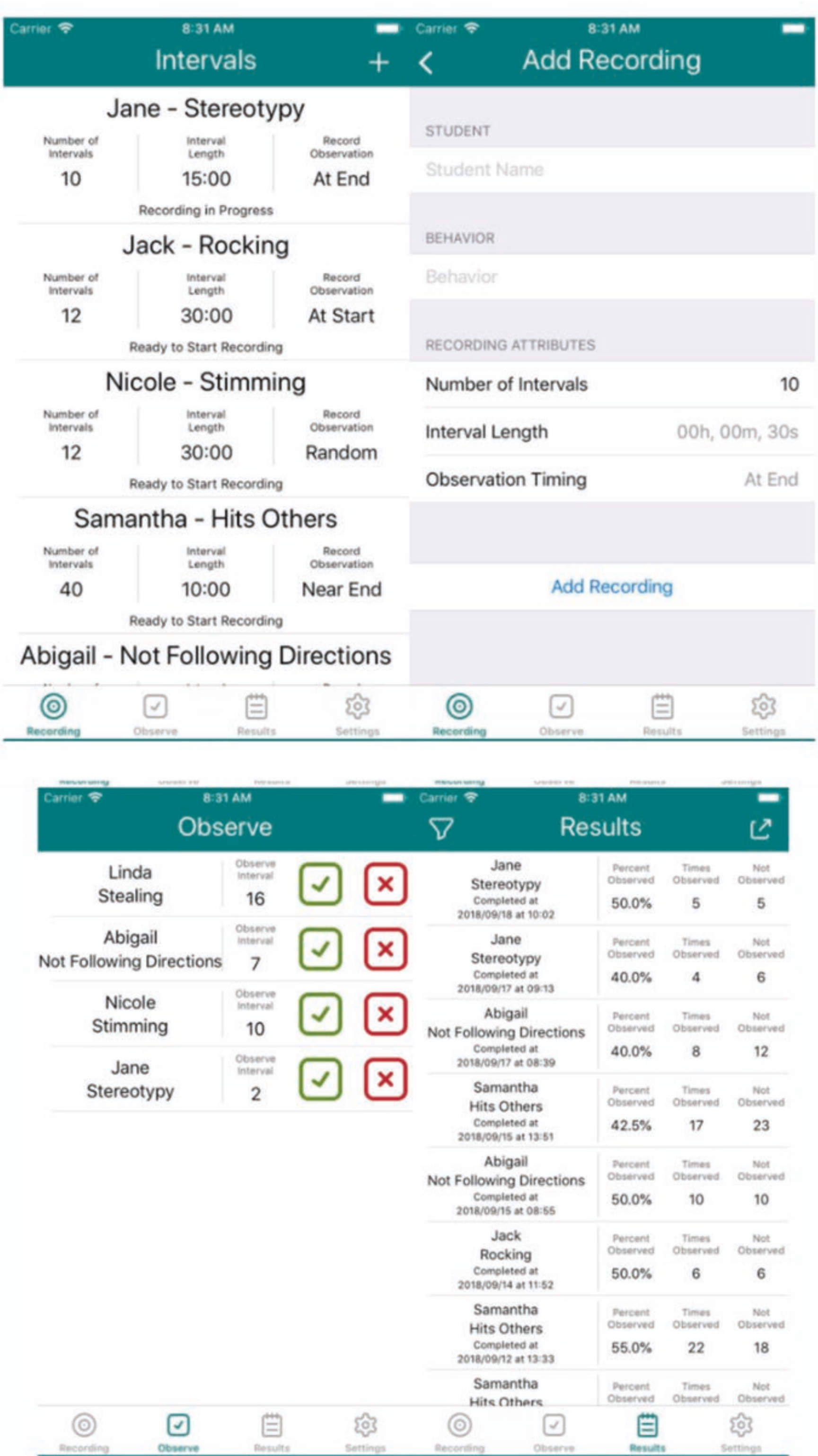

Fig. 43.1 Screenshots from Intervals ABA (Mays, 2019)

Fig. 43.2 Screenshot from Behavior Tracker Pro® (Marz Consulting, 2019)

in the data, thereby pinpointing the most salient environmental variables. As noted in Fig. 43.3, many of the apps will allow for phase lines to be drawn to help the user see the effects of changes to intervention. Further, many apps have a function by which the practitioner can share the results with the clients, family members, teachers, or other people for whom that information may be useful. Figure 43.4 shows how data can be exported (note the export arrow on top right) to share results with stakeholders.

Historically, data collection was completed using paper forms. These paper forms were often stored and organized into files and hand graphed or graphed within a computer software system. This was generally cumbersome and time consuming. Since the advent of mobile devices that have Internet or mobile connectivity, the profusion of data collection apps has allowed practitioners to assess, graph, and communicate outcomes more efficiently with caregivers and clients.

One interesting outcome of the advance of mobile device technology is that it provides a way to engage in real-time data collection in the individual's natural environment. Real-time data collection reduces the need for retrospective self-report or for information to be collected in a contrived setting. The mobility of these technologies has also increased the ability to conduct ambulatory assessments (AA) that provide experience sampling or ecological momentary assessment (EMA; Trull & Ebner-Priemer, 2014). AA allows the individual to collect data on themselves and encompasses a wide range of methods used to study individuals in their natural environment. It also encompasses EMA (Stone & Shiffman, 1994) and experience sampling (Csikszentmihalyi & Reed, 1987) to provide a real-time self-report (i.e., EMA), as well as a random sampling of data using alerts sent to phones (experience sampling). Through AA, practitioners and researchers are provided with a way to assess self-collected data in their natural environment throughout the day within a particular context, as opposed to relying on recall (de Vries, 1987).

Ebner-Priemer and Trull (2009) identified the benefits of AA that would be of particular importance to the field of behavior analysis. First, the use of real-time data collection circumvents inaccuracy or bias in recollection of experiences. AA

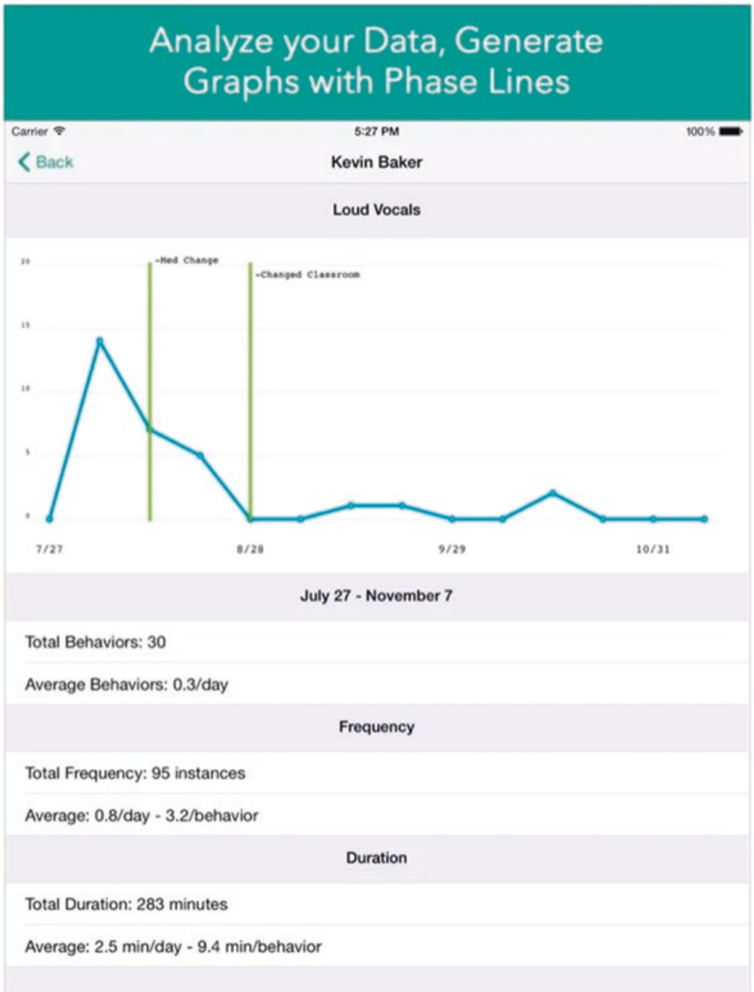

Fig. 43.3 Screenshot from Nulite Behavior Tracker for Special Education® (Moy, 2015)

does not require trained or skilled data collectors to be sent to the field to collect data. Rather, the individual records their own behavior using cell phone technology and the researcher and practitioner can analyze those data. Additionally, the ease of data collection allows for continuous and repeated assessment. For behavior analysts working with limited resources, this could be especially beneficial.

Second, collecting data in the natural environment allows practitioners to improve generalizability. Measuring components of behavior as they are occurring in the individual's environment, a practitioner may be able to design an intervention that can address an individual's natural contingencies. Behavior analysts can use this information to structure environments, so the individual is more likely to be successful. Finally, AA allows for the opportunity to investigate context-specific contingencies. Behavior analysis has long desired the ability to assess naturally occurring contingencies, and AA offers a promising way to do this.

Research on AA suggests that the approach appears to be a cost-effective and easy-to-use method of data collection. Haedt-Matt and Keel (2011) used AA to determine that individuals who engage in binge eating record negative affect before and after an episode, which had not been the predicted result. AA has also been used to

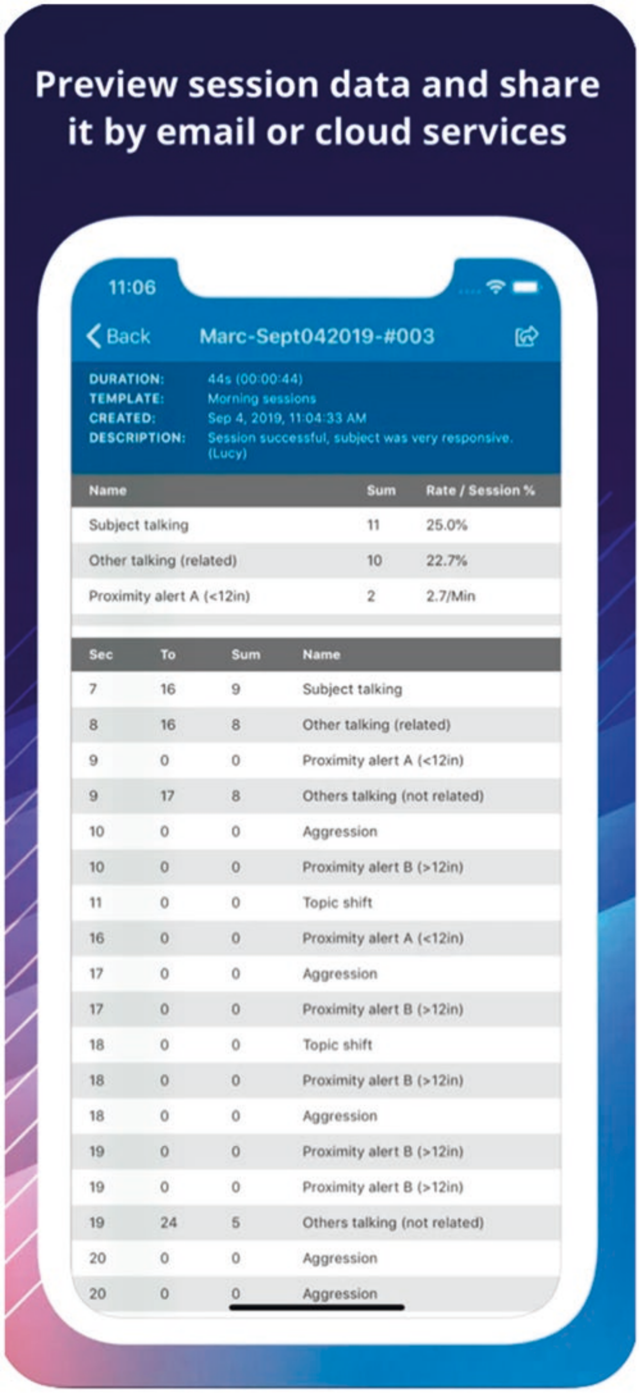

Fig. 43.4 Screenshot from Countee (Piec-Gavran & Hernández, 2019)

study self-reports for other addictive behaviors, such as tobacco or alcohol use (Hofmann et al., 2012). Individuals using AA have high levels of compliance with the study protocols, even those with serious and chronic mental health conditions (Trull & Ebner-Priemer, 2014).

Communication Applications of Mobile Devices Within ABA

Providing caregivers with feedback on client progress toward meeting specific skills is important for practitioners of ABA. This helps to achieve the core tenet of ABA by focusing on interventions that are *effective* (Baer et al., 1968). Delivering effective interventions is important; integral to that is the ability to communicate to other stakeholders regarding the successes or failures of the intervention as it provides a sense of accountability to the consumer. Mobile technology has become a common vehicle for providing this accountability related to intervention effectiveness. As noted above, many of the apps used by ABA practitioners allow for instantaneous communication of assessment results and progress monitoring to interested stakeholders.

One aspect of increased communication using mobile devices is the delivery of telehealth services. Telehealth is “the delivery of healthcare services, where patients and health care providers are separated by distance” (World Health Organization, 2021). The use of telehealth to deliver ABA is an increasing practice that saw great growth throughout the COVID-19 pandemic; many states passed emergency resolutions to allow for the delivery of telehealth provision of ABA (Pollard et al., 2021). This use of technology assisted practitioners in continuing to be able to communicate and serve their clients without having to be physically present. Telehealth has also been shown to be effective at delivering interventions and more cost effective than in-home, in-person treatment (Lindgren et al., 2016). This suggests that the trend of increased telehealth services may not decrease following the end of the pandemic.

Telehealth has been used on mobile devices to deliver services on several topics including brief functional analysis (Gerow et al., 2021), functional living skills (Craig et al., 2021), and tacting (Ferguson et al., 2020). In addition, the utilization of telehealth with mobile devices has been provided for adults (Shawler et al., 2021), children (Sivaraman et al., 2020), parents (Boutain et al., 2020), and in rural communities (Hamrick & Lock, 2020). Utilizing telehealth to reach those who may not have direct access to ABA services allows for practitioners to meet the needs of those who may not otherwise receive services. Mobile devices that improve access to communication between practitioner and client may be able to increase the impact that ABA can have in the community. See Tomlinson et al. (2018) and Ferguson et al. (2019) for recent reviews of literature regarding training and coaching of individuals to provide ABA using telehealth.

Mobile Devices as Teaching Tools

Teaching new skills that are socially significant is a defining feature of our field (Baer et al., 1968). Mobile devices have proven to be an effective tool for behavior analysts to improve skill development for their clients. Mobile devices have been used to help prompt specific behaviors (Shepley et al., 2018), organize the day (Spriggs et al., 2015), and serve as a system to assist in reinforcement (Getty et al., 2019). The benefit to using mobile devices for these teaching techniques is that they are ubiquitous in the population, so the client will not need to carry around extra reinforcement schedules or prompting cards or calendars. In this way, mobile devices as mobile technology have improved and expanded in utility, so has the use of the device to teach skills.

The types of skills that are available for teaching on mobile devices encompass a spectrum of academic (Tingir et al., 2017), functional (Smith et al., 2015), vocational (Hayes et al., 2015), and social (Tetreault & Lerman, 2010) behaviors. Researchers have shown that skills taught to individuals using mobile devices also encompass the spectrum of ages from early childhood (Lorah et al., 2014) through adolescents (Shepley et al., 2018) and into adulthood (Bicard et al., 2012). As these technologies have been further incorporated into daily practice, there is still work to be done to examine the effects of mobile devices on how they work to provide instruction. Cumming and Rodriguez (2017) conducted a meta-analysis of the utilization of mobile technology for students with disabilities. The authors noted that the evidence is emerging to support this practice when teaching academic skills, daily living skills, vocational skills, and communication. There is also evidence to support using mobile devices to improve transition behaviors between activities and settings (Cihak et al., 2010), increase task engagement and completion, and decrease challenging behaviors.

Video-based instruction (VBI) is one of the more common strategies utilized within the context of mobile devices to teach new skills (Cumming & Rodriguez, 2017). Video-based instruction utilizes video modeling or video prompting, interventions that have been employed for decades across multiple environments and individual functioning levels. Video modeling involves the learner watching a skill in its entirety and then performing that skill (Bellini & Akullian, 2007). Video prompting involves the learner watching part of a skill, completing that step (or steps), and then watching another part of that skill and completing that step (or steps) until the entire skill has been completed (Banda et al., 2011). VBI is based on Bandura's (1977, 1997) social learning theory that individuals learn a myriad of skills through observing others perform the skill then imitating what was observed. This theory of learning new skills was perfectly suited for mobile devices since VBI allows the observer (i.e., the learner) to watch the skill needed to be performed in the environment in which it needs to be performed. The video serves as the S^D for the behavior that needs to be performed and is particularly useful as a video is consistent each time it is accessed.

VBI on a mobile device can lead to increased quality of life as the learner can rely on it as a self-instructional tool. Self-instruction is a critical skill to consider when teaching new skills since the goal is for learners to gain skills independent of another person's direction. Mobile devices can serve as self-instructional tools, allowing them to serve as the mechanism for instruction delivery. Devices can be set up to include a video library of common tasks to be performed, learners can be taught to search the Internet for videos, and learners can be taught to activate the virtual assistant within their device (e.g., Siri, Alexa) to locate videos. There are applications that can be downloaded to store videos. One application, *ChoiceWorks*, encourages self-instruction by embedding video models into visual activity schedules. The application displays a daily schedule using thumbnail pictures. Each picture (or select pictures) can be linked to a video of the task to be completed. The idea is that as an individual progresses through their daily routine, if they come to a task that they do not know how to complete, they can touch the picture and a video model of the task will appear. These video activity schedules can lead to greater independence as the learner begins to rely on the prompts within their mobile device, as opposed to relying on another adult to provide the prompts (e.g., Shepley et al., 2018; Spriggs et al., 2015).

Mobile Devices in K-12 Classrooms

Due to the increase in mobile device use within broader society, it is of little surprise that mobile phones have also increased in school settings. Mobile device use is pervasive in middle and high school settings given the large percentage of youth and teens who own a device (Hernan et al., 2019). It has been reported that school-aged students interact with their device an average of 8 hours a day, in both personal and classroom environments (Schreiner, 2018), with many students communicating with other users during class (Burns & Lohenry, 2010). Unfortunately, schools have not been prepared for the academic and social impact created by the rapid adoption and technological dependence of such devices (Tulane et al., 2017). School administrators and teachers currently face a multitude of advantages and disadvantages surrounding the topic of mobile device usage in the classroom.

Educators and researchers have begun to explore how mobile devices can be used for academic gain. As has been noted, mobile devices have been widely accepted among school-aged children; therefore, it makes sense to leverage their popularity in an attempt to improve academic skills. School-aged children can use devices to conduct independent research, access educational apps and tools, collaborate through texting and cloud-based programs such as Google Drive, and improve writing through auto-correct or text to speech options (Hernan et al., 2018; O'Bannon & Thomas, 2014; Vaterlaus et al., 2012). As noted in preceding sections, mobile devices have been used to provide instruction on a wide array of academic, social, and functional behaviors. It is through this medium (i.e., mobile device) that educators must continue to determine evidence-based practices on how to utilize these tools to maximize student performance. As the technology is changing faster than the research can be conducted, educators will have to remain cognizant of the most recent approaches to using these devices.

Despite the potential of numerous benefits, many researchers have debated whether the negative outcomes of school-aged children mobile device usage in the classroom overshadow the benefits (Hernan et al., 2018; Mendoza et al., 2018). One reason is that mobile devices can prove detrimental to a student's social development. Principals and teachers have conveyed concerns regarding cases of cyberbullying (National Center for Education Statistics, 2019), cheating (Hernan et al., 2018), sexting (Hachiya, 2017), and increased interpersonal conflicts (Tulane et al., 2017). Virtually engaging with peers, regardless of the detrimental outcomes, is a highly reinforcing act for students (Tulane et al., 2017). Students check devices regularly in a way considered analogous with individuals with compulsive or addictive behaviors (Lee et al., 2017). As aforementioned, researchers have coined the term "nomophobia" to describe the heightened anxiety, distress, and discomfort experienced in the absence of one's mobile device (Carels, 2019; Lee et al., 2017; Mendoza et al., 2018; Tams et al., 2018).

Along with the social concerns of mobile devices in schools, numerous reports show that significant loss in academic performance occurs when youth simultaneously interact with a device during lecture (Carels, 2019; Diamantes, 2010; Hachiya, 2017; Hayashi & Blessington, 2018; Hernan et al., 2018; Hernan et al., 2019; O'Bannon & Thomas, 2014; Tams et al., 2018; Thomas & Muñoz, 2016; Tulane et al., 2017). For example, studies have suggested that engaging with a device during a lecture results in losing course-related information and ultimately performing more poorly on exams (Froese, 2012; Lee et al., 2017; Shelton et al., 2009).

Given the benefits and drawbacks of mobile device use in schools, it is not surprising that students and teachers/administrators have vastly different perspectives about device use in the classroom. Students believe that they should be allowed to text during class (Tulane et al., 2017) and teachers should integrate mobile device use in the classroom (Thomas & Muñoz, 2016). They believe that the devices do not present interference with their academic performance, despite the research that states otherwise (Carels, 2019). Conversely, teachers overwhelmingly conveyed that mobile devices were an unnecessary distraction in the classroom and were largely utilized for non-academic purposes, and allowed for cheating, cyberbullying, viewing inappropriate content, and a general class disruption (Thomas & O'Bannon, 2014; Hernan et al., 2019). School administrators viewed student mobile device usage analogously with teachers and staff, with most supporting some implementation of mobile device restrictions in middle and high school settings (Tandon et al., 2020). It is clear that mobile device use within the K-12 classroom is an issue that has the potential to both support a student's education and hinder their social or academic performance. It is unknown as to how these devices will be used in future classrooms; however, it is unlikely that they will decrease in prevalence within the K-12 settings.

Summary and Future Impacts of Mobile Devices in ABA

Fifty years ago, it would be difficult to imagine our current world with the mobile technology that exists today. Throughout this chapter, we have attempted to show how mobile devices have rapidly impacted most facets of life. Mobile device usage has shown an accelerated trend in over the last 10 years, and the devices will most likely remain prevalent for the foreseeable future. As we look to the future, it is difficult to imagine a world without mobile devices. Given how these tools have become so intertwined in social and professional lives, further studying the best practices for utilization will continue to be important. Mobile devices have afforded practitioners (ABA clinicians, educators, and researchers) the opportunity to widen the horizons of practice and research through the use of apps, academic and behavioral monitoring, reinforcement, and video-based instruction. As noted in the chapter, mobile usage can have negative social, behavioral, and academic outcomes, which further heightens the importance of researchers finding methods that can reduce the potential harmful effects and accentuate the promise that mobile devices can produce. Mobile technology has the ability to change human behavior; therefore, we must continue to understand the behavioral mechanisms responsible for behavior change and the best utilization of this technology in the field of ABA.

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44 Teaching Musical Skills and Developing Music Therapy Interventions

Hayoung A. Lim

A behavioral view of the management of behavior in teaching musical skills has been and continues to be a dominant and influential paradigm in both music education and music performance. Despite a rich history and extensive empirical underpinnings, the behavioral perspective on teaching and management is not highly regarded in the music education and performance community. Moreover, behavioral research in music seems to be misunderstood and behavioral strategies have been implemented incorrectly or inconsistently in teaching music. Despite the discordance of the practice of behavioral management in teaching music, the behavioral view remains a frequent theme in the literature on music education, preparedness of musicians, pedagogical approaches in music lessons, and music therapy. This chapter will provide some examples of solid applications of behavioral management strategies and modification techniques directed from Applied Behavior Analysis (ABA) methods used in teaching musical skills and therapeutic application of music.

Numerous studies have been contributed to augment the level of understanding for the application of the principles of behavioral psychology in music education (Sink, 2002). Most of these studies provide evidence of the efficacy in direct music instruction including systematic observation and teaching behavior techniques for the music student's attentiveness, attitude, and achievements (Sink, 2002). One of the compelling behavioral approaches in teaching music is direct music instruction with the three-step instructional sequence: the teacher presents a task, students respond to the task, and the teacher provides feedback to students in a manner that stresses positive learning experiences (Madsen & Madsen, 1981; Sink, 2002; Yarbrough & Price, 1981). These three sequences in direct music instruction can be understood and demonstrated within ABA functional analysis. In teaching musical skills, task presentation is the antecedent; learning musical skills is the behavior; and the teacher's feedback is the consequence. Therefore, this chapter focuses on musical task presentation using behavioral development techniques including imitation, shaping, and chaining. Teacher feedback while teaching musical skills based on four basic behavioral operations such as positive reinforcement, negative reinforcement, extinction, and punishment with an aversive will be discussed.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_44

Developing Musical Skills

Teaching musical skills is directly involved in developing new behaviors in learners. Developing new musical behaviors by learning musical skills can be achieved by imitation, modeling, behavioral shaping, and behavioral chains.

Imitation

The process of acquiring new musical skills through imitation is evident in any music lesson since imitation is the essential process for demonstration and explanation of the necessary skills.

Imitative musical behaviors are acquired and maintained like other operant behaviors within the following three environmental arrangements: (1) a model is presented as the most optimal antecedent stimulus that is topographically identical to the behavior the student wants imitated; (2) the imitated behavior is promptly emitted after the model within a designated response interval; and (3) the imitative behavior produced by the student is reinforced (Cooper et al., 2020). In teaching music, the teacher naturally provides imitative models and demonstrates the target behaviors. These models can include the actual demonstrations such as the teacher's movements (e.g., playing the instrument with a certain fingering or changing a posture) or desirable sounds. Models can be planned or unplanned; however, an imitative behavior by the student should immediately follow a model's demonstrating behavior.

The purpose of using imitation in teaching music is for the student to obtain similarity between the teacher providing a model and the individual emitting imitation. The instructor should reinforce the imitative behavior that is similar to the model. Once the student has perceived the similarity between his/her imitative behavior and that of the instructor, the student's self-efficacy might reinforce further imitations. A model with prestige, confidence, and instruction will increase the imitative behaviors in the learner (Cooper et al., 2020).

Modeling

Modeling is a behavior change strategy in which learners acquire new skills by imitating skill demonstrations of live or symbolic models (Cooper et al., 2020). Since online teaching and virtual music lessons have become inevitable, video modeling has captured a high level of attention from music instructors and teachers. In online music lessons, video modeling is a major teaching technique that involves the teacher's demonstration of desired behaviors (e.g., correct finger numbers, handling instrument, posture, movements, facial expression, musical pattern production, and sound production) through video presentation (on screen) of the behavior.

Through online music lessons, not only is video modeling possible but so is video self-modeling given common virtual platforms (e.g., Zoom, FaceTime, Skype). Video self-modeling is a specific application of video modeling that allows the student to analyze the multistep procedures embedded within complex target behaviors by observing themselves successfully performing a behavior (Cooper et al., 2020). Video modeling can be used to introduce new musical skills, correct a problematic behavior or habit, and provide feedback. Video self-modeling can be used to acquire the desired musical skills by practicing and rehearsing the newly learned behaviors to perform music. Recording and replaying performances is useful to master the respective musical skill sets because it allows for modeling and self-modeling of a particular musical skill or a set of behavioral sequences.

Behavioral Shaping

Shaping, or behavior shaping, is a variant of the operant conditioning paradigm used primarily in the experimental analysis of behavior. This method uses differential reinforcement of successive approximations—a gradual, behavior modification technique in which successive approximations to the desired behavior are rewarded. Instead of waiting for a student to exhibit a desired behavior, any behavior leading to the target behavior is rewarded. The process of establishing a behavior that is not learned or performed by an individual at present is referred to as *shaping*. Shaping can also be defined as the procedure that involves reinforcing behaviors that are closer to the target behavior, otherwise known as successive approximations (Cooper et al., 2020). Figure 44.1 provides an example of behavioral shaping in teaching music illustrated by multiple steps that differentially reinforce the performance of a new piece of music on the piano.

Musical behavior shaping is defined as the differential reinforcement of successive approximation toward a terminal behavior such as mastering/performing an entire piece of music. If the final behavior is performing "*Fur Elise*" by Beethoven, the necessary prerequisites include reading every note, playing keys (on the piano) with the assigned finger numbers for both hands, following every dynamic and incidental marking/sign, and musical expression.

Each of these behaviors would be differentially reinforced to achieve a successful performance of the piece. Performing music is a higher-order member of a response in which the form of the behavior is the same. However, the intensity (amount or duration of the behavior) is not equal and multiple layers of responses occur simultaneously. Behavior shaping is considered to be a positive approach when teaching new musical skills. Reinforcement is delivered consistently upon the occurrence of successive approximations to the desired musical behaviors including producing the correct pitch/intonation and rhythm, keeping a consistent tempo, and

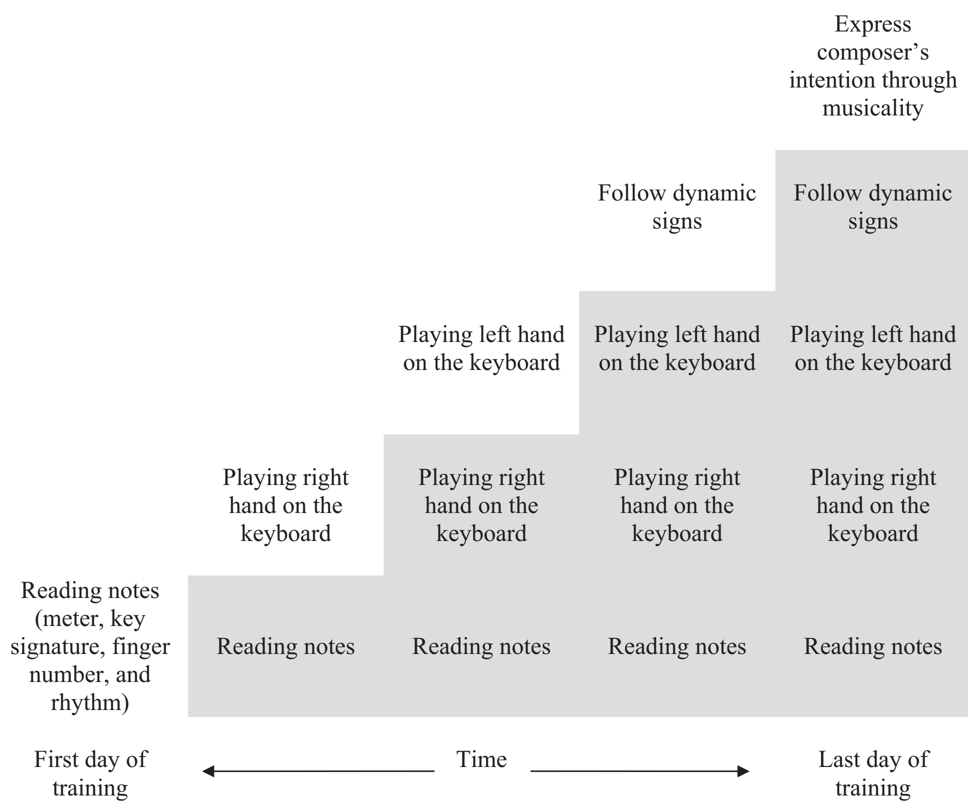

Fig. 44.1 Behavioral shaping with differential reinforcement in a piano lesson

expressing every assigned dynamic. Punishment or other aversive procedures are not involved in teaching musical skills by shaping. Behavioral shaping in musical skill development should be systematically and gradually implemented, and the end goal should always be fully anticipated and achieved.

Teaching how to perform a musical instrument with behavioral shaping is time consuming. Both teacher and learner must be prepared for the possibility of an extended training duration before the final goal is achieved. In addition, the teacher should consistently monitor the student's progress because the student does not always proceed from one skill to the next in a continuous, uninterrupted flow for a linear progress (Cooper et al., 2020). As the student masters each step, the teacher should inform the student that he/she must now advance to the next objective to receive a positive reinforcement. If the jump between two steps is too difficult, then the teacher must break down the steps even further into smaller increments. It is recommended that the teacher clearly indicates and demonstrates the expectations. Furthermore, the teacher should check if the student has acknowledged and agreed to the level of expectation for every behavior, including the terminal behavior. The criterion for a successful performance should be specified. The teacher must determine the concrete and specific expectation for the terminal behavior (i.e., performing the musical piece) before it can be considered learned. A rubric for the end goal will be helpful.

When the student performs the entire piece, it is necessary to continue to reinforce the performance until the criterion for success is achieved and a maintenance schedule of reinforcement is established. Performing for a recital or concert will be the further reinforcement when the final goal is for the student to demonstrate the piece. Continuous reinforcement will improve the performance quality and the individual's musicality as generalization of a new musical skill. An example of rubric and procedure for behavioral shaping in teaching music is presented in Table 44.1.

Table 44.1 Behavioral shaping in teaching music rubric and procedure

Example of rubric for terminal behavior	How to use shaping in teaching music
1. Identify the key signature and meter of the piece 2. Read the notes correctly by playing the accurate intonations (pitches) and rhythmic figures 3. Keep the indicated tempo from the beginning of the piece to the end 4. Follow every dynamic marking/sign (i.e., *crescendo*, *decrescendo*, *ff*, *mp*), incidental signs (sharps, flats, etc.), and tempo change marks (i.e., *retardando*, *rubato*, *molto*) 5. Express the composer's indicated intention with personal musicality 6. Play the entire piece by memory 7. Perform the piece for any audience	1. Identify a desired behavior for the student 2. Determine the final goal 3. Identify the student's current level of performance in displaying the desired behavior 4. List the steps that will eventually take the student from his/her current level of performance to the final desired behavior.*These levels of skill should be progressively more demanding, and the complexity of step should be increased 5. Tell the student that s/he must accomplish step 1 to receive the positive reinforcement 6. Once the student has mastered a specified musical skill, require that s/he demonstrate the next level of skill to receive a positive reinforcement

Behavioral Chains

Acquiring musical skills, such as playing a musical instrument, performing songs from a Broadway musical, and composing a song, consists of multiple tasks and requires sequential responses. A particular behavior modification method called *behavior chains* might be beneficial when teaching these musical skills.

A behavior chain involves the performance of a specific series of discrete responses. The performance of each behavior in the sequence changes the environment to produce a conditioned reinforcement for the preceding response while also serving as a stimulus for the next response. In addition, the behaviors must be performed in the correct order, preferably in close temporal succession to one another (Cooper et al., 2020). These parameters indicate that a musical behavior can be categorized as a behavior chain. Furthermore, in music, these behaviors are linked together beginning with the first behavior in the sequence; it fits for *forward chaining*. In forward chaining, the behaviors identified in the task analysis are taught in their naturally occurring order (Cooper et al., 2020).

A behavior chain in music can be defined as a specific sequence of musical responses, each associated with perceiving and producing a musical pattern (e.g., rhythm, tempo, meter, pitch, interval, key, scale, harmony, chord progression, dynamic, timbre, form, instrumentation). Each discrete response and its associated musical pattern (stimulus condition) serve as an individual component of the chain. When individual components are linked together, the result is a behavior chain, which is the complete production of musical patterns. In a chain, the stimulus conditions (i.e., the discriminative musical patterns and the musical sound as conditioned reinforcers) operate so that each musical response (i.e., sound or musical notation) produces a conditioned reinforcer that simultaneously serves as a discriminative stimulus for the next response (i.e., next notes, rhythm figures, chord progression). The complete chain will be a musical product and/or performance of a piece of music.

Furthermore, this chaining technique is commonly used when the teacher breaks down a sequence of events into smaller parts. Chaining can provide both perceptual and behavioral tools by which a series of discrete behaviors can be combined to form a more complex series of responses that occasion the delivery of positive reinforcement (Cooper et al., 2020). Chaining is a procedure that can be used to add behaviors to an existing behavior repertoire. When teaching music, this element of the chaining technique is fully utilized. For instance, a music teacher may begin his/her lesson by teaching a student how to hold an instrument (e.g., violin, clarinet) through a series of simplified sequential steps. In this way, the chaining procedure enables simple behaviors such as holding a violin to be combined into a longer/multiple series of complex responses such as playing a G major scale on the violin. The music teacher could also use a chaining procedure to increase the number of measures or lines on a music sheet that must be performed before reinforcement is delivered. The completion of a musical piece can be the ultimate positive reinforcement.

When practicing the chaining procedure in teaching various musical skills, it is recommended that the teacher analyzes and organizes the multiple components of the targeted musical and behavioral sequence in the lesson plan. Behavior chains can be established by task analysis. Task analysis involves the breaking of a complex skill or series of behaviors into smaller, teachable units (Cooper et al., 2020). Task analysis can be used to correct and/or modify a specific musical behavior during the lesson. For example, when the student repeats the same mistakes in specific bowings for a very challenging section of a violin sonata, the teacher can implement a task analysis in which (1) the student moves the right arm without the violin in upward and downward bowing strokes; (2) the student speaks or sings the rhythmic and melodic pattern (i.e., solfège) while moving his/her arm in bowing strokes; (3) the student picks up the bow and plays each bow stroke in a very slow tempo on the open strings; (4) the student plays the same part with a slightly increased tempo on the open strings; and (5) the student plays the musical phrase by combining the corrected bowings and the melodic intonations with the left hand. The teacher should determine the sequence of critical behaviors that the student must perform to complete each assigned task efficiently and successfully.

Behavioral Modification in Teaching Musical Skills

Teacher Feedback Using Behavioral Modification Techniques

The teacher's feedback can greatly improve the student's musical skills. High approval reinforcement from the teacher improves student attention and achievement in learning music. Half a century ago, Madsen and Madsen (1972) reported that students achieved significantly more accurate intonation in choir performance when contingent reinforcement was used rather than when the teacher refrained from providing reinforcement. Since then, a large body of literature pertaining to the behavioral approach in teaching music has supported the theory that teacher feedback characterized as high approval reinforcement improves the student's attention, learning attitude, direction following, endurance, on-task behaviors, and performance (Sink, 2002). However, several music educators who researched and practiced the behavioral approach reported that most music teachers do not effectively deliver contingent reinforcements as feedback nor properly practice the behavioral modification techniques (Madsen & Duke, 1985; Sink, 2002). Given the prevalence of behavioral topics in professional literature and courses of music education and music therapy, it is imperative that teachers, practitioners, and researchers take a logical and empirical approach to understand the behavioral view of teaching music and utilizing musical experiences for behavioral modification. It would seem important to fully understand what behavioral modification methods should be implemented for teaching musical skills.

Behavior modification in teaching music relies on the concept of operant conditioning, which is a form of learning, and involves using a system of rewards and/or punishments. In behavior modification, certain musical behaviors can be learned and unlearned. Many different techniques can be implemented to either elicit a behavior or stop it. The purpose of using behavior modification in teaching musical skills is to improve target behaviors of performance or production of music by changing the behavior. This can be accomplished through various methods including positive reinforcement, negative reinforcement, extinction, and punishment.

Positive Reinforcement

Positive reinforcement is pairing a positive stimulus to a behavior. A good example of this is when a cello teacher rewards the student for using the correct fingering shift from the first position to the fourth position. The reward can be a positive stimulus like praise, a sticker, or moving to the next page/piece. Positive reinforcements will increase the hours of practice, level of attention during lessons, and quality of musical performance.

Negative Reinforcement

Negative reinforcement is the opposite of positive reinforcement and it is the increase in a behavior due to the removal of a stimulus. In a piano lesson, if the student plays the entire musical piece without any error, he/she will not have the weekly music theory homework. Removing a less-preferred musical task might increase the hours of practice, level of concentration when playing the piece, and quality of musical performance.

Extinction

Extinction is the removal of all reinforcements that might be associated with a behavior. This is a powerful management tool for teachers and works especially well with young children (Landrum & Kauffman, 2006). There are many different styles of music and techniques in playing instruments. After a piano student practiced for many weeks and successfully performed a piece composed in a slow ballad form with *legato* style of expression (i.e., notes in each phrase are connected), the teacher gave the student well-deserved verbal praise and the student's favorite CD as a reward (i.e., positive reinforcement). In the next piano lesson, the teacher introduced a different style of music in a fast *scherzo* (a vigorous, light, or playful composition) form with *staccato* technique (i.e., performed with each note sharply detached or separated from the others). However, the student played the piece with *legato* style in a slower tempo. The teacher needs to use the extinction method as the proper form of feedback in this situation and they should not reinforce the student's legato style of playing.

Extinction is often referred to as *planned ignoring* and is used to decrease negative or undesirable behaviors that have been previously maintained by a reinforcer (Landrum & Kauffman, 2006). If the student played the new piece with a *staccato* technique in a correct tempo and expression, the teacher should reinforce this new behavior. This process involves providing a reinforcer contingent upon a desired response (i.e., playing *staccato* in a fast tempo) and withholding the reinforcer when the response is not occurring or when an undesired response is displayed (i.e., playing *legato* in slow tempo). In the preceding example, the piano teacher would respond positively to the student playing the appropriate style for the new piece and give feedback such as “your staccato has improved and I can hear the strong beat of every note in this page,” while ignoring any legato style of playing the student learned from the previous piece.

Punishment

Punishment is a basic principle of learning and is particularly designed to diminish behaviors by pairing an unpleasant stimulus to a behavior. Learning from consequences that produce pain, discomfort, or the loss of reinforcers has constructive value for the students (Cooper et al., 2020). Punishment can be used in teaching necessary musical skills. For example, the teacher observes significant errors in intonation when their voice student sings his/her favorite song during the lesson. The teacher discovered that the student incorrectly read the score, skipped the sight-reading exercise, and did not use solfege while practicing on their own. The consequences of poor performance during the lesson might be eliminating the student’s favorite song until he/she corrects errors in intonation (i.e., negative punishment) and singing extra scales or vocal exercises with only solfège for the rest of the lessons (i.e., positive punishment). Punishment used in teaching music can eventually increase/improve the terminal target behaviors. The vocal student’s intensive training with vocal exercises that include solfège will improve his/her performance of the favorite song with less error in intonation.

Use of Music in Reinforcement

Reinforcement in Teaching Music

Positive reinforcement functions as a way to increase or maintain a desirable behavior. However, teachers must use an appropriate reinforcer, one that is truly reinforcing and motivating for the student and reinforces the student immediately after the student exhibits the target behavior (Adamek & Darrow, 2018). In teaching music, reinforcers might be social (e.g., praise, a pat on the back), tangible (e.g., a star on their paper, a sticker, a prize), or activity-related (e.g., extra music time, free time). Reinforcement in a music classroom and/or music lesson must be immediate, continuous, and consistent when the appropriate musical skills (behaviors) are being produced (Adamek & Darrow, 2018). Praise is frequently used as a positive reinforcement to improve the student’s musical skills. Praise from a teacher’s detailed or intense response to a student’s behavior consists of high approval and feedback for a particular response or behavior. Therefore, praise in teaching musical skills should have the qualities of contingency, specificity, sincerity, variety, and credibility (Adamek & Darrow, 2018). After the positive reinforcement has been implemented, teachers should evaluate the efficacy of their task presentation and instruction for the target behavior pertaining to the reinforcement.

Use of Music for Reinforcement

Music is highly effective as a contingent factor for either increasing desirable behavior or reducing undesirable behavior. Early educators found music to be a reinforcing, valuable tool to facilitate learning and strengthen the student’s achievement (McDowell, 2010). Standley (1996) conducted a meta-analysis on the effects of music as reinforcement for educational/therapeutic objectives. The study reported that the contingent music was more effective than contingent nonmusical stimuli used in these studies and more effective than continuous music. Pairing other stimuli (e.g., food, approval, or visual stimulation) with the music decreased its effectiveness as a reinforcer. Music interruption is more effective than music initiation as the procedure for establishing the contingency and immediate initiation of the music is more effective than delayed initiation. Uniquely, music functioned simultaneously as a reinforcer and the subject matter. There was also evidence of generalized benefit to other academic and social behaviors that were measured but were not contingently reinforced with music (Standley, 1996).

The most frequent use of contingent music has occurred in the field of education (Adamek & Darrow, 2018; Byo & Sims, 2015; Standley, 1996). In regular school classrooms, music in various forms of delivery has reinforced other academic achievements, particularly reading and math skills. Forms of music deliver may include listening to preferred pieces, individual music lessons, group ensembles/choir, and/or musical games (Lim et al., 2014). Piro and Ortiz (2009) reported that students who received piano lessons had significantly higher vocabulary and verbal sequencing scores than students who did not receive piano lessons. Several meta-analyses of music education have shown that carefully designed music instructions can have a positive impact on cognitive development and academic performance of children (Lim et al., 2014; Portowitz et al., 2009).

Jellison and her colleagues (1984) indicated that the frequent positive social interactions among children with and without disabilities in the inclusive music classroom are dependent upon the degree to which the teaching method structures antecedents and reinforcement for these instructions. The research findings suggest that music lessons also serve as a reward for successful completion of academic tasks; contingent music functions as a "social agent" for interactions in a small group of music class (Jellison et al., 1984). Thirty-two at-risk elementary school students were randomly assigned to 10 weeks of 30-minute one-to-one training conditions (piano lesson, music therapy, and no-training). No significant difference between the training conditions was found on the pre-post comparisons of academic achievement (Lim et al., 2014). However, behavioral observations of both piano lessons and music therapy instructors indicated the positive impact of training conditions on social and emotional variables: increased assertiveness when singing and playing self-composed songs, increased smiling and verbalizations pertaining to musical tasks as lessons progressed, decreased resistance and increased initiative in learning more songs than were required, increased positive self-statements and desire to perform for others, pride taken in songs learned, improved walking and sitting posture, and increased volume of speech (Lim et al., 2014).

Classroom teachers might use music-related reinforcement to motivate students to complete academic works and improve the learning environment. A primary criticism of reinforcement for education endeavors has been the contentions that reinforcement reduces intrinsic motivation including self-engagement, self-efficacy, and enjoyment of the activity itself (Cooper et al., 2020; Maehr et al., 2002; Standley, 1996). Since student motivation is a critical factor in academic and social-emotional learning, establishing a positive contingent reinforcement that might improve intrinsic motivation is essential. Music enhances a student's motivation to learn and improves self-esteem by making their learning experience more positive (Costa-Giomo, 2004; Lim et al., 2014).

Motivation in Music Reinforcement

The understanding of motivation is concerned with observable behaviors that reflect engagement in a particular activity (Maehr et al., 2002). Teaching children any desirable skill begins with the teacher encouraging cooperation with the child's current level of motivation. For example, if the child wants to watch a video, the instructor might use that motivation along with the reinforcement of turning on the video to establish target behaviors. The desired training relationship is established when the instructor is consistently associated (paired) with the delivery of reinforcing items and events to the child (Lim, 2010;

Sundberg & Partington, 1998). Musical activities such as playing the preferred instrument or listening to a favorite piece of music might be optimally paired with reinforcements for establishing the desired musical skill.

The most fundamental principle of the ABA approach is to select and use the effective reinforcer for every trial in the training with high-preference stimuli being the most effective (Lim, 2010). Music stimuli can be the most effective reinforcement for desired musical behaviors. Music can function as an establishing operation (EO) in the ABA-incorporated music classes. Various musical experiences can provide students with effective motivational variables (i.e., EO) for many musical skills. Musical stimuli within the musical instrument(s) including sounds, movements, notations, and instruction can motivate students to produce better musical responses such as creating desirable musical sounds, practicing target musical skills, and performing pieces. Furthermore, the motivational variables established in such musical experiences result in improved self-efficacy, attributions, goals, values, and interest when facilitating learning and achievement (Byo & Sims, 2015; Lim, 2010; Maehr et al., 2002).

Maehr and his colleagues (2002) demonstrated four behavioral indicators (action patterns) of motivation in student learning that might address why music students want to achieve greater musical skills: choice and preference, intensity, persistence, and quality of engagement. Music functions as an EO, which is the motivational variable, in each behavioral indicator. Some examples include: a student who chooses to practice the piano instead of playing video games (choice and preference), or focuses all of their attention on practicing a difficult passage in his/her favorite piece (intensity), or continues to practice the cello solo after the orchestra rehearsal ends (persistence), or analyzes a piece that is difficult to play, and works on those passages until he/she can play up to the tempo (quality of engagement).

Music can also function as an automatic reinforcement. Skinner (1957) used the term *automatic reinforcement* to indicate that the reinforcement occurred without manipulating or demeaning the learner. Automatic reinforcement involves a strengthening effect that occurs due to an antecedent pairing of a neutral stimulus with the established form of reinforcement. Such reinforcement is a result of pairing what the student needs to learn with what he/she wants as reinforcement. The behavior that is paired with reinforcement becomes a target behavior for further training. An example of the application of music as an automatic reinforcement procedure is pairing singing with playing a drum. This pairing might increase vocal behavior in a child who particularly likes the drum. Since playing instruments can become a strong reinforcer for the child, singing (vocal/verbal behavior) then becomes reinforcing (Lim, 2010). Musical training should be enjoyable for the student and paired with musical automatic reinforcement for further development of musical skills.

Musical automatic reinforcement is also used to develop non-musical behaviors in therapeutic settings. If the target behavior is sitting on a chair for a certain duration and the therapeutic goal is to increase attention span, playing the individual's preferred instrument can function as the automatic reinforcement. Playing the instrument can be established as contingent reinforcement for further target behaviors such as completion of a task. If the target behavior is upper body movement exercise for a patient who had a stroke (cerebrovascular accident [CVA]) and the therapeutic goal is to increase endurance and range of motion in the upper body, playing a drum with a mallet in a physical rehabilitation setting will function as the automatic reinforcement. The musical experience can be inherently enjoyable for individuals and, therefore, can automatically reinforce further musical and non-musical behaviors.

Behavioral Modification in Music Therapy

Music has been used to change an individual's behavior throughout history; music therapy is defined as the systematic use of music or musical experiences to make positive changes in particular non-musical human behavior. The music therapy profession has adopted behavioral modification techniques since the infancy of the therapeutic application of behavioral principles (Standley et al., 2004). The effective application of the behavioral approach in music therapy identifies the functions of music as a cue, time and body movement structure, focus of attention, and reward. The correct adaptation and utilization of the behavioral approach in music therapy requires a solid understanding of the behavioral principles, ability to analyze the treatment procedures, and extensive training of clinical implications (Standley et al., 2004).

ABA is often used in music therapy because ABA approaches and procedures have been validated through scientific research and clinical practice in educational and clinical settings (Standley et al., 2004). The common behavior modification techniques pertaining to ABA methods including positive/negative reinforcement of target behaviors, punishment and extinction of undesirable behaviors, token economies to strengthen socially adaptive behaviors, and shaping are frequently used in music therapy (Davis et al., 2008). Behavior modification techniques such as reinforcement and shaping can be particularly easy to integrate into music therapy sessions by music therapists to help clients engage and participate successfully in the therapy sessions (Davis et al., 2008). Other behavioral operant techniques include task analysis, prompting, errorless learning and chaining, The Premack Principle, modeling, generalized conditioned reinforcer, group contingencies, time out, overcorrection, and negative practices. These techniques establish an environmental antecedent event that will teach new behaviors and encourage appropriate behavioral responses (Standley et al., 2004).

The behavioral approach to music therapy is defined as the use of music in association with the therapist to change undesirable patterns of non-musical behavior into more desirable behavior. For instance, music can be used to help a child who frequently screams in the classroom to find more constructive ways of interacting and communicating with others. Standley's meta-analysis on the effects of music as reinforcement for educational and therapeutic objectives indicated that contingent music reinforced overt non-musical behaviors of patients with comatose, decreased crying of infants with colic syndrome, improved neck strength and head posture of individuals with neurologic impairments, and reduced headache pain through biofeedback (Standley, 1996). Procedures derived from behavioral therapy, such as ABA, have been used to assess and treat a wide range of clinical populations (Davis et al., 2008). The final section of this chapter will demonstrate how ABA can be incorporated within music therapy for major clinical entities including children with developmental disorders, individuals with psychiatric disorders, and patients with physical disabilities and neurologic disorders.

Music Therapy for Developmental Disorders: Special Education

During the early history of music education in the United States, music was an important part of the school curriculum for students with disabilities (McDowell, 2010). Music educators today find themselves teaching special learners with far greater needs and more severe disabilities than in years past. Music teachers make adaptations in curriculum, classroom activities, and materials for students with special needs; music therapists become actively involved in education and therapy for students with special needs. The music therapist may work individually with a student who has music therapy listed as a related service on their individualized education program (IEP) to help that student make progress toward various therapeutic goals and objectives.

In special education, contingent music has been used to increase self-feeding skills for children with cerebral palsy; decrease habitual regurgitation or disruptive behaviors for children with autism spectrum disorder (ASD); decrease off-task behaviors for children with learning disabilities; and increase appropriate social behaviors in the classroom such as eye contact, following directions, and imitation in children with attention deficit hyperactivity disorder (ADHD) (Standley, 1996; Standley & Jones, 2007). Music can be used to teach spelling for children with specific learning disabilities. For example, a melody (pitch and rhythm) is attached to "teacher, teacher, T, E, A, C, H, E, R," which the children are prompted to sing before the spelling test. The student gets to play the ukulele if they memorize the correct spelling by singing. Other behavioral modification techniques including approving/disapproving, prompting, task analysis, evaluating, chaining, fading, ignoring, and modeling have been used along with the positive reinforcement of music to change the children's behaviors in music therapy sessions (Standley & Jones, 2007). Table 44.2 indicates examples of musical activities and corresponding ABA techniques for target behaviors of common developmental disabilities.

Lim and Draper (2011) compared a common form of Applied Behavior Analysis–Verbal Behavior (ABA-VB) approach and music incorporated with ABA-VB method as part of developmental speech-language training in the speech production of children with autism spectrum disorder (ASD). This study explored how the perception of musical patterns incorporated in ABA-VB operants (mand, tact, echoic, and intraverbal) impacted the production of speech in children with ASD. Participants included 22 children with ASD between the age of 3 and 5 years who were verbal or pre-verbal with presence of immediate echolalia. Every child was randomly assigned a set of target words for each of the three training conditions: (1) music- incorporated ABA-VB, (2) speech (ABA-VB), and (3) no-training. Results showed how both music and speech trainings were effective for production of the four ABA verbal operants. However, the

Table 44.2 ABA techniques incorporated in music therapy for children with developmental disabilities

Disability	Target behavior	Use of music	ABA techniques
ASD	Verbalize vocabulary	Singing	Mand; tact; modeling; imitation; intra-verbal
	Increase joint attention	Listening to preferred music	Contingent reinforcement
	Decrease inappropriate, stereotypical mannerisms	Playing instruments in an ensemble	Prompting; ignoring
ID	Follow specific directions	Movement to music	Chaining; modeling; prompting; task analysis
	Increase socially appropriate manners	Choral performance	Modeling; prompting; fading
	Recall-procedural memory	Playing color-coded chords on the guitar	Automatic reinforcement; modeling; prompting
Hearing impaired	Use signs	Signing to recorded song with repeated words	Chaining; modeling; prompting
	Read musical notes/rhythms	Written measures of rhythm patterns	Chaining; modeling; prompting
Visually impaired	Indicate body parts	Actions songs with body parts	Chaining; prompting
	Practice grooming skills	Newly composed song with instructions	Prompting
SLD	Improve spelling	Newly composed songs with spelling	Task analysis; prompting Automatic reinforcement
	Improve reading	Melody adapted from familiar song	Chaining; prompting Automatic reinforcement
Behavior disorders	Follow rules	Complex rhythm production	Automatic reinforcement Chaining
	Reduce inappropriate behavior	Client selected music	Contingent reinforcement Prompting

ASD autism spectrum disorder; *ID* intellectual disability; *SLD* specific learning disability difference between music and speech training was not statistically significant. Results also indicated that music-incorporated ABA-VB training was most effective in echoic production, and speech training was most effective in tact production. Music can be incorporated into the ABA-VB training method, and musical stimuli can be used as successfully as ABA-VB speech training to enhance the functional verbal production in children with ASD (Lim & Draper, 2011).

Music Therapy for Psychiatric Disorders: Mental Health

Applied Behavior Analysis is one of the main approaches in contemporary behavior therapy for individuals with mental illness and it has been responsive to advances in experimental psychology and innovations in clinical practice. Since music functions as both a stimuli and response and musical behavior, music can provide essential therapeutic elements in ABA therapy. Therefore, the application of music in behavioral therapy can be justified because the perception of musical stimulus properties is not an end in itself but leads to transferable responses that can be meaningful determinants of musical behavior (Unkefer & Thaut, 2002).

The fundamental aim of behavioral music therapy for an individual with mental illness might be to create an environment in which positive, desirable behaviors are rewarded and negative/disruptive behaviors are reduced by eliminating reinforcement of those negative actions. Consequently, the music therapist should not only analyze and evaluate the client's present behaviors but also manipulate music (the essential form of communication) because music functions as an engaging and rewarding sensory stimulation and is used as a contingent reinforcement to encourage the desired target behaviors or to eliminate the negative behaviors.

Problem behaviors are identified and documented during the music therapy assessment based on the antecedent and the extent to which they occur. During the music therapy assessment, the client's musical preference and positive musical responses should be noted because they will be used as a primary reinforcement. Finding a reinforcement that is truly meaningful to the individual client with a psychiatric disorder is an essential procedure of music therapy. One of the special tools that music therapists use for reinforcement is music, because well-designed music interventions that include the client-preferred music experiences (e.g., music listening, playing musical instruments, singing, song writing) can be gratifying and used as a reward to help change behavior in the desired direction (Davis et al., 2008). Unkefer and Thaut (2002) classified the taxonomy of programs and techniques in music therapy for mental disorders and the application of music in treatments for individuals with mental disorders. Table 44.3 exhibits the taxonomy, which includes music performing, music psychotherapy, music and movement, music combined with other expressive arts, recreational music, and music and relaxation.

In music therapy, music, often referred to as the "language of emotions," becomes a significant tool for emotional experience and expression (Davis et al., 2008; Unkefer & Thaut, 2002). Music enhances non-verbal expression; therefore, it facilitates communication between therapists and clients. Through the music-making experience, the individual with emotional problems can increase their sense of mastery, sense of reality, sense of control over his/her own reactions, and sense of self-esteem. Standley (1996) indicated that individuals with mental disabilities demonstrated greater benefits from music contingencies than individuals with medical/physical impairments. If the music therapist has been successful in establishing a positive therapeutic relationship with the client with mental illness, the interventions designed with pleasant musical experiences and operated with positive musical reinforcements will result in beneficial therapeutic outcomes. Behavioral music therapy can be used to improve a wide variety of behaviors including interpersonal skills, anger manage-

Table 44.3 Taxonomy of programs and techniques in music therapy for behavior–emotional disorders

Programs	Music therapy techniques
Music performing	*Instrumental group improvisation*: A technique using musical instruments to provide experiences for socialization, communication, and expression of feelings and emotions among group participants *Instrumental performance ensemble*: A technique using the client's existing musical skills, as well as newly acquired skills, to form teaching and rehearsing performance groups on various musical instruments *Group singing therapy*: A technique using singing activities to provide experiences for socialization, communication, and expression of feelings and emotions among group participants *Vocal performance ensemble*: A technique using existing and newly acquired vocal music skills to provide experiences in cooperation among group participants through teaching and rehearsing *Individual instrumental instruction*: A technique focused on the acquisition of musical skills by an individual client on any one of a variety of musical instruments *Individual vocal instruction*: A technique using the private voice lesson to provide the client with an opportunity to develop and improve singing skills through a series of formalized appointments for instruction and planned periods of individual practice *Individual music improvisation/interaction*: A technique using musical instruments in individual therapy settings to provide a structured non-verbal mode for communication and expression of thoughts and feelings as well as reality- and sensory-ordered behavior patterns between clients and therapist

(continued)

Table 44.3 (continued)

Programs	Music therapy techniques
Music psychotherapy	*Supportive music group/individual therapy*: A technique using music activities as a starting point and catalysis for individual and group therapy processes *Interactive music group/individual therapy*: A technique using music and/or music activities as stimuli for initiating individual and group therapy processes *Catalytic music group/individual therapy*: A technique using music activities as the starting point and catalyst for individual and group therapy processes
Music and movement	*Movement awareness*: A technique using music and movement activities to encourage clients to interact and express themselves on an introductory level through body movement in a group setting *Movement exploration*: A technique using music stimuli and the elements of movement to explore and improve the client's body image and feelings of competence in moving effectively and comfortably *Movement interaction*: A technique using music and movement activities to provide the opportunity to experience social and emotional concepts in an affective, essentially non-verbal modality *Expressive movement*: A technique using music and movement activities to assist clients in becoming aware of feelings and emotions that are relevant to their personal functioning and coping abilities in daily life *Dance*: A technique using established and pre-structured dance forms, steps, and styles with music to encourage social interaction, self-confidence, and recreational skills *Music and exercise*: A technique using music to provide the temporal framework for adaptive physical exercise

(continued)

Table 44.3 (continued)

Programs	Music therapy techniques
Recreational music	*Music games*: A technique using music games to provide experiences in which human behavior can be acted out in play form, providing participants with an opportunity for emotional and social learning in a safe and predictable environment *Music appreciation awareness*: A technique using a variety of music stimuli to provide the experience of listening to, and at times creating and performing, music in group or on a one-to-one basis *Recreational music performance groups*: A technique providing diversional and success-oriented music experiences using instrumental and/or vocal media *Leisure time skill development*: A technique to emphasize music's role in a client's discharge planning and community follow-up
Music and relaxation	*Music with progressive muscle relaxation training*: A technique using music in conjunction with progressive muscle relaxation training in individual or group settings. *Music for surface relaxation*: A technique using music as a medium for temporary respite from anxiety/stress conditions in individual or group settings *Music imagery*: A technique that involves listening to music in a relaxed state to facilitate increased self-awareness, which in turn may facilitate psychological and physical relaxation *Music-centered relaxation*: A technique using music as a perceptual focus and stimulus for relaxation training
Music combined with other expressive arts	*Music and fine arts* (drawing, Drama, sculpting): A technique focused on combining music and fine arts to provide for expression of feelings and emotions among group participants or on a one-to-one basis *Music and writing* (poetry, prose): A technique focused on combining music and writing to provide experiences for expressions of feelings and cognitive responses among group participants on a one-to-one basis

Note: The author reorganized "Taxonomy of Programs and Techniques in Music Therapy for Mental Disorders" from *Music Therapy in the Treatment of Adults with Mental Disorders* by Unkefer and Thaut (2002)

ment, appropriate expression of emotion, communication skills, concentration, executive functioning skills, coping skills, and one's physical condition/relaxation. Other behavioral therapeutic techniques including approving/disapproving, ignoring, role playing, modeling, and teaching action steps have been used with the positive reinforcement of music to change the behaviors of individuals with mental illness in music therapy sessions (Standley & Jones, 2007).

Music Therapy for Neurologic Disorders: Rehabilitation

As interest and research in music's influence on brain function increase, a reciprocal relationship in musical behavior has been recognized. This relationship demonstrates that the brain that engages in music is also changed by engaging in music through reorganization of musical stimuli and production of new behaviors (i.e., neuroplasticity) (Thaut, 2005). The effect of music on brain structure and function as the non-musical therapeutic response has been studied for the fundamental mechanism of music therapy for individuals with neurologic disorders including strokes, Parkinson's disease, traumatic brain injuries (TBIs), and dementia. The therapeutic application of music necessitates a rational translation of a musical experience into a non-musical therapeutic experience including production of target behaviors. A scientific-empirical and theoretical understanding of music perception and production validates the application of music in treating individuals with neurologic disorders. This understanding determines music's physiological and psychological foundation as well as its influence on human behavior in producing non-musical target behaviors (Thaut, 2005).

In neurological rehabilitation, therapy should help prevent complications such as illness, muscle weakness, or contractures that can constrict the natural recovery process. Therapy also involves teaching adaptive strategies so that the patients can learn to use the unaffected parts of the body in place of the affected ones; it is directed at retraining the affected parts of the nervous system through specific exercise techniques (i.e., motor performance, speech, attention, and memory). Principles for the development of treatment techniques emphasize functional, task, and goal-oriented activities and exercises through the training of functional movements and behaviors in a highly repetitive, patterned, and rhythmic manner (Davis et al., 2008).

Neurologic music therapy might not directly utilize ABA methods and techniques in treating individuals with neurologic disorders. However, the rationale and logic for the use of music to enhance non-musical functions incorporates the concept of music as a mediating stimulus for the desired therapeutic response (Thaut, 2005). Music can engage behavior and mediate changes in behavior. The music response mediates between current behavior or brain function, the goals of therapy, and the desired therapeutic response. The mediating response in music is caused by the individual's perception of the intrinsic pattern in the music (i.e., tempo, rhythm, pitch, melody, chord progression, dynamics, instrumentation, and form) that has become linked to the music through some associative learning process (Thaut, 2005). Production of musical responses (i.e., emitting musical responses) evidenced by intact perception of those musical patterns (through musical experience) would be transformed into desirable non-musical behaviors as a therapeutic outcome.

According to a transformational design model (TDM), music therapy and music medicine require systematic procedures, such as treatment planning, implementation, and evaluation, for them to be functional for individual with neurologic disorders (Thaut, 2000). Treatment planning is the first step of practicing neurologic music therapy. Transformational design model (TDM) provides a system for music therapists to follow for planning music therapy interventions in their music therapy practice. TDM is designed for the systematic application of the knowledge of music therapy on clinical practice, which is based on the scientifically examined rationale for the use of music to enhance non-musical functions/behaviors. TDM suggests five steps of the planning processes: (1) Diagnostic and functional assessment of patients; (2) Development of therapeutic goals/objectives; (3) Design of functional, non-musical therapeutic exercises and stimuli; (4) Translation of step 3 into functional, therapeutic music experiences; and (5) Transfer of therapeutic learning to real-world applications. TDM for functional music therapy is presented in Table 44.4.

TDM provides a clear direction for each procedure in treatment planning. Each step in the model aims at one therapeutic purpose, which is enhancing a non-musical function that the client needs to improve. It is a goal-directed and client-

Table 44.4 Transformational design model (TDM) for functional music therapy

1. Diagnostic and functional assessment of patients
The first step is to gain information about the client. In the assessment, music therapists analyze the client's ability including current functions, needs, and problems. The result of the assessment should address the dysfunctions or deficits of the clients and guide the nature and scope of following treatment procedures. The most important part of the assessment is to know the client's current functioning levels and to determine the client's needs in detail *Assessment example*: The client is a 76-year-old Caucasian female who resides in a nursing home. She has been diagnosed with hand osteoarthritis. The music therapist observed stiffness and weakness of the client's wrist and finger movements. The client has also displayed insufficient wrist/finger movements and inefficient fine motor skills. She has complained about arthritic discomfort, but voluntarily participated in music therapy sessions focused on movement enhancement. Moreover, she has intact cognitive function and is able to follow simple motor tasks
2. Development of therapeutic goals/objectives
The second step is to determine therapeutic goals and objectives based on information from the assessment. A goal may be defined as a broad statement of the desired outcome of treatment. Objectives are more specific and short-term. Each objective should describe a small step in the process of achieving a final goal. A certain behavior that the client needs to enhance (the target behavior) must be stated in the objective. In addition, criteria (i.e., range, intensity, quality, and quantity) of the target behavior, a target date of achievement, and the termination date should be indicated to evaluate the achievement of the goal/objectives *Example goal*: To increase strength, stability, and pliability of the joints in the wrist and fingers *Example objective*: The client will complete 15 repetitions for each of the 5 different functional upper extremity (wrist and fingers) movements during one music therapy session by May 1, 2021
3. Design of functional, non-musical therapeutic exercises and stimuli

(continued)

Table 44.4 (continued)

The third step is to design therapeutic exercises and activities to implement, based on the established goals and objectives. The purpose of the step is to develop a therapeutic experience for enhancing the target behavior. Since the target behavior is non-musical, the initial treatment plan should be directly focused on the non-musical therapeutic experience rather than the musical experience. A benefit of planning non-musical therapeutic experiences lies in sharing the client's treatment procedures with other therapeutic disciplines. Facilitating common therapeutic experiences by aiming at the same clinical goal is critical for treating the client. Additionally, it justifies the music therapy treatment procedure as a clinical therapy discipline *Example of non-musical therapeutic exercise*: To improve strength, stability, and pliability of the joints in the wrist and fingers, the client needs to engage in the repetitive practice of using the muscles in movements. This practice needs to be completed at an appropriate pace and for an adequate duration of time
4. Translation of step 3 into functional, therapeutic music experiences
The fourth step is to translate functional and therapeutic exercises into music experiences. The functional exercises in music experiences should contain the common mechanisms of the non-musical therapeutic exercise developed in the previous step. The TDM defines these functional therapeutic music exercises as "isomorphic" to the non-musical therapeutic exercises. In this step, music therapists should determine precise musical elements to use in the functional exercises and choose effective music therapy protocols for the therapeutic experiences. The therapeutic application of music on non-musical functions is completed throughout this step. Music therapists should design the musical experiences based on the scientific logic that researchers have examined. Creativity, advanced musical analysis, and thoughtful consideration of the client's musical preference will facilitate the process of planning music therapy interventions *Example of music therapy protocols*: Wrist flexion and extension (raise and lower) with a song in a ¾ meter (30 measures) at a moderato tempo. The tempo of this sing will determine the pace and number of the wrist movements. The meter will provide the temporal cuing (timing) for the movements. The rhythmic cuing by a specific accompanying pattern will indicate the initiating point of each movement and enhance the patterned/efficient muscle control
5. Transfer of therapeutic learning to real-world applications
The fifth step is to finalize music therapy treatment procedures. In this step, the client completes the target behavior in the therapeutic/clinical situations and starts to apply the practiced function in the real-life situations. In this step, the effect of the music therapy treatment should be evaluated by the client and the therapist and certain processes should be modified for further treatments *Example of transferring of therapeutic learning to real-world applications*: The client tries to push a large button on the table

Note: The author reorganized the five steps of TDM from *A Scientific Model of Music in Therapy and Medicine* by Thaut (2000)

centered model for the application of music in rehabilitation. TDM assists music therapists to adapt common therapeutic mechanisms, including ABA, that are frequently used by other therapeutic disciplines. The third step of TDM is to design functional, non-musical therapeutic exercises and stimuli. It is an excellent approach to demonstrate that music therapy treatment can share common therapeutic goals and mechanisms with other science-based, non-musical therapeutic modalities (Thaut, 2000).

Conclusion

There has been dynamic growth in behavioral music therapy and development of diverse techniques over the past 60 years. An examination of contemporary literature serves to indicate the continued prominence of behaviorism in music therapy practice and reveals the beneficial application of music in treatments for various clinical populations. The theoretical underpinnings and empirical evidences of the behavior music therapy approach conclude that music can be used as an antecedent, temporal stimuli for brain function (movement, speech, cognitive and affective domains), behavioral momentum, establishing operation, and reinforcement. The effective application of music in ABA requires a solid understanding of the principles of behavior, refined training for behavior observation and analysis, and extensive creativity in designing intervention procedures. However, because of the promising outcomes and benefits of ABA incorporated in music therapy, it is worthwhile to explore and examine the application of music in treatments for individuals in need due to developmental disorders (ASD, ID, speech-language impairment, etc.), physical disabilities, emotional and behavior disorders (mental illness), and neurologic disorders (CVA, Parkinson's disease, TBI, Alzheimer's disease, and dementia). Further research will allow music therapists and music educators to investigate and determine the extended range of the application of music in the field of ABA for various behavior functions. Teaching musical skills and using musical stimuli for non-musical therapeutic responses indicate the efforts to expand the field of ABA.

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45 Behavior Analysis and Sports Performance

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Behavior Analysis and Sports Performance

One of the most important features of applied behavior analysis (ABA) is that the science targets behavior deemed important by society (Baer et al., 1968). This is a slightly different aim than a pure scientific approach as it allows us to take the established science of behavior and demonstrate its significance to everyone. ABA researchers have focused on numerous target behaviors deemed important to society and sports is one of those behaviors.

Engaging in and viewing sports is a ubiquitous activity that has been a celebrated part of society for nearly all of written history. Not only will nearly all people participate in sporting activities during their life (even as simple as throwing a Frisbee), but also the impact of sports transcends its immediate reinforcing properties. As stated by Jones (2015), "sports are a major part of U.S. culture, … are a big driver of economic activity, and the market for commerce related to sports is enormous." In fact, the global sporting industry is estimated to be worth more than 500 billion dollars annually ("Why the Sports Industry is Booming,", 2020). Thus, it is our responsibility to determine how behavior analysis can contribute to the development of sports. Fortunately, everything one does when participating in sports is behavior and, thus, relevant subject matter for ABA.

In our view, approaching sports from a behavioral perspective provides three substantial benefits to the athlete. First, behavioral interventions can promote skill development when specific athletic skills are not in the participant's repertoire (e.g., Luyben et al., 1986). Second, behavioral interventions can enhance performance when a skill is present but not demonstrated to a desired level (e.g., Kelley & Miltenberger, 2016). Third, behavioral procedures can change potentially harmful behaviors to minimize the likelihood of injury (e.g., Tai & Miltenberger, 2017).

Studying sports can also contribute to our understanding of behavioral science as sports environments provide analogue settings for the study of behavior. In sports, one can study basic principles, such as manipulating schedules of reinforcement, to better understand how basic principles and procedures derived from them affect behavior in the natural environment (see Schenk & Reed, 2020). Therefore, it is conceivable that by studying behavior in a sporting environment, we might better understand factors that influence behavior more broadly. Thus, combining ABA and sports is beneficial to both the behavior analysts and the athletes involved.

The purpose of this chapter is to discuss research findings on the application of ABA to

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_45

enhance sports performance. The chapter discusses the different types of sports and target behaviors, the ages and populations of research participants, the different types of interventions evaluated in research, and some issues for future research directions.

Sports and Target Behaviors Addressed in ABA Research

This section focuses on each of the sports and target behaviors addressed in the literature (see review by Schenk & Miltenberger, 2019). Some of the sports are recreational and some are competitive with a range of age groups. Most of the target behaviors focus on improving the athlete's performance directly. However, some of the research focuses on improving the coach's performance to in turn enhance the athletes' performance. The section is ordered by the most to least studied sports.

There have been 15 studies to enhance the performance of skills in tennis or table tennis. Seven studies improved the execution of the service swing (e.g., Rikli & Smith, 1980) and four studies enhanced the performance of forehand or backhand swings (e.g., Buzas & Ayllon, 1981). Two studies improved the performance of service returns (e.g., Scott et al., 1998). Two studies decreased inappropriate outbursts during play to improve performance (e.g., Allen, 1998). Two studies improved hitting trajectory or ball placement (e.g., Todorov et al., 1997), and one study improved the execution of a paddle swing (Carroll & Bandura, 1982).

We found 11 studies on enhancing basketball skills. Eight evaluated behavioral interventions for improving shooting form (e.g., Hall & Erffmeyer, 1983). One study attempted to decrease fouls and increase assertiveness (Connelly, 1988). One study focused on improving defensive performance (Kendall et al., 1990), and one study taught an individual with autism nine essential basketball skills using a combination of interventions (Lambert et al., 2016).

We identified 11 studies on enhancing football performance. Four studies focused on improving tackling form (e.g., Harrison & Pyles, 2013) and two focused on improving offensive blocking (Allison & Ayllon, 1980; Stokes et al., 2010). Some studies focused on improving multiple behaviors including route running, initial release, and play execution (e.g., Smith & Ward, 2006). Two studies focused on improving defensive responses accuracy and speed to an offensive play (e.g., Ward & Carnes, 2002).

We identified 11 studies that enhanced the performance of swimmers. Three studies increased the number of lengths swam during practice (e.g., Schonwetter et al., 2014) and two decreased the number of stroke errors and improved stroke execution (e.g., Koop & Martin, 1983). One study each taught three new swimming skills (Rogers et al., 2010), decreased the strokes needed to swim a set distance (Polaha et al., 2004), improved attendance and work output (McKenzie & Rushall, 1974), decreased nonproductive behavior and increased productive behavior (Hume & Crossman, 1992), improved the coach's correct use of reinforcement and feedback to improve athlete performance (Rushall & Smith, 1979), and improved the performance of swimmers with spina bifida (Dowrick & Dove, 1980).

Nine studies focused on enhancing golf performance. Five studies increased the form accuracy of a golf swing (e.g., Fogel et al., 2010), three increased shot making and decreased the number of strokes to complete a round (e.g., O'Brien & Simek, 1983), and one focused on improving power and distance control when putting (Fery & Ponserre, 2001).

Six studies evaluated behavioral interventions for improving dance performance. All of these studies focused on improving different dance moves and typically focused on increasing the percentage of steps correct in a task analysis of the movement (e.g., Fitterling & Ayllon, 1983; Quinn et al., 2015, 2020).

Six studies focused on improving gymnastic performance. The target behaviors included rope climbing/dancing skills (Magill & Schoenfelder-Zohdi, 1996), three basic entry-level gymnastic skills (Allison & Ayllon, 1980), pommel horse skills (Baudry et al., 2006), three skills on the uneven bars (Boyer et al., 2009), and overall behavioral output during practice (Wolko et al., 1993).

We identified five studies to enhance the performance of ice skaters. Two studies improved the performance-specific "figures" (e.g., Ming & Martin, 1996), two increased the overall output of athletes during practice (e.g., Wanlin et al., 1997), and one improved the correct execution of relay tagging (Anderson & Kirkpatrick, 2002).

We identified five studies to enhance soccer performance. Two studies focused on improving passing (e.g., Ziegler, 1994), one improved the performance of headers, throw-ins, and goal kicks (Rush & Ayllon, 1984), one improved the athlete's on-field positioning during game-play (Brobst & Ward, 2002), and one improved the number of effective coaching strategies used to improve player performance (Partington et al., 2015).

Four studies have been published on behavioral approaches in baseball. Simek and O'Brien (1988) used a combination of interventions to help hitters discriminate the difference between strikes and balls, as the more quickly a batter recognizes the pitch, the easier the pitch is to hit. Osborne et al. (1990) also used behavioral interventions to improve curveball hitting. Heward (1978) used reinforcement to increase the overall offensive efficiency average, a combination of successful performance indicators. Additionally, Little and Simpson (2000) focused on decreasing negative thoughts to improve baseball performance.

We identified four studies enhancing the performance of track and field athletes or runners. Two studies decreased the time taken to complete a race (e.g., Shapiro & Shapiro, 1985). One study improved the performance of throwing the discus and hammer (Maryam et al., 2009), and one study increased the height of a pole extension in pole vault (Scott et al., 1997). Another study increased weekly distance of runs for recreational runners (Wack et al., 2014).

We identified three studies enhancing the performance of volleyball skills. One study improved the ability to receive the ball (Barzouka et al., 2007), one taught the overhand pass and serve (Zetou et al., 1999), and one improved the execution of ball setting and serving (Zetou et al., 2002).

Three studies evaluated behavioral procedures to enhance cycling performance. Two studies focused on improving pressure distribution (e.g., Sanderson & Cavanagh, 1990) and one focused on improving the standing start (Jennings et al., 2013).

Three studies improved the performance of rowing athletes. Two decreased the amount of time it took to complete a race (e.g., Thelwell & Greenlees, 2001) and one increased the amount of distance covered over a 40-min period (Scott et al., 1999).

We identified two studies to improve hockey skills. One focused on increasing the number of goalie saves (Rogerson & Hrycaiko, 2002) and the other decreased the number of penalties incurred while increasing goals and assists (Silva III, 1982).

Two studies focused on kickball players. One improved sportsmanship (Hupp et al., 2002) and the other increased attentive behavior while decreasing disruptive behavior (Reitman et al., 2001).

We identified two studies that enhanced martial art performance. One study improved the athletes' performance of three different techniques (BenitezSantiago & Miltenberger, 2016), and the other increased the athlete's use of varied techniques so as to not become predictable (Harding et al., 2004).

We identified one study to enhance the performance of rock climbers; this study improved the performance of the drop knee, heel hook, and rear flag techniques (Walker et al., 2020).

One study evaluated behavioral procedures to enhance the performance of three different horseback riding skills (Kelley & Miltenberger, 2016).

We identified four studies enhancing the performance of weight lifters, and all studies improved the correct execution of one or more lifts Sewal et al., 1988).

One study enhanced the performance of rugby players. This study increased the number of ball carries, tackles made, successful kicks, and takeaways won (Mellalieu et al., 2006).

One study evaluated behavioral procedures to enhance field hockey skills. O'Neill and Miltenberger (2020) focused on improving three types of shots players use to shoot on goal or pass the ball.

One study focused on performance in lacrosse. DePaolo et al. (2019) evaluated behavioral procedures to increase the percentage of times players called the name of the player to whom they were passing the ball.

Research has shown that numerous behaviors have been targeted for improvement across sports. The target behaviors have included (1) skill acquisition or skill improvement, typically measured as the number of steps completed correctly in a task analysis of the skill (e.g., Boyer et al., 2009; Quinn et al., 2015; Stokes et al., 2010) or (2) behavioral output during practice or performance of mastered skills during practice (e.g., DePaolo et al., 2019; Wolko et al., 1993). Thus far, behavior analytic techniques have been used to enhance athletic performance in at least 23 different sports. Because there are hundreds of different sports across the world, there is much room to expand research on ABA interventions across sports. Each sport has its own set of complex behaviors, rules, and strategies, which would allow for multiple aspects of each sport to be targeted for improvement. Because all sports performance is behavior, every measurable aspect of the performance could become a target behavior in future research.

Ages and Populations in ABA Sports Research

The participants in research on ABA procedures to enhance sports performance range from 4-year-olds to over 60-year-olds. Study populations have also ranged in competition levels, including recreational, beginner, high school, collegiate, and professional athletes, although the fewest studies have been conducted with professional athletes (Schenk & Miltenberger, 2019).

The number of participants in research on ABA and sports performance up to this point is surprisingly small, with just over 1500 total participants (Schenk & Miltenberger, 2019). According to a recent review of participant characteristics in behavior analytic sports studies, 52% of participants are female and 48% are male (Rotta et al., 2020). About one-third of the participants have been children, and well over 90% of the participants have been considered typically developing (Schenk & Miltenberger, 2019). The limited number of studies with participants who have been diagnosed with a developmental disability are often focused on team sports, not only to improve skills but also to lead to greater inclusion of individuals with disabilities (e.g., Lambert et al., 2016; Luyben et al., 1986). Because sports performance is relevant to all ages or populations, the scope of research should continue to be extended to all individuals who participate in sporting activities. Furthermore, participant demographics should only be a limiting factor as it relates to the purpose of a given study or availability of athletes as research participants. Systematic research on different ages, populations, and ability levels will tell us more about interventions that are most successful for each individual participant.

Types of ABA Interventions for Sports Performance

This section focuses on the numerous different behavioral interventions used in sports performance research. Because most of the research on enhancing athletic performance involves skill acquisition or improvement, and a skill that cannot be unlearned or untaught, multiple baseline designs are the most common form of experimental design used for sports performance research and reversal designs are relatively rare (Schenk & Miltenberger, 2019). The important aspect of each study is that it focuses on an observable and measurable behavior and implements procedures to change that behavior. Some of the interventions use basic behavioral principles (e.g., positive reinforcement; Buzas & Ayllon, 1981), whereas others use techniques that may be based on several behavioral principles (e.g., video feedback; Kelley & Miltenberger, 2016), and many use combinations of procedures (e.g., behavioral skills training [BST]; Tai & Miltenberger, 2017). Across these varied interventions, researchers described procedures to facilitate replication and demonstrated beneficial changes in the targeted athletic skills.

Antecedent Procedures

Antecedent interventions, often consisting of some form of instructional procedure, are implemented in advance of performance and are designed to evoke the correct performance. Antecedent procedures most often are used as part of a package intervention (Schenk & Miltenberger, 2019).

Expert Modeling Expert modeling involves having someone demonstrate the behavior for the participant so the participant can imitate it. We identified 20 studies using expert modeling. For example, Koop and Martin (1983) used expert modeling to show coaches how to deliver prompts and different consequences to decrease problem behaviors and increase appropriate behaviors of competitive swimmers. This study is also an example of teaching coaching strategies that in turn enhance competitor performance.

Instruction Instruction involves the clear and concise explanation of each aspect of a target behavior. Also, depending on the research aims, the instructions might include an explanation of the appropriate context for the target behavior. Over 30 studies used instruction as part of an intervention to improve athletic performance (Schenk & Miltenberger, 2019). For example, Komaki and Barnett (1977) used instruction along with other intervention components to teach proper play execution to youth-level football players. Instructions for this behavior included describing to the participant the stimulus to be observed (e.g., which direction a quarterback moved) and then explaining to the participant the proper response to the stimulus.

Goal Setting Goal setting involves setting attainable and measurable performance targets and documenting behavioral achievements related to the targeted goals. With goal setting, reinforcement might occur in the form of achieving the set goal, but additional reinforcement can also be programmed for reaching specific goals. We identified 12 studies using goal setting to improve athletic performance. For example, Mellalieu et al. (2006) used goal setting to increase several specific on-task behaviors of rugby players, and they demonstrated desirable effects of goal setting on individual performance. Additionally, they found that team performance concurrently improved as a result of individual performance enhancement.

Physical Prompting Physical prompting in sports is used to help an athlete move their body in a specific way to produce the desired effect. For example, when coaching young or beginner athletes (young tee-ball players) the coach may have to physically adjust a child's hands or feet for the child to learn correct form when throwing or hitting a baseball. We identified five studies using physical prompting to improve athletic performance. Luyben et al. (1986) used physical prompting to teach participants with developmental disabilities how to pass a soccer ball using the side of their foot. This allowed the individuals to play soccer together and engage in sporting activity that had previously been unavailable to them.

Video Modeling Video modeling involves the athlete viewing a video recording of an individual correctly engaging in the target behavior. Often, each step in a task analysis of the behavior is observed and identified in the model while the video is played. We identified 20 studies using video modeling to enhance athletic performance. For example, Maryam et al. (2009) used video modeling to demonstrate an improvement of track and field athletes' ability to throw the discus and hammer. However, recent research indicates that video modeling does not substantially improve athletic performance without other intervention components such as video feedback (Quinn et al., 2020).

Discrimination Training Discrimination training involves reinforcing correct responding in the presence of discriminative stimuli, and then fading the stimuli to get the behavior to occur in a competitive setting. In the one study using discrimination training, Osborne et al. (1990) used marked baseballs to help hitters discriminate between a curveball and other pitches, as correct identification of a pitch promotes successful hitting. The experimenters demonstrated that participants hit a greater percentage of marked balls than unmarked balls; however, the degree to which this generalized to in-game performance was not established.

Contingency Management

In contingency management, reinforcing consequences are delivered contingent on some measures of successful performance.

Reinforcement Procedures Reinforcement procedures program the delivery of a reinforcer contingent on athletic performance to improve that performance. Although reinforcing consequences occur following the correct behavior in each study to some degree, we identified 20 studies that specifically programmed reinforcement contingencies. Tangible reinforcers are occasionally used, but the most common form of reinforcement used in sports research is praise from the experimenter or the coach (Schenk & Miltenberger, 2019). Rushall and Pettinger (1969) increased the work output of swimmers during practice by providing a reinforcer for each lap completed. Furthermore, they compared the use of candy, money, and coaches' attention as reinforcers and found that reinforcement in any form improved behavior compared to no reinforcement. However, candy and money improved performance more than a coach's attention.

Token Economies Token economies involve delivering tokens for correct performance and exchanging tokens later for different types of reinforcers. Two studies used token economies to improve athletic performance. For example, Hupp et al. (2002) used a token economy to improve sportsman-like behavior of five kids diagnosed with attention deficit hyperactivity disorder (ADHD). They demonstrated that the delivery of immediate tokens for sportsman-like behavior helped improve the behavior while playing kickball.

Feedback Procedures

In feedback procedures the researcher or coach gives information about correct and/or incorrect aspects of performance immediately after the target behavior occurs. Feedback might function as reinforcement to increase correct responses or as punishment to decrease incorrect responses. Furthermore, feedback may serve as instructions to guide future performance. Because feedback could have both punishing and reinforcing properties as well as instructional properties, these procedures are categorized as feedback instead of contingency management or antecedent interventions.

Graphical Feedback Graphical feedback involves providing participants with information on their performance in graphical form. We identified six studies using graphical feedback to enhance athletic performance. For example, Wack et al. (2014) used graphical feedback along with goal setting to increase the distance run each week by five runners. The participants and experimenters set running goals and the experimenters provided weekly verbal and graphical feedback to the participants. This intervention increased the distance for all participants.

Public Posting Public posting involves providing information on the participant's performance in a setting that is available to the participant and others. We identified nine studies using public posting to enhance sports performance. Brobst and Ward (2002) used public posting along with goal setting and feedback to improve three behaviors of three competitive soccer players. The researchers measured the three behaviors during scrimmages or games, and provided performance feedback orally and in graphical form prior to each practice. All participants met the goals for each behavior.

Self-Monitoring Self-monitoring involves participants recording their own behavior during practice or as they perform their athletic skill. Critchfield and Vargas (1991) used self-recording along with instructions and public posting to increase the number of lengths swum by competitive swimmers. At the end of every four lengths swam, swimmers recorded their behavior on a board poolside. They found that self-recording improved the performance of all swimmers, but sustained and substantial improvement occurred after the public posting component was added to the intervention for four of the seven swimmers.

Verbal Feedback Verbal feedback is often provided by coaches in a sport setting, but verbal feedback in research only refers to verbal feedback that was a programmed part of an intervention. In research, verbal feedback is the delivery of spoken information about performance immediately following performance. It may involve descriptive praise and/or instructions for improvement. We identified 28 studies using verbal feedback to enhance sports performance. For example, Schonwetter et al. (2014) used verbal feedback with self-monitoring to improve the number of laps swum by six competitive swimmers. Participants recorded the number of laps they swam during practice, and then the experimenter provided positive feedback regarding number of laps swum or correct recording of behavior. Although behavior improved for all participants with self-recording, performance improved further with the addition of the verbal feedback component.

Video Feedback Video feedback involves video recording a participant performing the target behavior and then reviewing the video with the participant while identifying correct aspects of performance and providing further instruction to correct incorrect aspects of performance. Over 20 studies used video feedback to enhance sports performance. For example, BenitezSantiago and Miltenberger (2016) used video feedback to improve three martial arts behaviors for five participants. Each participant was filmed engaging in the target behavior. The experimenter and the participants then reviewed the recording, and the experimenter provided praise for correct execution of each step with the task analysis (TA) and corrective feedback for incorrect execution of each step. As a result, all participants improved all target behaviors.

Auditory Feedback Auditory feedback is provided in the form of a sound such as a clicker directly following a correct behavior and is intended to function as a conditioned reinforcer to increase correct responding. Seven studies used auditory feedback to enhance athletic performance. Quinn et al. (2017) used auditory feedback to improve complicated dance moves of six competitive dancers. They created a TA for the target behavior and trained peers to provide auditory feedback following correct responses of each step of the TA. Their results show that auditory feedback was an effective intervention. Additionally, they demonstrated that peers could provide auditory feedback successfully, increasing the efficiency of the intervention.

Skills-Training Procedures

Skills-training procedures refer to procedures that teach athletes a specific skill that is not the target behavior but that facilitates improvement of the target behavior.

Relaxation Training Relaxation training involves teaching different strategies to help a participant become calmer, in turn improving performance. Eight studies used relaxation training to enhance sports performance. For example, Kearns and Crossman (1992) used relaxation training along with self-imagery to help increase the free-throw percentage of college basketball players. Participants were trained to engage in a relaxation exercise during which the participants engaged in covert behavior related to decreasing anxiety and focusing on correct musculoskeletal movements. During practice and at home, all participants engaged in these relaxation and self-imagery behaviors each day. All participants' free-throw percentage improved during practice following the implementation of the intervention.

Self-Imagery Self-imagery involves teaching a participant how to engage in the covert behavior of imagining correct overt execution of the target behavior. We identified ten studies using self-imagery to enhance sports performance. For example, Thelwell and Greenlees (2003) used self-imagery along with relaxation training to help recreational athletes decrease the amount of time needed to complete a triathlon. Each participant was trained to use self-imagery and relaxation to minimize the effects of pain and fatigue and help them maintain desirable levels of relaxation. Following implementation of the intervention, all participants substantially decreased the amount of time needed to complete the race.

Self-Talk Self-talk involves a participant engaging in covert verbal behavior to promote correct execution of the target behavior. We found 12 studies using self-talk to enhance sports performance. For example, Landin and Hebert (1999) developed a self-talk procedure to improve the volleying skills of five collegiate tennis players. Participants were taught to engage in two self-talk steps to promote correct movement after each ball strike. A ball strike prompted self-talk, which prompted movement to improve volleying and overall scoring performance. All participants improved their performance following the self-talk intervention.

Acceptance Commitment Therapy Acceptance and Commitment Therapy (ACT) is becoming a widely used psychological intervention in which psychological flexibility is promoted so that covert behavior does not adversely impact overt behavior (see Hayes et al., 2006). Little and Simpson (2000) used ACT to improve the performance of collegiate softball players. Participants engaged in a 30-min ACT session 2–3 days before certain game days. During these sessions a therapist reviewed performance with each athlete and different strategies to deal with covert behavior during athletic performance, and four of five players improved their performance over the course of the study.

Rehearsal Procedures

In rehearsal procedures, the athlete is instructed to engage in the skill a set number of times as a stand-alone procedure or combined with other interventions.

Additional Rehearsal Additional rehearsal involves the participant practicing the target behavior outside the context of coaching; thus, no feedback or critique is provided. Often, an individual can improve their performance via repetition of the target behavior, especially when the outcome of the behavior can function as a reinforcer (Larry Bird famously shot at least 500 free throws every day). Six studies used additional rehearsal to enhance sports performance. For example, Kirschenbaum et al. (1998) used additional rehearsal and self-monitoring to improve the performance of five experienced golfers. They had all participants focus their attention on good shots as opposed to problematic shots, and then had the golfers practice doing this while playing rounds of golf. As a result, they found that all golfers improved their average golf scores.

Simulated Practice Simulated practice involves a participant engaging in the target response while interacting with a visual-electronic device often using a device similar to a video game console. We identified five studies using simulated practice to enhance sports performance. For example, Christina et al. (1990) used a joystick and a video recording to improve response accuracy of a linebacker for a college football team. The researchers video recorded offensive plays, had the participant watch the plays, and asked the participant to respond by moving the joystick in the appropriate direction according to the play being shown. Correct responding was dependent on the offensive player movements. Over the course of the intervention, not only did the participant's responding become more accurate, but his response time slightly decreased as well. A limitation of this study was that it did not examine generalization to on-field performance. However, Scott et al. (1998) demonstrated that simulated practice of tennis skills could generalize to actual performance.

Behavioral Skills Training BST involves the systematic use of instruction, modeling, rehearsal, and feedback to enhance performance. Two studies evaluated behavioral skills training (BST) to enhance athletic performance. For example, Tai and Miltenberger (2017) used BST to teach safe-tackling techniques to six pop-warner football players. They instructed the participants how to properly engage in each step in a ten-step TA and then modeled each step. Following instructions and modeling they had the participants rehearse the steps while making a tackle and provided immediate feedback to the participants on which steps were done correctly or incorrectly. All participants improved responding following the introduction of BST.

Habit Reversal Habit reversal involves awareness training to help an individual recognize an undesirable response and teaching that person a competing response to replace the undesirable response. Allen (1998) used a habit reversal procedure to decrease anger outbursts of a competitive teenage tennis player. An auditory device was used to help the participant identify when the inappropriate behaviors were about to occur, and the participant engaged in a competing response that was similar to a deep-breathing exercise. The participant's parents then reinforced the use of this competing response. Over time, the intervention eliminated the anger outbursts during tennis matches.

Research has demonstrated that multiple forms of behavioral interventions can be used to enhance sports performance (Schenk & Miltenberger, 2019). These interventions include antecedent approaches to evoke correct performance, reinforcement approaches to strengthen correct performance, feedback approaches that may serve multiple functions, and skills training approaches. Antecedent procedures are most often used in conjunction with other procedures such as reinforcement or feedback. Although reinforcement procedures are effective in strengthening correct forms of behavior that may be evoked by instructions or modeling, providing immediate reinforcement (or punishment) within a sports setting is often difficult because the game flow cannot be interrupted. Therefore, reinforcement procedures are often used in practice in the hopes that behavioral improvement will also occur in games. Because correctly engaging in the target behaviors related to sports performance usually produces naturally occurring reinforcement (e.g., correct performance of the skill or its outcome [making a goal, making a tackle] functions as a reinforcer for most competitive athletes), interventions involving different forms of feedback are often effective. Although the behavioral mechanism involved in feedback interventions is not clear, research shows they are effective for enhancing athletic performance.

Research Considerations

Since the late 1960s (Rushall & Pettinger, 1969), there has been a growth in research evaluating ABA procedures to enhance sports performance using single-subject research designs to demonstrate intervention effects. Although this research has demonstrated the effectiveness of numerus interventions across numerous sports skills, there are still multiple considerations to be addressed. First, the majority of studies to this point have used multi-component interventions to improve performance (Schenk & Miltenberger, 2019). These package interventions are often useful because of the small amount of time that can be allotted to research in a sports setting. In most studies, there is a limited number of sessions because of the time-frame of a sports season and the need for the athlete (and sometimes the coach) to dedicate time in or outside of practice to participate in research. Therefore, research often focuses on results-driven package interventions. This approach has not allowed researchers to identify the effectiveness of individual intervention components. It would be beneficial to know which intervention components are most effective so coaches can provide the most efficient interventions for each target sport, behavior, and age group. Thus, there is a need for further research analyzing the individual components of package interventions.

Second, most sports research is divided into training sessions and assessment sessions. In training sessions, the behavioral procedure is implemented and in assessment sessions, the performance is evaluated under natural (extinction) conditions. Often, multiple training trials are conducted before completing assessment trials, and this process is repeated until a mastery criterion has been reached in assessment trials. Although it is during the training phase that behavior is modified, data from the training trials are usually not reported. However, it would be useful to see the degree of behavior change over each implementation of the intervention. Without data from training sessions the change in behavior that occurs on a trial-to-trial basis is unknown, and if efficiency is an important factor in choosing which intervention to use, these data would be important to monitor and report.

Third, there is an important distinction between skills acquisition and performance management in sports. New or amateur athletes have yet to correctly engage in many of the target responses required of the sport. Therefore, behavioral interventions will focus on teaching a new skill and consist of antecedent strategies such as instruction and modeling or prompting to evoke the skill and reinforcement or feedback strategies to strengthen the skill. Thus, initial acquisition of skills most often requires teaching packages. However, when the goal is performance enhancement of an already learned behavior, teaching approaches might be less important than a reinforcement, feedback, or goal-setting intervention. In such cases, the goal is to manage the athlete's use of the skill in the correct circumstances—to promote the execution of the skills when needed. Researchers should focus on evaluating behavioral strategies for these two purposes in sports research.

A fourth issue for future research is promoting generalization of performance to games or competition. In the current literature, most studies do not measure the effects of the behavioral intervention during in-game performance. This may occur because the researcher has control over creating opportunities for the skills during practices but not during games or competition. In competition, the researcher has to wait for naturally occurring opportunities for the performance of the skill. In some sports the target behavior might be difficult to assess because it does not occur often. For example, in a football game, a player might have few opportunities to make a tackle for an entire game. Furthermore, attending competitions and games can be difficult for the researcher because of time and travel or because access is restricted, so finding a way to observe and record behavior can be difficult. Video recording may be a good alternative for researchers, but one must be aware of ethical considerations and who or what might be video recorded. Despite these difficulties, researchers should evaluate performance during games or competition whenever possible and implement behavioral strategies to promote generalization. Some methods to promote generalization could include training coaches to implement behavioral interventions, providing reinforcement for in-game performance, or increasing practice in competition-like settings.

In summary, numerous behavioral approaches have proven effective for teaching sports skills and improving athletic performance. Because of the importance of sports across the world, this line of research should continue to grow and mature. One benefit of further research in ABA and sports is to identify which interventions are most effective for different sports, different skills, different age groups, and different levels of expertise. The research tells us generally that behavioral interventions work to enhance sports performance, but it does not yet tell us how to choose specific interventions for specific athletes. Our hope is that refinements in this research will begin to answer that question.

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46 Physical Activity, Exercise, and Fitness

Paul Oh, Lisa Cotie, and Lais M. Vanzella

Guidelines for Physical Activity and Exercise

Regular physical activity is one of the most important things people can do to improve their health. Physical inactivity puts people at a very high risk for adverse short-term and long-term health outcomes including heart disease, diabetes, some types of cancer, and mental health issues. These chronic health problems place an enormous clinical and financial strain on the healthcare system and society as a whole. In 2020, about half of all American adults, about 117 million people, were living with one or more preventable chronic diseases related to physical inactivity (U.S. Department of Health and Human Services, 2018). There is a plethora of information from large clinical studies to demonstrate that physical activity has a dramatic impact on reducing the incidence and improving the management of these chronic conditions.

Unfortunately, the majority of population is physically inactive. Nearly 80% of North American adults are not meeting the key guidelines for both aerobic and muscle-strengthening activity, while only about half meet the key guidelines for aerobic physical activity (U.S. Department of Health and Human Services, 2018; A common vision for increasing physical activity and reducing sedentary living in Canada, 2018).

The recent *Physical Activity Guidelines for Americans*[1] (U.S. Department of Health and Human Services) provides detailed recommendations for cohorts across the life span. Preschool-aged children (aged 3 through 5 years) should be physically active throughout the day to enhance growth and development. Active play that includes a variety of activity types should be encouraged throughout the day. Older children and adolescents aged 6 through 17 years should do 60 minutes or more of moderate to vigorous-physical activity (MVPA) daily including a mix of aerobic, muscle, and bone strengthening activities on at least 3 days a week. These physical activities should be age appropriate as well as fun and engaging.

Adults should move more and sit less throughout the day. Excessive sedentary time has independently been linked with marked increases in the risk of developing chronic conditions such as diabetes and heart disease, as well as total mortality (Biswas et al., 2015). Getting any level of physical activity, including sitting less, is a great start for people who are largely sedentary.

To achieve optimal health benefits, adults should do at least 150–300 minutes a week of moderate-intensity or 75–150 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_46

vigorous-intensity aerobic activity. Preferably, aerobic activity should be spread throughout the week. Adults should also do muscle-strengthening activities of moderate or greater intensity and that involve all major muscle groups on 2 or more days a week, as these activities provide additional health benefits (U.S. Department of Health and Human Services). In addition to the above guidance, as part of their weekly routines, older adults should do mixed physical activity that includes balance, aerobic, and muscle-strengthening activities. Older adults should be mindful of their level of effort during any given activity, as well as the impact of underlying medical conditions (U.S. Department of Health and Human Services, 2018).

The Canadian Society of Exercise Physiology (CSEP) recently produced the *Canadian 24-Hour Movement Guidelines* (Ross et al., 2020). This document also provides advice specific to age categories, and emphasizes engaging in activity throughout the day, reducing sedentary behavior (such as limiting screen time to less than 3 hours per day for children, or breaking up extended sitting time for adults), and an additional recommendation around practicing healthy sleep hygiene for all age groups (i.e., developing routines, behaviors, and environments conducive to sleeping well) (Ross et al., 2020). The 2020 World Health Organization (WHO) guidelines on physical activity and sedentary behavior are very consistent with the North American guidelines (WHO guidelines on physical activity and sedentary behaviour, 2020).

For adults who are living with chronic conditions or disabilities, the *Physical Activity Guidelines for Americans* recommend that for those who are able, performance of at least 150–300 minutes a week of moderate-intensity, or 75–150 minutes a week of vigorous-intensity aerobic physical activity, spread throughout the week. Those who are able to should also do muscle-strengthening activities of moderate or greater intensity that involve all major muscle groups on 2 or more days a week (U.S. Department of Health and Human Services, 2018). These recommendations are very consistent with the guidelines from disease-specific groups including those affiliated with diabetes, cardiovascular, and cancer organizations. The American Diabetes Association statement highlights that physical activity and exercise improves blood glucose control in type 2 diabetes, reduces cardiovascular risk factors, contributes to weight loss, and improves well-being (Colberg et al., 2016). Regular exercise also has considerable health benefits for people with type 1 diabetes (e.g., improved cardiovascular fitness, muscle strength, insulin sensitivity, etc.) (Colberg et al., 2016). Physical activity and exercise recommendations should be individualized since glucose control may vary by diabetes type, activity type, and presence of diabetes-related complications (Colberg et al., 2016). Current guidelines published by the American Heart Association and the American College of Cardiology broadly recommend lifestyle approaches to prevent and treat important and common cardiovascular risk factors such as elevated blood pressure and cholesterol. For patients with mildly or moderately elevated blood pressure and blood cholesterol, lifestyle-only approaches are actually endorsed as the first line of therapy rather than initiating medications (Gibbs et al., 2021). A recent consensus statement and guideline in oncology indicated that exercise training and testing were generally safe, that every survivor should avoid inactivity, and that specific doses of aerobic, combined aerobic plus resistance training, and/or resistance training could improve common cancer-related health outcomes, including anxiety, depressive symptoms, fatigue, physical functioning, and health-related quality of life (Campbell et al., 2019). People with chronic conditions should consult with their healthcare professional or physical activity specialist about the types and amounts of activity appropriate for their abilities, symptoms, health status, and medications (U.S. Department of Health and Human Services, 2018).

Importance of Behavior Change in Fitness

An abundance of strong evidence exists, outlining the benefits of physical activity and fitness. A relatively small increase in oxygen uptake (VO_2)

of one metabolic equivalent (MET; 3.5 mL O_2/kg/min) is associated with large (10–25%) improvements in survival (Kaminsky et al., 2013). A 1000 kcal/week increase in physical activity (approximately 1-MET increase in fitness) leads to a 20% mortality benefit (Myers et al., 2004). Health benefits from physical activity and fitness occur in healthy people and those with established disease or disability and the literature consistently reports the benefits of good fitness and regular physical activity in all age categories and in every racial and ethnic group studied to date (Bull et al., 2020).

A large prospective study from 1989 studied physical fitness and risk of all-cause and cause-specific mortality in 10,224 men and 3120 women. Risk estimates for all-cause mortality suggest that low physical fitness is an important risk factor in both men and women and that higher physical fitness appears to delay all-cause mortality (Blair et al., 1989). This is primarily due to lowered rates of cardiovascular disease (CVD) and cancer (Blair et al., 1989). Another study including 122,007 patients from a tertiary care academic medical center between 1991 and 2014 (mean age 53.4 years, 59% male) found that cardiorespiratory fitness was inversely associated with long-term mortality and that there was no upper limit to this observed association (Mandsager et al., 2018). Extremely high aerobic fitness was associated with the greatest survival and was associated with benefits in older patients and those with hypertension (Mandsager et al., 2018). In summary, higher physical fitness from regular physical activity has a positive effect on reducing all-cause mortality.

In addition to decreasing mortality rates, improved fitness also has a positive effect on many other variables. Undeniable evidence exists in the literature highlighting the effectiveness of physical activity in the primary and secondary prevention of many chronic diseases (Bull et al., 2020; Booth et al., 2012; Warburton et al., 2006; Pronk et al., 1998; Reddigan et al., 2011; Taylor et al., 2004). These include cardiovascular disease (Reddigan et al., 2011; Alves et al., 2016), cancer (Thune & Furberg, 2001; Paffenbarger Jr. et al., 1992; Kampert et al., 1996), stroke, (Hu et al., 2000; Kurl et al., 2003), diabetes (Helmrich et al., 1994; Helmrich et al., 1991; Lynch et al., 1996), hypertension, (Diaz & Shimbo, 2013) and obesity (Blair & Brodney, 1999), among others (Bull et al., 2020). An adequate level of aerobic endurance is required to perform activities of daily living. It has been estimated that a minimum VO_{2max} of 15 mL/kg/min is necessary to maintain independence (Paterson et al., 2007). Good physical fitness from regular physical activity leads to longer independence, such that as people age, they do not need to rely on others for their activities of daily living as early nor as frequently. Healthcare costs have steadily increased in the United States for over 50 years. The longer one can stay independent and not have to rely on the healthcare system, the less money they need to spend.

Regular physical activity contributes to improved sleep (Kredlow et al., 2015), cardiovascular health (Nystoriak & Bhatnagar, 2018), promotes strong bones and muscles (Janssen & LeBlanc, 2010), and can help to maintain a healthy body weight and reduce fat stores (Swift et al., 2014). Good physical fitness does not only have physical benefits but also mental health advantages. For instance, regular physical activity improves cognition, depression, and anxiety and reduces stress (Rebar et al., 2015; Salmon, 2001; Saunders et al., 2020). We also know that both aerobic and muscle-strengthening fitness are beneficial.

The WHO has recently released guidelines which highlight that some physical activity is better than none (Bull et al., 2020); however, evidence suggests that as people reach 150–300 minutes per week of moderate-intensity physical activity, we see even more substantial health gains (WHO | Physical activity. World Health Organization, 2017). Furthermore, additional benefits occur as the amount of PA increases, such that the higher the intensity, greater the frequency, and longer the duration, the greater the health outcomes. In most cases, the risks of adverse outcomes or injury from regular physical activity are far outweighed by the benefits incurred.

Factors Influencing Physical Activity and Fitness

Despite well-consolidated benefits, most recent data published by *The Lancet Global Health* indicate that worldwide around 32% of women and 23% of men are not reaching the recommended 150 minutes per week of moderate–vigorous physical activity to stay healthy (Guthold et al., 2018). In 2016, more than a quarter of the worlds' adult population were considered insufficiently active, putting them at a greater risk of CVD, type 2 diabetes, dementia, and cancer (Guthold et al., 2018). While having a chronic disease, individuals seem to be more likely to adhere to physical activity and fitness recommendations. A systematic review including 3721 individuals with CVD, diabetes, or cancer reported an adherence rate of 74% and 80% to clinic-based and home-based programs, respectively (Bullard et al., 2019). The included studies focused on aerobic exercise interventions designed to meet the PA guidelines at a minimum of 150 minutes of moderate–vigorous aerobic activity per week. No differences between the three chronic diseases were reported for both adherence and dropout rates (Bullard et al., 2019).

Adherence to physical activity and fitness recommendations might be influenced by several factors, usually described as individual-, provider-, and system/environmental-level barriers and motivators (Tsujimura et al., 2018; Seefeldt et al., 2002). Figure 46.1 shows the most described barriers and motivators to physical activity and fitness highlighted in the literature.

Knowledge

Knowledge is considered as both a motivator and a barrier to physical activity and fitness (Baert et al., 2011; Costello et al., 2011). Knowing about the importance and benefits of being physically active may guide an individual's decision toward behavior change. Benefits that might motivate individuals to improve their physical activity and fitness level include those experienced in either a short- or a long-term perspective. The release of endorphins and serotonin experienced right after a physical fitness performance addresses important psychological issues, as it improves an individual's mood (Wegner et al., 2014), motivation (Bethancourt et al., 2014; Yi et al., 2016), self-confidence, and sleep and relieves stress (Simmonds et al., 2016; Bird et al., 2010). From a long-term perspective, knowing about benefits like improvements on an individual's balance, walking ability, sleep, and muscle strength, and reduction in muscle pain, morbidity, mortality, and hospitalization rates may motivate people to improve their physical activity and fitness level (Welmer et al., 2012; de Groot & Fagerström, 2011; Miller & Brown, 2017). Counseling on the perception of barriers including strategies to improve physical activity and fitness knowledge is recommended to achieving long-term behavior changes (Herazo-Beltrán et al., 2017; Bouma et al., 2015).

Conversely, a lack of knowledge may decrease physical activity and fitness levels. Not being aware about benefits of being physically active may lead individuals with health impairments and limitations to fearing physical activity and being dependent while exercising. Most commonly these feelings occur when there are difficulties in walking, physical weakness, and symptoms associated with chronic diseases (Simmonds et al., 2016; Bird et al., 2010; Eronen et al., 2014; Rowiński et al., 2017; Macniven et al., 2014; Gillette et al., 2015; Shiraly et al., 2017). Additionally, not knowing the most important physical activity (PA) recommendations to stay healthy contributes to the individual's misperceived belief that they already have good physical activity habits, and thus there is a lack of motivation to change behavior further (O'Neill & Reid, 1991; Hoare et al., 2017).

Time Constraints

Time is a system-level barrier to physical activity and fitness. In many countries and cultures, the responsibilities of taking care of children and managing the home environment occupy many

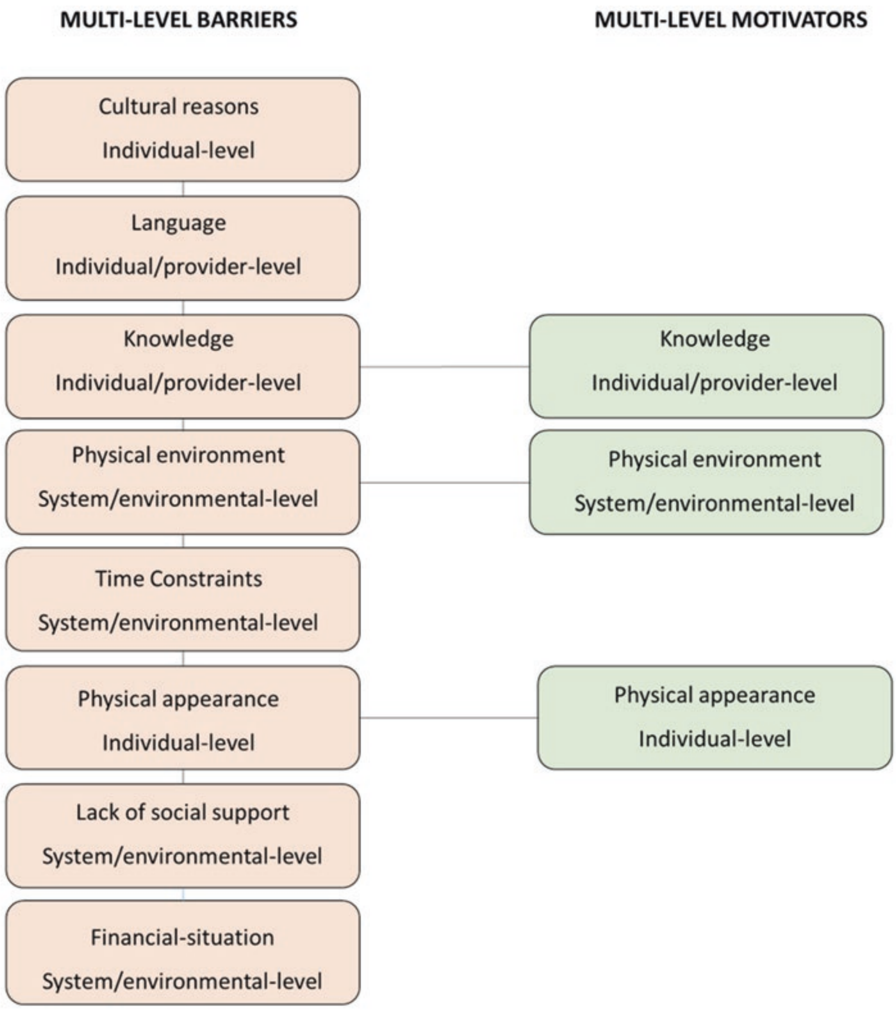


Fig. 46.1 Multi-level barriers and motivators to physical activity and fitness

hours in the day of adult caregivers, which negatively impacts the health behaviors of this population (Macniven et al., 2014). In adults and teenagers, the ability to perform physical activity is mainly influenced by social and family responsibilities, work hours, and putting academic success as a priority in life (Arzu et al., 2006).

Physical Appearance

Physical appearance is consistently reported as a motivator to physical activity and fitness, especially because of the association between weight loss/muscle gain and physical activity practice (Gavin et al., 2014). The perception and desires regarding the ideal body guide women to have higher body dissatisfaction compared to men. The internalization of the ideal body also differs between genders, as typically weight loss and being thin are desired by women and muscular bodies are desired by men (Fredrickson & Roberts, 1997). This indicates that there might be an interaction between an individual's self-perception and the extent to which an individual engages in health behaviors such as increases in physical activity (Hoare et al., 2017).

Physical Environment

Physical environment is considered as both a barrier and a motivator to physical activity and fitness. Many problems related to the environment have been reported in studies examining certain urban settings. Cited barriers include high crime rates, parked vehicles that impede access, obstacles along walking routes (e.g., potted plants, food retailers, broken sidewalks, scaffolds, snow accumulation along the street in winter), and lack of facilities such as benches for resting (Eronen et al., 2014; Shiraly et al., 2017; Chen et al., 2015; Chippendale & Boltz, 2015; Van Holle et al., 2015; Rantakokko et al., 2010). Alternatively, safe routes, pleasant landscapes, streetlights, sidewalks, bike riding routes, established walking paths, the neighborhood suitability for walking, interconnections between streets, environment free from threatening social activities (e.g., smoking, drinking alcohol, gambling), green space, benches for resting, a smooth surface for hiking, and good weather conditions seem to motivate the overall population for improving physical activity and fitness levels (Yi et al., 2016; Macniven et al., 2014; Chippendale & Boltz, 2015; Van Holle et al., 2015; Yoo & Kim, 2017).

Social Support

Social support is an important motivator to physical activity and fitness. Usually, more social support is needed for older than for younger cohorts because of waning independence (Baert et al., 2011; Miller & Brown, 2017). Close physical activity supervision and encouragement by fitness professionals has an important impact on adherence to physical activity reported by this older group. It has been suggested that by providing information and raising awareness about physical activity and fitness, providers augment the self-confidence of elderly individuals to begin their exercise regimens (de Groot & Fagerström, 2011). Social support provided by government and private institutions to improve access to adequate spaces or equipment that facilitate active lifestyles, as well as safe physical and social environments are recommended (Herazo-Beltrán et al., 2017).

Financial

Financial barriers to physical activity and fitness are reported by low-income populations as the number one cause of low PA levels (Steenhuis et al., 2009). The financial problems involve costs for membership of fitness clubs, and costs for clothing and equipment. Although some individuals identify they found a cheaper alternative to exercise (e.g., walking in a mall instead of exercising at a health club), this option might not be their preferred activity, which might also contribute to a low adherence to physical fitness observed in this population.

Language

Language is among the most important barriers that ethnic minorities face while engaging in physical activity and fitness programs. Insufficient communication might create misunderstandings and pose challenges to gain in-depth knowledge about the importance of physical fitness and the current guidelines and recommendations (Jacobs et al., 2004). It might also pose challenges to other medical treatments and negatively impact on the health of ethnic minorities in the long term (Al-Sharifi et al., 2019; Trinh et al., 2019). A language barrier is not only considered an individual-level barrier but also a provider-level barrier (Jacobs et al., 2004). The use of interpreters in physical activity and fitness programs and development of multi-language documents with a cultural repertoire to provide fitness education might help to engage with diverse groups and improve adherence in following overall health recommendations.

Designing Physical Activity and Fitness Interventions

Physical activity and fitness interventions aim to change a specific behavior pattern, such as being sedentary. An effective "behavior change intervention" should be designed based on factors influencing behavior change as well as the components and concepts involving the behavior system. Designing and planning the behavior change intervention is as important as the application of the intervention per se as it might directly influence motivation and adherence to behavior change.

Well-established behavioral researchers suggest that understanding factors influencing a specific behavior before designing the intervention is crucial to the development of strategies to improve motivation and overcome barriers (Michie et al., 2011). Next steps involve determining the broad approach that will be adopted and working on the specifics of the intervention design (Michie et al., 2011). In the behavior change model proposed by Michie and colleagues (Michie et al., 2011), the main components of the behavior system include capability, motivation, and opportunity. Those are key factors that interact with each other to guide a specific behavior, like exercising. Capability is *the individual's psychological and physical capacity to engage in the activity concerned*, including having the necessary knowledge and skills. Motivation is *all brain process that energize and direct a behavior*, including not only goals and conscious decision-making but also habitual processes, emotional responding, and analytical decision-making (Michie et al., 2011). Opportunity is a group of *factors that lie outside the individual to make the behavior possible* (Michie et al., 2011). When designing an intervention, it is important to keep in mind what components of the behavior system need to be changed in the individual. A full range of theory-based behavior change models exist and help the development and implementation of effective interventions to improve physical activity and fitness level.

Theory-Based Behavior Change Models

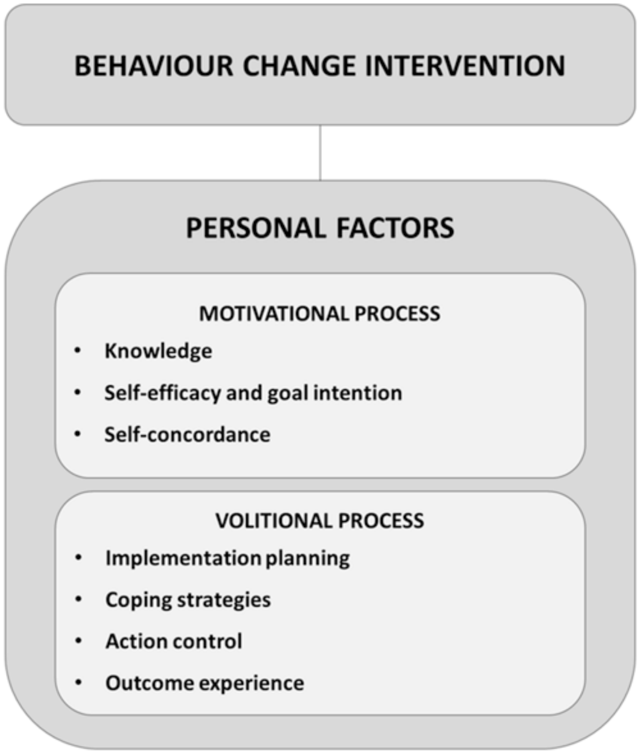
About 75 different theories have been described in the literature as effective options to promote health behavior change (Michie et al., 2011). It is important to highlight that having a broad number of theory-based behavior change models do not necessarily guarantee effectiveness of the intervention. The choice of a theory-based model that best fits with the program's main goals is key for a successful intervention. In clinical practice, most interventions seem to be designed based on a common-sense behavior change model (Michie et al., 2009). This opens a huge gap, as some theory-based models may not cover the full range of possible factors that influence behavior change, compromising the effectiveness of the intervention. Thus, systematic methods aimed to understand the nature of the behavior and identify components that can be used for its understanding are important (Michie et al., 2011).

In the literature, psychological theory-based models are well accepted to define personal determinants that might influence the initiation and maintenance of health behaviors, such as changing from a sedentary lifestyle to regular physical activity (Nieuwenhuijsen et al., 2006). Theory-based models such as the Health Action Process Approach (Schwarzer et al., 2011), the Integrative Model of Motivation and Volition for the Initiation of Regular Health-enhancing Physical Activity (Sudeck & Höner, 2011), and the Motivation-Volition (MoVo) Process model (Fuchs et al., 2011) are described as *neighboring psychological health behavioral change models* (Geidl et al., 2014), used to explain and predict physical activity behavior, integrate important findings from both social cognitive models and action control theories, and explain cognitive mechanisms of behavior change and exercise adherence. These theory-based models have as a consensus that a two-stage process to behavioral change should be taken into consideration while designing a behavior changing intervention. These stages are the motivational and volitional processes. Figure 46.2 illustrates components of the behavior change design process based on psychological theory-based behavior change.

Motivational Process

The motivational process involves knowledge, risk perception, outcome expectations, self-efficacy, goal intention, and self-concordance. These are factors associated with an individual's capability and motivation. Strong motivation is key for the development of the intention, which is essential for an effective behavioral change (Rhodes & de Bruijn, 2013). These modifiable

Fig. 46.2 Components of the designing behavior change process based on psychological theory-based behavior change



personal determinants and main related program goals for improving adherence to physical activity recommendations were summarized by Geidl et al. (2014). Those are described below.

Knowledge

In this stage, individuals should understand about the main exercise concepts (i.e., physical activity, exercise, fitness, types of exercise, intensity, duration, frequency, and progression), and outcome expectations like important health benefits associated with regular physical activity and exercise practice (i.e., feeling of well-being and reduced stress, improved health and fitness). It is also important to have an individual assess their physical activity behaviors in a realistic way and to understand the negative impact of being insufficiently active or sedentary (Geidl et al., 2012, 2014).

Self-Efficacy and Goal Intention

Individuals should be certain they need to be physically active on a regular basis and organize their routine to do it. Their life should be adapted for them to be overall physically active, and to plan effectively to respond to some relapses. Also, the pattern of the physical activity program should comply with and be assessed against the established guideline recommendations (Geidl et al., 2012, 2014).

Self-Concordance

The intention of being physically active should be guided by personal and internal reasons that are important and self-reinforcing. For example, physical activity practice is routine in their life, it is fun, and offers good experiences they tend to not want to miss it, and thus for them the benefits of being physically active are worth the effort (Geidl et al., 2012, 2014).

Volitional Process

The volitional process is a pre-action phase in which an individual decides and commits to a particular behavior change. In this preparatory phase, the individual considers and identifies the best method to meet their behavioral goal (Geidl et al., 2012; Caudwell et al., 2016). This process involves multiple stages including implementation planning, coping strategies, action control, and outcome experience (Geidl et al., 2012). These stages are described further below.

Implementation Planning

This stage includes the planning to incorporate physical activities into an individual's daily routine. Individuals will specifically identify the type and intensity of physical activities, and the frequency, duration, location, and other enablers for success in the activity to be carried out (Geidl et al., 2012, 2014).

Coping Strategies

In this stage, individuals will identify and recognize internal and external barriers to physical activity and create strategies to overcome barriers and improve motivation. They should also identify barriers that may lead to relapses, such as holidays or vacations, and develop a plan to keep their physical activity routine over these periods (Geidl et al., 2012, 2014).

Action Control

Action control refers to self-monitoring. Individuals must be able to continuously evaluate their physical activity behavior with regard to their goal intentions and physical activity recommendations and be aware of potential changes to their exercise programs or physical activity plan (Geidl et al., 2012, 2014).

Outcome Experience

In this stage, individuals identify potential positive effects of regular physical activity behavior and fulfilled former outcome expectations, and recognize the need to reach personal goals by being physically active on a regular basis (Geidl et al., 2012, 2014).

Measuring Fitness and Behavior Change Success

In order to evaluate the success of fitness behavior change interventions, a validated fitness assessment is invaluable. There are several ways to measure fitness and increased physical activity levels, including both objective and subjective tools and tests. Objective fitness tests often provide a more accurate value (Prince et al., 2008); however, they are sometimes more logistically challenging and expensive. A cardiopulmonary exercise test (CPET) is the gold standard for measuring maximal oxygen uptake (VO_{2max}), an indicator of cardiopulmonary fitness and exercise capacity (Cardiopulmonary & Testing, 2018). CPET involves the pulmonary, cardiovascular, hematopoietic, neuropsychological, and skeletal muscle systems and their combined overall responses to exercise (ATS/ACCP Statement on cardiopulmonary exercise testing, 2003). These tests are typically done using either a treadmill or cycle ergometer (ATS/ACCP Statement on cardiopulmonary exercise testing, 2003). A gold standard CPET can provide many output variables, the most important of which is VO_{2max}, for measuring fitness changes. For individuals who are not physically active at all, improvements in VO_{2max} can be seen in as little as 4–6 weeks. The fitter that an individual is at baseline, the longer it takes to see improvements in VO_{2max}.

When a CPET is not available, there are other objective methods of measuring fitness change. Many submaximal tests have been used in research and clinical settings; these estimate VO_{2max} values and are less costly, shorter in duration, and may be more accessible. The premise of estimating a VO_{2max} from a submaximal test is built from several assumptions. Primarily it is assumed that a linear relationship exists between VO_2 and heart rate (HR) within the range of 110–150 bpm (Heyward & Gibson, 2014). Therefore, the HR and work rate from two submaximal work outputs can be plotted against each other to extrapolate the HR_{max} and estimate VO_{2max} from submaximal data. However, we know that this relationship turns curvilinear at higher workloads decreasing the accuracy of submaximal tests to estimate maximal values (Heyward & Gibson, 2014). Submaximal exercise tests can be conducted on a variety of equipment including, treadmills, steps, cycle ergometers, and arm ergometers. Like the maximal tests, many of the exercise protocols involve a multi-stage ramped approach, where each subsequent stage becomes progressively more difficult using either speed or resistance/grade to increase intensity.

Other methods of measuring exercise capacity and physical fitness exist, that do not provide a VO_2 value. The Senior Fitness Test (SFT) was designed to assess physical fitness in older populations across a range of age groups and ability levels (Rikli & Jones, 2013). The SFT is a comprehensive battery of tests that provide information related to upper and lower body strength, aerobic endurance, upper and lower body flexibility, agility, and dynamic balance (Rikli & Jones, 2013). There is typically no overall score related to SFT but instead individual values can be compared to population norms for each of the different test components. Changes in the SFT over time provide a good indication of overall fitness changes that can be related to changes in physical activity behaviors. For older adults, this can translate to more independence for a longer time.

The 6-minute walk test (6MWT) is a commonly used assessment to measure functional exercise capacity (*American Journal of Respiratory and Critical Care Medicine*, 2002). The 6MWT evaluates the integrated responses of the pulmonary and cardiovascular systems (*American Journal of Respiratory and Critical Care Medicine*, 2002), and is commonly used in individuals with lower aerobic capacity. Typically, individuals do not achieve maximal exercise capacity and therefore it reflects the functional exercise level achieved during daily activities more than a CPET.

When objective testing is unavailable, self-report options are available to measure change related to fitness and physical activity. The validated Duke Activity Status Index (DASI) is a questionnaire that asks the user to determine whether they can perform a variety of everyday physical activities (Hlatky et al., 1989). Each question is weighted and scored based on the known metabolic cost of each activity in metabolic equivalent of task units (Hlatky et al., 1989). The responses are added together and used to estimate the individuals' VO_{2max} (Hlatky et al., 1989). The DASI is an effective tool to measure fitness. There are a number of other validated questionnaires to measure physical activity levels. The Godin Leisure Time Physical Activity (Amireault & Godin, 2015; Godin & Shephard, 1985) and the International Physical Activity Questionnaires (Craig et al., 2003) are among the most commonly used self-report tools used to measure physical activity levels. Tracking physical activity levels would allow one to measure the success of behavior change related to fitness.

Use of Technology/Wearable Devices to Improve and Motivate Behavior Changes

Each year technology access and use increases. As of July 2020, 4.57 billion people worldwide were active Internet users, equating to approximately 59% of the world population (Clement, 2020). Technology offers an accessible, cost-effective, and time-efficient approach for the promotion and assessment of exercise behavior change (WHO | eHealth. World Health Organization, 2017). As technology develops, options to monitor fitness and physical activity levels have become more widely available. There are a variety of ways technology can be used to improve and motivate behavior change. Among these options are websites, activity tracking wearable devices, smartphone applications, and text messages. A recent systematic review ($n = 60$ studies) and meta-analysis ($n = 20$ studies) summarized the effectiveness of eHealth technologies to improve moderate-to-vigorous physical activity in the short term in working-aged women (Cotie et al., 2018). The meta-analysis demonstrated eHealth interventions improved moderate-to-vigorous physical activity on average by 25 minutes/week (Cotie et al., 2018). The American physical activity guidelines suggest individuals should complete a minimum of 30 minutes/day of MVPA (Piercy & Troiano, 2018), suggesting that eHealth interventions could act as a stepping stone to achieve these behaviors. In the last decade, wearable fitness tracking devices have become more popular.

Wearables are technology or devices incorporated into items that can be comfortably worn on the body. These devices are used for tracking information in real time and include fitness trackers, smartwatches, heart rate monitors, and Global Positioning System (GPS) tracking devices. Many of them have various sensors built in to track health parameters (steps, calories, heart rate, etc.). The idea is that by recording and reporting information about behaviors, the device can then motivate and educate people toward behavior change. Fitness behavior changes could lead to meaningful improvements in overall health, but likely only if they are long term and sustained. Despite the short-term success many people experience using wearable technologies, there is very little evidence to suggest the sustainability of their benefits. There is a large gap in knowledge between recording behavior and making the necessary changes. Wearable devices tend to be targeting individuals who are already motivated to change, suggesting they are tools that can be used to facilitate but are likely not drivers of behavior change (Patel et al., 2015). Research is ongoing when it comes to the use of technology to promote fitness and physical activity behavior change.

Summary

Physical inactivity is a very common issue around the world and is associated with the development of many frequently occurring and costly chronic physical and mental health conditions. There are many national and international guidelines around physical activity and exercise that all support the recommendation that our entire population across the age spectrum needs to move more each and every day. Physical activity and exercise plans should include being less sedentary along with a mix of aerobic, resistance, and balance activities throughout the day and week. Recommendations can be adjusted to meet the needs and preferences of each person according to age, ability and comorbidity. The evidence for adoption of regular physical activity is very compelling including reductions in the incidence and improved management of chronic diseases like diabetes, heart disease, certain cancers, mental health issues, and overall improved survival. Successful behavior change can be complex. Addressing knowledge gaps about the importance of physical activity and understanding of individual circumstances, motivators, and barriers is key. Designing physical activity interventions requires thoughtful planning and application of behavior change models appropriate to the setting and population. Once implemented, the effects of the intervention should be evaluated through quantification of fitness measures and physical activity patterns. There are many validated measures of fitness ranging from laboratory based cardiopulmonary stress testing, functional assessments, to questionnaires. New technologies, such as wearable devices, can be very helpful in these assessments and may also aid in the adoption of regular physical activity.

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47 The Good Behavior Game

P. Raymond Joslyn and Emily A. Groves

Introduction

The Good Behavior Game (GBG) was first described by Barrish et al. (1969) as a classroom management procedure for fourth-grade students. In this intervention, researchers divided the class into two teams and asked students to follow specific classroom rules (e.g., receive permission before leaving their seats or talking). Whenever a student broke one of the rules, their team received a mark on the board and teams with less than six marks at the end of the 30-minute period won the game. If both teams had more than five marks at the end of the period, the team with the lowest score won. Winning teams received extra privileges such as lining up early for lunch, wearing "victory tags," and free time at the end of the day. The GBG produced substantial reductions in inappropriate talking out and out-of-seat behavior (see Fig. 47.1).

Since this initial evaluation, the GBG has been replicated and extended in a range of education settings, showing consistent effects on student behavior (Bowman-Perrott et al., 2016; Flower et al., 2014a; Tingstrom et al., 2006). Behavioral research has repeatedly demonstrated that the GBG produces immediate and substantial effects on student behavior such as disruptive talking out, out-of-seat behavior, and off-task behavior. As we will discuss below, researchers have also demonstrated increases in other behaviors such as class participation and physical exercise. The considerable empirical support for the GBG has established it as a best-practice intervention in education, and it may be implemented in schools as a Tier 1 (preventive) or Tier 2 (targeted) intervention in the Positive Behavior Supports framework (Horner et al., 2005; Wright & McCurdy, 2011). It has also been shown to be a robust procedure, remaining effective under challenging conditions, low levels of treatment integrity, and given procedural modification.

In addition to the immediate short-term effects on student behavior, longitudinal research has demonstrated that the GBG may benefit students later in life. When implemented with young students (i.e., in first or second grade), the GBG has been demonstrated to reduce rates of substance abuse disorders, incarceration for violent crimes, risky sexual behavior, and other undesirable outcomes in adulthood (Kellam et al., 2008, 2011, 2014). Although the findings are promising, it should be noted that the exact mechanisms for these changes are not known. Later in this chapter, we will discuss possible underlying mecha-

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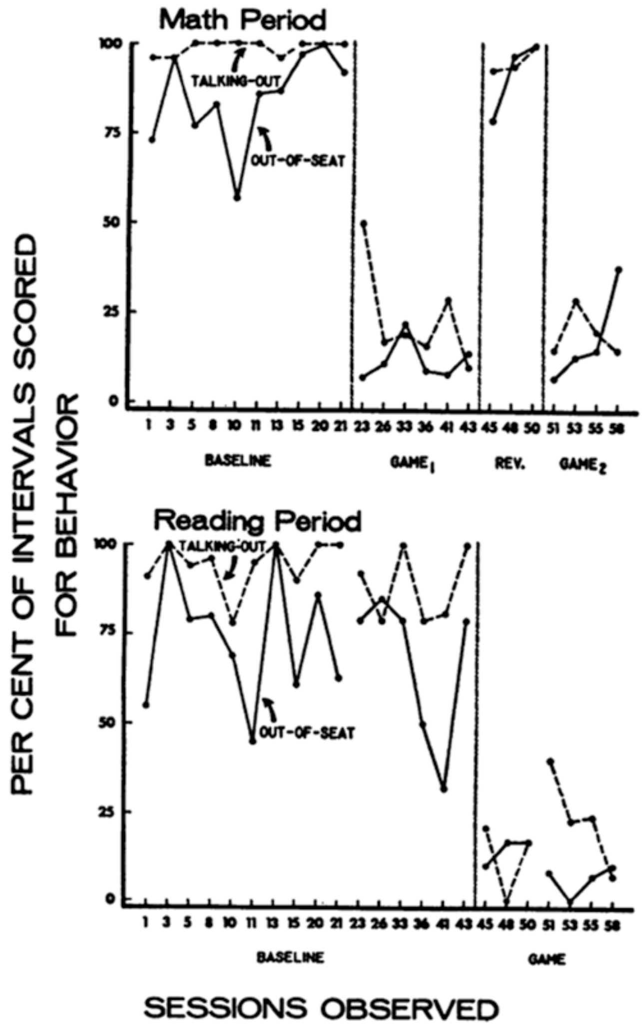


Fig. 47.1 Data from the original Barrish et al. (1969) Good Behavior Game study

nisms that may be responsible for the short- and long-term effects of the GBG.

Despite its substantial literature base, there are still important unanswered questions about the GBG, and it remains underutilized in education (Joslyn et al., 2019b; Stormont et al., 2011). Understudied areas related to the GBG include applications in novel settings outside of education, determining its underlying behavioral mechanisms, methods for streamlining and optimizing the procedure, and ways to improve contextual fit. As researchers address these questions, the task of effectively disseminating the GBG to educators will become more feasible. Currently, however, the extensive literature base and large number of variations and applications may make it difficult to provide clear treatment directions in clinical scenarios. In this chapter, we will discuss the specific procedures and common variations of the GBG, scenarios in which the GBG has been demonstrated effective, key considerations for implementation, and the potential mechanisms responsible for behavior change. We will conclude with a discussion of the current limits to our knowledge and understanding of the GBG, including areas in which more research is needed.

Good Behavior Game Procedures and Variations

The original GBG article (Barrish et al., 1969) established the framework for the GBG that is implemented today. Although published demonstrations vary in terms of procedures and behavior goals, implementation of the GBG typically includes establishing rules, delivering marks or points to teams whose members break the established rules throughout the game, and rewarding teams who remain below some point threshold at the end of the game. Because students typically "work together" to win the game, accessing rewards is contingent on team members' behavior as well as their own, making the GBG an interdependent group contingency (Litow & Pumroy, 1975).

It is recommended that behavior analysts collaborate with teachers or other stakeholders when designing a GBG intervention. This will improve social validity outcomes and facilitate data collection. Typical design of the GBG for a specific classroom consists of:

1. Selecting and establishing the rules of the game targeting the most problematic student behavior (e.g., vocal disruption).
2. Determining when the GBG will be implemented (e.g., math class) and for how long (e.g., 30 minutes).
3. Selecting the rewards students will receive for winning the game (e.g., small snacks, extra free time, and classroom privileges).
4. Baseline data collection to determine the point threshold and monitor effectiveness. Point thresholds may be based on rates of problem behavior in baseline or selected arbitrarily.

Once the above parameters have been set, implementation consists of:

1. Dividing a class into teams. Ideal team selection involves equally distributing students likely to engage in high rates of problem behavior and likely to serve as models for appropriate behavior to other students equally across the teams.
2. Writing the rules and teams on the board or otherwise displaying them where they are visible to all students. In some cases, teachers may prefer to use a computer- or web-based implementation platform where points can be delivered remotely. See Fig. 47.2 for an example of a GBG board display.
3. Introducing the game to students. This consists of explaining the rules of the game, who is on which team, and describing or showing students what rewards are available to winning teams.
4. Announcing the beginning of the game.
5. Throughout the game, the implementer should deliver a mark and feedback to a team whenever a team member breaks a rule. This consists of saying something like, "Team 1, remember to raise your hand and receive permission before you leave your seat," and placing a hatch mark under their team on the game display.
6. At the end of the game, the implementer announces that the game is over, counts the points, and announces the winners. Then, rewards are delivered to the winning team(s) immediately.

   *See Joslyn et al. (2020) for a more detailed guide to planning and implementing the GBG for practitioners.

GBG Variations

A large proportion of recent GBG research has followed similar procedures to those listed above. However, there are also several ways in which these components may be varied in an effort to improve effectiveness, address specific classroom needs, and improve contextual fit for teachers. Variations of the GBG with empirical support include contingency modifications such as awarding points for appropriate behavior, response cost, and independent group contingencies. Researchers have also conducted component analyses and explored using point thresholds and rewards that are not revealed to students until the game is over. Below, we will describe each of these variations and their empirical support.

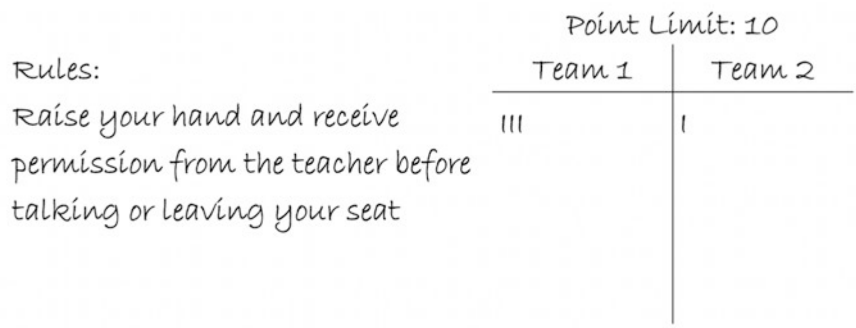


Fig. 47.2 An example board display for the GBG

The "Caught Being Good Game"

In one of the most common GBG variations, the group contingency is placed on rule following rather than rule breaking. That is, students are awarded desirable points for being in compliance with the rules and win the game by exceeding the point threshold. On a time-based schedule, the implementer scans the rooms and awards points to teams whose members are all following the rules. This variation, sometimes referred to as the Caught Being Good Game (CBGG), has been demonstrated to be similarly effective to the GBG although there have been relatively few comparison studies (Tanol et al., 2010; Wahl et al., 2016; Wright & McCurdy, 2011).

Although the CBGG produces similar effects to the standard GBG arrangement, it has advantages and limitations. There are at least three contexts in which the CBGG can be advantageous. First, because the contingency is placed on appropriate behavior rather than inappropriate behavior, it may be preferred by some teachers or school administrators (Tanol et al., 2010). Although the GBG and its variations are reinforcement based and social validity data indicate that most students enjoy playing the game (Joslyn et al., 2019b), stakeholders may view the marks delivered in the traditional GBG as punitive or disciplinary (we will discuss mechanisms of behavior changer later in this chapter). A second potential advantage of the CBGG is in its interval-based implementation, which may make it more suitable for targeting continuous (non-discrete) behaviors such as on-task behavior. Targeting continuous behaviors may be more challenging with the traditional GBG arrangement due to the continuous schedule of point delivery; whenever a rule is broken, a mark should be delivered. It is not generally feasible for a teacher to deliver a point whenever any student stops being on task for a few moments. However, for discrete behaviors like calling out, the CBGG may be less suitable due to the delay in feedback inherent in the procedure. For example, if the CBGG is being implemented on a 3-minute schedule, a student who calls out early in the interval may not receive feedback on their behavior for up to 3 minutes. This could make the GBG more appropriate for younger students who have difficulty with delayed consequences. Third, some teachers may prefer the time-based schedule of the CBGG over the continuous schedule of the GBG. Comparison studies have indicated that some teachers prefer the less frequent but more effortful scoring of the CBGG, while others prefer the more frequent but less effortful scoring of the GBG (Wahl et al., 2016). Point delivery can be disruptive to instruction, so it is important to consider teacher preference when arranging the GBG in their classrooms. The class activity during which the game will be played may also be relevant during the design of the intervention. For example, a teacher may find the continuous schedule of the GBG more feasible when students are working independently or prefer the CBGG when they are delivering instruction.

Response Cost

Another variation of GBG procedures involves the use of a response cost component in the intervention (Leflot et al., 2010; Silva & Wiskow, 2020; Tanol et al., 2010). In this variation, students are given a certain number of points at the start of the game and points are removed contingent upon rule violations. In the response cost variation, teams win by having a certain number of points left at the end of the game. Tanol et al. (2010) compared the GBG variation in which points were awarded for rule following (i.e., the CBGG) to a response cost variation of GBG and found that while both versions of the game were effective at reducing rule violations, the teacher preferred awarding points for rule following. Silva and Wiskow (2020) compared the original GBG to a response cost GBG and also found that both interventions were effective; however, the teacher appeared to prefer the response cost GBG and chose to implement this version when given a choice. The teacher reported that she found it easier to play the response cost GBG than the original GBG. The response cost adaptation is uncommon in the GBG literature relative to other variations. However, the response cost GBG may be a viable option for teachers who do not prefer the traditional GBG or CBGG variation.

Independent Group Contingency

Implementers may also choose to implement an independent group contingency rather than an interdependent group contingency during the GBG. In an independent group contingency, common rules and criteria are applied to the group and each individual's access to rewards is based solely on their own performance (Litow & Pumroy, 1975). That is, each student is effectively "on their own team." There have not been many direct comparisons of the traditional arrangement and the independent arrangement. However, Groves and Austin (2017) conducted a comparison of the two contingencies and found them to be similarly effective, although social validity data indicated that the teacher and a majority of students preferred the interdependent contingency. This variation may be advantageous with students who struggle with working collaboratively on a team, such as some students with emotional and behavioral disorders. However, the independent arrangement of the GBG is unlikely to support these students in improving peer interactions and relationships. Working together on a team may help these students gain social skills.

"Mystery" Win Criteria

Researchers have also explored the utility of an "unknown" or "mystery" win criterion in the GBG, meaning that the criterion to win the game varied across sessions and was not revealed to students until the end of the game. Studies using a "mystery" win criterion indicated characteristic GBG effects; immediate and substantial improvements in student behavior (Flower et al., 2014b; Lannie & McCurdy, 2007; Wahl et al., 2016; Wright & McCurdy, 2011), but there have been few studies that have directly compared known and unknown win criteria. Groves and Austin (2020) compared GBG implementation with known and unknown win criteria and found that both variations were equally effective, but teachers preferred the unknown criteria and student preferences were mixed. The utility of this variation will be discussed further in the implementation considerations section later in this chapter.

Component Analyses

One of the most effective ways to examine the limits of procedural variations could be to conduct component analyses. However, there have been few component analyses with the GBG. In a notable exception, Foley et al. (2019) conducted a component analysis of the GBG with preschool students. Beginning with classroom rules only, they incrementally added feedback for rule violations, a win criteria, and noncontingent reinforcement. However, they found that all components of the GBG were required to decrease disruptive behavior. Other researchers have opted to examine variations of specific components such as feedback for rule violations. Wiskow et al. (2019) compared different types of feedback for rule violations (i.e., no feedback, visual, vocal, and both) with preschool students, and found that vocal feedback was required to produce notable decreases in disruption. It is important to note that both of these studies were conducted with general education preschool students and their findings may not extend to other student populations. For example, middle- or high-school students may not require as salient feedback or the implementation of all traditional GBG components for behavior change.

Teacher Preferences

It is worth noting in this section that teacher preferences across studies and variations are inconsistent and likely idiosyncratic. Although most GBG research indicated teacher preference for the GBG over no intervention (cf., Joslyn et al., 2019a), preferences between variations of the GBG vary across studies and participants. For example, teachers in Wahl et al. (2016) indicated mixed preferences for traditional GBG and the CBGG variation, citing the point delivery schedules as a factor in their preference. In addition, although a teacher may indicate preference for the GBG, there can be components of the procedure that they find aversive or effortful which may be detrimental to sustainability over time (Joslyn et al., 2019a). Therefore, researchers and practitioners working with teachers should be aware of the established variations, their empirical support, and how they are implemented. Presenting teachers with choices and alternatives can improve contextual fit, resulting in faster adoption of procedures, higher treatment integrity and quality, and intervention sustainability (Johnson et al., 2014).

Applications

Given the versatility of the GBG, it may not be surprising that it has been implemented in a wide array of contexts. Behavioral researchers have extended the GBG beyond the fourth-grade classroom to a range of student ages, in different settings, and to address various forms of behavior beyond classroom disruption.

Student Population Characteristics and Settings

The GBG is most commonly implemented in elementary schools (Bowman-Perrott et al., 2016; Flower et al., 2014a) to reduce student disruption and increase on-task behavior (e.g., Lannie & McCurdy, 2007; Lynne et al., 2017; Wright & McCurdy, 2011). Bowman-Perrott et al. (2016) conducted a quantitative analysis of GBG studies and found that the majority were conducted with students in kindergarten through to fifth grade. Although the majority of published research has been conducted with this student age group, recent research has shown that the GBG can be equally effective with a range of student ages.

The GBG has also been evaluated in preschools with students as young as 4 years old (e.g., Foley et al., 2019; Swiezy et al., 1993; Wiskow et al., 2019). Swiezy and colleagues implemented the GBG in a preschool with children who were reported to be particularly disruptive and noncompliant. During the GBG, children worked in pairs and a “Buddy Bear” puppet provided regular instructions to the children (e.g., “Get a book from the bookcase”). When both children complied, they were given a smiley face or dinosaur token and each pair could win the game by meeting a specific point criterion that was individualized for each pair. Winning pairs received a small animal-shaped snack. The GBG was effective at increasing compliance with instructions in all pairings of children. More recently, Wiskow et al. (2019) demonstrated that variations of the GBG were effective at reducing disruption in preschoolers, with the strongest effects demonstrated when students were provided vocal feedback (alone or in combination with visual feedback).

Applications of the GBG with older students are more limited. However, researchers have demonstrated that the GBG can be effective with students up to high school and college age. Kleinman and Saigh (2011) extended the GBG to a ninth-grade classroom in a high school. The GBG was played daily and winners received a bite-sized piece of candy (identified as preferred via a student preference assessment questionnaire). The team with the lowest number of points at the end of the week was declared the "weekly winners" and received a special pizza party. The GBG was effective at reducing verbal disruption, seat leaving, and aggression, and a social validity assessment revealed that students and teachers responded favorably to the GBG. Other researchers have also successfully implemented the GBG in secondary school settings (e.g., Flower et al., 2014b; Joslyn et al., 2019a; Mitchell et al., 2015); however, the GBG should continue to be studied with this population to further understand potential age and population differences.

In a unique application, Cheatham et al. (2017) used a modified version of the GBG in three introductory psychology courses to increase class participation (i.e., hand raising) in college classrooms (see Fig. 47.3). In this application,

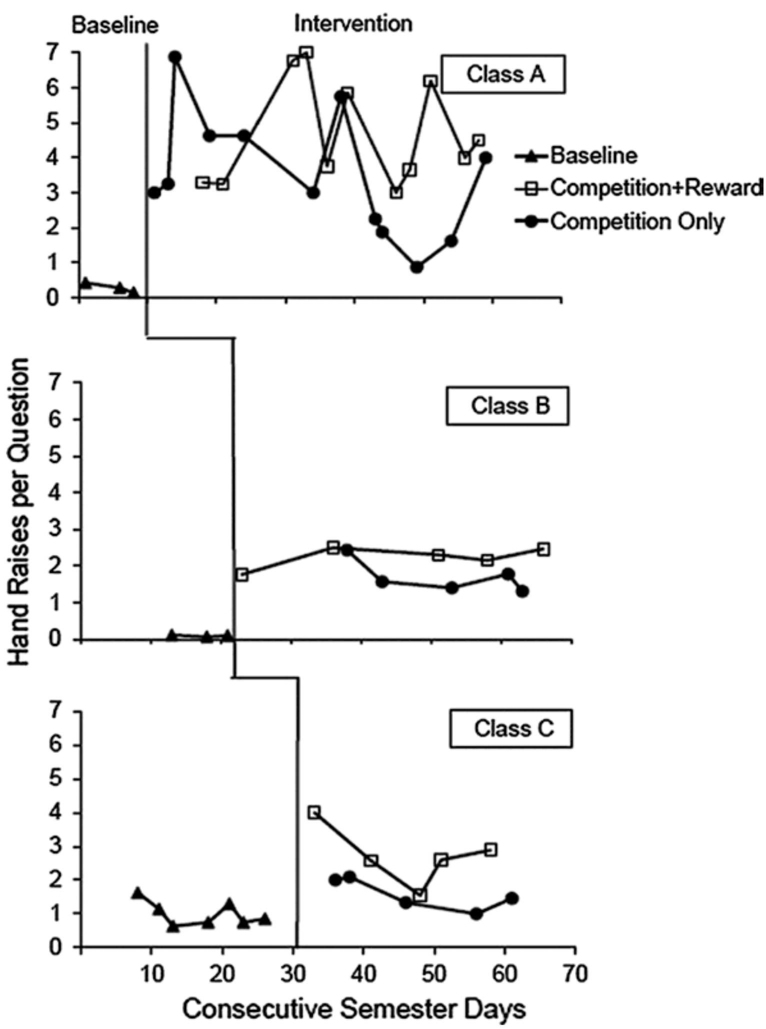


Fig. 47.3 Class participation data from Cheatham et al., 2017

each class was divided into two teams and a tally mark was awarded to a team if a member of the team raised their hand and answered a question correctly during a lecture. A team won the game by having more tally marks at the end of the lecture than the other team. This is a slight departure from typical GBG procedures, as traditionally teams compete against a fixed criterion, rather than each other (Barrish et al., 1969). Two versions of the GBG were compared in this study; in one condition (competition plus reward) the winning team received a reward (one activity point) upon winning and in another condition (competition only) the winning team did not receive a reward. Cheatham et al. found that both versions of the GBG were effective at increasing hand raising in all classes, with the competition plus reward condition producing slightly greater increases in hand raising.

The majority of GBG evaluations have been conducted with students of typical development in general education classrooms (Bowman-Perrott et al., 2016; Flower et al., 2014a). However, the GBG has also been extended to students with autism and intellectual disabilities (e.g., Breeman et al., 2016; Vargo & Brown, 2020; Wiskow et al., 2018). Vargo and Brown (2020) implemented the GBG in a special education structured learning classroom, with six high school students with autism. The researchers compared the effectiveness of the traditional GBG with technology enhanced GBG variations (GBG with ClassDojo and ClassBadges). All GBG variations were found to be effective at reducing disruptive behavior displayed by students. In another evaluation with children with disabilities, Wiskow et al. (2018) implemented the GBG in a small-group setting to successfully reduce the disruptive behavior of a 4-year-old boy with fetal alcohol syndrome. As previous research indicates, the GBG might provide a simple and effective strategy to reduce problematic behavior with students with disabilities. Although the recent GBG research in special education is encouraging, further research should be conducted to enhance our understanding of the effects of the GBG when used with students of varying degrees of intellectual disability and to evaluate the extent to which adaptations may be necessary.

Alternative education (i.e., schools for students with emotional and behavioral disorders who engage in severe problem behavior) is another setting with a strong and growing GBG literature base (e.g., Groves & Austin, 2017, 2019; Joslyn et al., 2014, 2020; Joslyn et al., 2019a; Rubow et al., 2018; Sy et al., 2016). Group-oriented contingencies like the GBG might prove particularly useful in these settings due to the likelihood that many students in the classroom will engage in high levels of problem behavior. Joslyn et al. (2019a) implemented the GBG in three high school classrooms with students with EBD and histories of delinquency. The GBG targeted disruptive behavior (talking out and out-of-seat behavior) in these classrooms, due to the high frequency at which these behaviors occurred. The authors used a modified GBG, whereby students in each class were placed on one team (as opposed to multiple, smaller teams as is typical in the GBG; Barrish et al., 1969). This modification was made due to the smaller class sizes in this setting and to prevent students from “sabotaging” the game for other students by taunting students on opposing teams into breaking the rules. The GBG was successful at reducing disruptive behavior in all classrooms.

Rubow et al. (2018) also implemented the GBG in two classrooms with students with EBD and/or severe problem behavior in an alternative school. The GBG effectively reduced disruptive behavior in both classrooms, increased teacher praise delivery relative to reprimands, and social validity assessments found that students and staff rated the GBG positively. Both of the aforementioned studies conducted in alternative education settings targeted high-frequency, low-intensity behaviors. Future research should address the potential of targeting these behaviors to prevent high-intensity problem behavior (e.g., aggression toward others, property destruction) from occurring in alternative education classrooms, as in some cases they can be precursor behaviors.

Target Behavior

Targeting low-intensity disruption is common in GBG studies. Previous reviews have found that the GBG typically targets behaviors such as calling out without permission, inappropriate sitting, seat leaving, verbal disruption, and physical disruption (Bowman-Perrott et al., 2016; Flower et al., 2014a). These disruptive behaviors are often combined into one "disruption" or "inappropriate behavior" measure in GBG studies. For example, Donaldson et al. (2011) used the GBG to reduce out-of-seat behavior, talking out of turn, and touching other students in five elementary school classrooms. The GBG is also commonly used to reduce off-task behavior (Flower et al., 2014b; Groves & Austin, 2017; Groves & Austin, 2020) and increase on-task behavior (Pennington & McComas, 2017; Lannie & McCurdy, 2007). Researchers have targeted other behaviors including aggression and property destruction (Kleinman & Saigh, 2011), swearing (Groves & Austin, 2019; Salend et al., 1989), and cell phone use in class (Groves & Austin, 2019).

Although typically used as a reductive behavior change strategy, the GBG has also been used to increase students' academic behaviors. Lynne et al. (2017) and Wahl et al. (2016) used the GBG to successfully increase students' academic engagement. Darveaux (1984) used the GBG to increase assignment completion and active participation in class, in addition to reducing problem behavior. Weis et al. (2015) evaluated the effects of the GBG on reading and mathematics in a large-scale study that included students from six school districts in the United States. The GBG was implemented in elementary classrooms across one academic year to measure the effects on academic behaviors. The study found that the GBG resulted in a statistically significant increase in basic academic skills in students who received the GBG, when compared to students in the control group who did not receive the GBG.

The GBG has also been applied to increase students' prosocial behavior. Patrick et al. (1998) evaluated the GBG in the context of volleyball games in physical education classes in an elementary school. Teams were awarded points during the GBG for appropriate social behaviors, including physical contact that was supportive in nature (e.g., pat on the back), supportive verbal statements between teammates (e.g., "good job"), and supportive gestures (e.g., thumbs up). Points were deducted from teams who displayed inappropriate social behaviors, including offensive physical, verbal, or gestural acts. The GBG was found to be effective at increasing appropriate social behaviors and decreasing inappropriate social behaviors during volleyball games.

In the classroom, Salend et al. (1989) measured students' negative comments directed toward peers (e.g., name calling), complaining about assignments, and complaining about the teaching, among other behaviors. The study was conducted in a residential school with "emotionally disturbed" students. The GBG was found to be effective at reducing all target behaviors, including negative comments and complaining about assignments or teachers. Groves and Austin (2019) further extended the GBG literature by directly measuring positive peer interactions (as well as negative peer interactions) in a primary and secondary school classroom (see Fig. 47.4). They reported that students in these classrooms had social skill deficits and poor relationships with one another and found that the GBG resulted in an increase in positive peer interactions and a decrease in negative peer interactions in both classrooms. Interestingly, the peer interactions measured in this GBG were not targeted in the GBG rules. That is, there were no contingencies in place to increase positive peer interactions or decrease negative peer interactions. This suggests that the changes in positive and negative peer interactions are welcome side effects of the GBG, rather than direct effects.

As well as evaluating the effect of the GBG on student behaviors, some researchers have measured teacher behaviors, including use of praise statements and feedback to students. Wahl et al. (2016) investigated the effect of the GBG on teacher's positive and negative statements. Positive statements included acknowledgement of rule following (e.g., "I like how everyone is focused on our work") and negative statements included disapproval of student behavior or lack

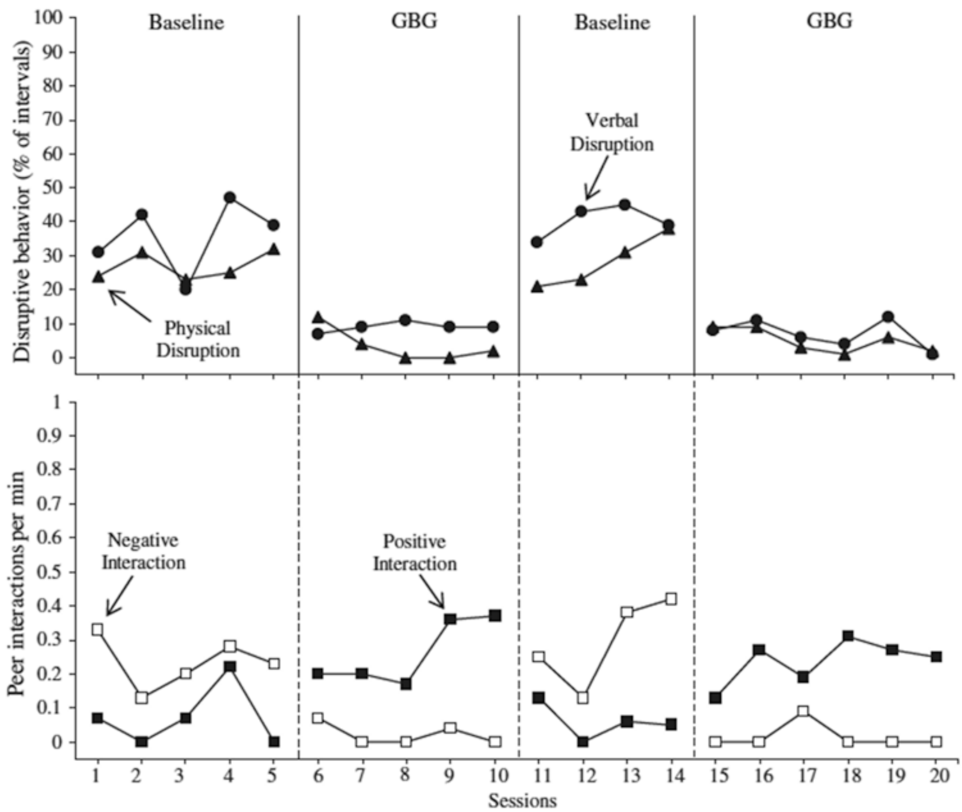


Fig. 47.4 Problem behavior and peer interaction data from Groves and Austin (2019)

of rule following and redirection (e.g., "Stop tapping your pencil on the desk, please"). The GBG did not result in an increase in positive teacher statements, nor did it decrease negative teacher statements. Conversely, Tanol et al. (2010) found that the GBG did result in a modest increase in teachers' use of praise statements. More recently, Rubow et al. (2018) found that the GBG resulted in an increase in teachers' use of praise statements relative to reprimands. Interestingly, the authors in this study did not specifically train teachers to provide praise statements and no contingencies were in effect for doing so. Rather, teacher praise statements seemed to be affected indirectly by the GBG.

The GBG has also been applied in contexts outside of the classroom, for example, in the library (Fishbein & Wasik, 1981), the cafeteria (McCurdy et al., 2009), and during school recess (Galbraith & Normand, 2017; Normand & Burji, 2020; Patrick et al., 1998). Fishbein and Wasik (1981) measured task-relevant behaviors, off-task behavior, and disruptive behavior in fourth graders during weekly library periods. The GBG was implemented by the librarian and the rules were centered around appropriate library etiquette (e.g., "if you talk, talk quietly" and "choose a library book or look at library materials"). The GBG was effective at increasing task-relevant behaviors and reducing off-task and disruptive behaviors. McCurdy et al. (2009) implemented the GBG in the cafeteria, which they referred to as the Lunchroom Behavior Game (LBG). The LBG was effective at reducing seat leaving, play fighting, physical contact between peers, throwing objects, and screaming during school lunch periods. In another novel application, Galbraith and Normand (2017) extended the GBG to school recess in order to increase physical activity in elementary school students. They measured the number of steps taken by students during recess via a pedometer. Students were divided into teams at the start of recess and the team who took the most steps was rewarded. The results showed that students took more steps during recess while playing the GBG than they did when the GBG was not played. These unique applications highlight the generalizability and flexibility of GBG procedures.

Previous reviews of the GBG literature suggest that the vast majority of applications have been conducted in the United States (Bowman-Perrott et al., 2016). However, there have been many noteworthy contributions to the GBG literature from outside of the United States (Nolan et al., 2014), including demonstrations from Belgium (Leflot et al., 2010), Belize (Nolan et al., 2013), Canada (Dion et al., 2011; Kosiec et al., 1986), Chile (Perez et al., 2005), the Netherlands (van Lier et al., 2004; Dijkman et al., 2015), Spain (Ruiz-Olivares et al., 2010), Sudan (Saigh & Umar, 1983), and the United Kingdom (e.g., Coombes et al., 2016; Groves & Austin, 2017; Phillips & Christie, 1986). However, in some of the above cases, the GBG was implemented in conjunction with other interventions (e.g., peer tutoring), limiting the extent to which we can draw conclusions about the effects of the GBG as a standalone intervention across cultures.

It is important to note that, although the GBG has been indicated effective in all of the above applications, there are key considerations for maximizing the likelihood of success. In addition, procedural variations have frequently been utilized in an attempt to optimize the intervention for a given setting, improve contextual fit, or explore specific variables in research. In the next section, we will discuss several key implementation considerations that can increase the likelihood of success across applications.

Implementation Considerations

The literature provides important considerations for implementing the GBG. However, not all aspects of GBG implementation have been experimentally manipulated. In this section, we discuss key aspects of GBG implementation and training that are supported by the empirical literature. We have supplemented this section with anecdotal information from the literature (e.g., Joslyn et al., 2020) and our collective experience for topics not yet addressed by researchers.

Designing the Good Behavior Game

An important first step in implementing the GBG is choosing the rules of the game. As mentioned previously, the GBG is typically used to reduce low-intensity disruptive behavior such as calling out, out of seat, and physical disruption, and to increase appropriate behaviors such as participation in class and assignment completion. The target behaviors (i.e., the behaviors targeted for decrease/increase) should be addressed by the rules of the game. For example, if you would like to reduce calling out in class, then a rule of the game may be, “Raise your hand and receive permission before talking.” There are typically between two to four rules in the GBG that cover the most problematic behaviors in the classrooms, as most problem behavior in the classroom can be addressed with just a few rules as long as they are carefully designed. The rules of the game should be developed with the teacher to ensure they cover the most pressing issues and also align with current behavior management practices in the classroom.

In the GBG, a class is typically divided in half to create two teams. However, the exact number of teams and how many students are in each team generally depends on the size of a class. Some studies have successfully implemented the game with three or more teams (e.g., Groves & Austin, 2020; Lynne et al., 2017), whereas some studies with smaller numbers of students per class have chosen to use the whole class as one team (e.g., Groves & Austin, 2019; Joslyn et al., 2019a). Donaldson et al. (2018) compared the GBG with one, two, and five teams in preschool classrooms and found that all were equally effective but that most teachers preferred the two-team arrangement. In games where one team is used, if any student in the class violates a rule the whole class gets a point (in the traditional GBG). When using two or more teams, it is useful to evenly distribute students who typically engage in higher levels of problem behavior across the teams. It is also useful to place students who are most likely to model appropriate behavior near the students(s) who are most likely to engage in problematic behavior.

Another important consideration when designing a GBG intervention is the selection of rewards that will be provided to the winning team(s). Each team that remains below the established point threshold will receive a reward at the end of the game. Rewards may include access to activities (e.g., games, extra recess, or time on computer) or tangible items (e.g., snacks, tokens, winner's badges). To ensure that the delivery of rewards doesn't interfere or disrupt ongoing class activities, rewards that can be delivered immediately and don't last very long are useful. Effective rewards may be idiosyncratic and tailored to the specific population or setting. For example, Cheatham et al. (2017) used activity points as a reinforcer in their application of the GBG in college classrooms. Activity points were typically earned by attending class and completing assignments and they made up 12% of the students' final course grade. Interestingly, Cheatham et al. identified the most preferred reward by conducting a preference assessment before the start of intervention and thus this was used as a reinforcer in the GBG. Other researchers have polled the class to obtain a list of students' most preferred reinforcers and offered a choice from an array to winning teams (e.g., Joslyn et al., 2019a).

Teacher Training and Consultation

In most applications of the GBG, the classroom teacher or a paraprofessional is trained to implement the procedures (Flower et al., 2014b). Ideally, all staff that work in the classroom will be trained to implement the GBG. Research has indicated that various training formats and durations can be effective. Groves and Austin (2017) trained teachers by providing a step-by-step description of the GBG, modeling of the procedures, the opportunity to roleplay, and via video observation. Wright and McCurdy (2011) also trained teachers via modeling and role-play opportunities and set a criterion of 100% procedural integrity in a role-play test before training was terminated. Alternately, some researchers have explored minimizing training duration and effort. Joslyn and Vollmer (2020) found that teachers can be trained to effectively implement the GBG effectively in as little as 20 minutes. In addition to employing evidence-based training strategies to train teachers, clinicians should consider providing follow-up support to teachers and other staff during implementation to avoid gradual decreases in treatment integrity and address problems should they arise.

It is important that the views and best interests of the teacher are considered when designing the GBG for each classroom. Teachers and other school staff should be consulted at each stage of the process when designing the exact procedures that will be implemented in their classrooms. This includes consulting with teachers regarding the specific rules of the GBG (i.e., the target behaviors), the variation of the game that will be employed (e.g., responding to rule following or rule violations), the duration of the game and how often it will be implemented, by whom it will be implemented, and the rewards that will provided to winning teams. Students can also be included in the design of the game in their classrooms. In particular, students can help choose target behaviors and rewards that they will receive if they win. As previously mentioned, preference assessments can be useful to help identify preferred rewards (e.g., Cheatham et al., 2017; Lannie & McCurdy, 2007). Preference assessments have also been used to identify preferred variations of the GBG. Groves and Austin (2017) conducted a group preference assessment with students to identify if students preferred an individual GBG (i.e., an independent group contingency) or a team-based GBG (i.e., an interdependent group contingency). Including teachers, school staff, and students in the design and implementation of the GBG can help to improve buy-in from these individuals and optimize social validity.

Data Collection and Analysis

Researchers and clinicians have used a variety of procedures to evaluate behavior change during the GBG. The specific data collection procedures used typically depend on the needs of each individual classroom, but it is common to use continuous measures (e.g., frequency, duration) or discontinuous measures (e.g., time sampling) to measure the effectiveness of the GBG. Data should be collected on behavior targeted by the rules of the game. Typically, GBG studies report on the behavior of students at the group level (Joslyn et al., 2019b). That is, data are recorded on the whole class, rather than on individual students. Collecting data at the group level may be suitable if you are interested in evaluating the effects of the GBG on the entire class (i.e., decreasing problem behavior in general). However, some researchers have chosen to collect data on individual student behavior (e.g., Donaldson et al., 2017; Groves & Austin, 2017; Tanol et al., 2010). Collecting data on individual students may be appropriate if you have a small number of students who display high levels of problematic behavior or you are primarily interested in improving the behavior of particular students without individualized interventions (e.g., when there are a few students in the class who engage in most of the disruptive behavior). This approach also allows for more efficient identifications of students who are not sensitive to the contingencies of the GBG and may require more individualized interventions (Donaldson et al., 2017).

Most behavioral GBG research has employed single-case designs to demonstrate the effects of the intervention on target behavior, including reversal, multiple baselines, and alternating treatments designs (Tingstrom et al., 2006). Before implementing the GBG, baseline data are typically collected to provide a measure of the target behavior prior to the intervention. Data collectors should work with the class teacher to identify the most appropriate times to collect data (e.g., when problem behavior is most likely to occur, during the times the teacher plans to implement the GBG). During baseline, teachers are typically asked to respond to problem behaviors as they typically would. However, it may be necessary to make slight modifications to facilitate data collection such as having the teacher signal times when calling out answers is allowed, when students may talk to each other without receiving permission (e.g., during a group activity), or when it might be acceptable for a student to leave their seat without permission (e.g., to turn in a paper or sharpen their pencil). Baseline data should be collected until a stable pattern of responding is observed. Once baseline is complete, the GBG can be implemented and ongoing data collection should continue to closely monitor the effectiveness of the intervention. In some cases, when stakeholders want the GBG implemented as quickly as possible, an alternating treatments design in which GBG and baseline sessions are rapidly alternated can be useful (e.g., Joslyn & Kronfli, 2021). This avoids prolonged baselines and can demonstrate treatment effects quickly.

It is worth noting that previous research has demonstrated that the effects of the GBG do not appear to maintain when the intervention is withdrawn and baseline is reinstated. Although this is desirable from an experimental control perspective, it is less practical for teachers who are seeking a long-term solution to behavior problems in their classrooms. Previous research has also demonstrated that the effects of the GBG do not appear to generalize outside of times in which the GBG is played. Donaldson et al. (2015) measured immediate and distal effects of the GBG by recording levels of disruption before, during, and after GBG implementation. The researchers found that while disruption did decrease during GBG sessions, it did not decrease during sessions preceding or following GBG implementation. Pennington and McComas (2017) measured individual student behavior during the GBG and in the subsequent period (in which the GBG was not implemented) and also found no generalization effects.

In addition to collecting data on student behavior, clinicians should also monitor the degree to which the GBG is implemented as planned. Treatment integrity is primarily monitored during the GBG in two ways: a) via procedural checklist, or b) scoring accuracy. Steps on procedural checklists may include the rules being visible to all students, the teacher delivering points for rule violations, and delivering the reward to winning teams (see Fig. 47.5

Appendix A

Basic Steps for Implementing the Good Behavior Game

Note: The following task analysis describes how to implement the traditional GBG. If you plan to implement the CBGG arrangement, you will be awarding points for following the rules on a time-based schedule (e.g., every 4 minutes) and students win by exceeding the point threshold.

1. Establish the rules of the game (e.g., you must receive permission to talk or leave your seat).
2. Select specific activities, class periods, or times of day to play. Choose activities and times in which the behavior you would like to improve is most problematic.
3. Choose rewards for winning the game that the students will like (e.g., snacks or free time). You can ask the students what they would like to win and let them choose from a variety of options or change the reward from day to day.
4. Divide the class into teams, distributing students likely to engage in problem behavior evenly across them. Ensure that the students know what team they are on before beginning.
5. Write the rules and teams where they will be visible to the class (e.g., on the whiteboard at the front of the room) or use a computer scoring system. This is where you will record marks.
6. Choose a mark threshold (i.e., how many marks can the students receive and still win the game). A common recommendation is to try for an 80% reduction in problem behavior from baseline. However, when first implementing the GBG, try to ensure that the students win the first game by either ending it early or using a high mark threshold.
7. During the game, consistently deliver marks to teams when students break the rules. When delivering a mark, be sure to notify the student why their team is receiving a mark.
8. At the end of the game, deliver rewards to students on winning teams and remind students who lose that they will have another opportunity next time. If both teams are under the mark threshold at the end of the game, both teams win. If both teams have exceeded the threshold, the team with the lowest score wins.

General Tips

1. Avoid delivering marks to students for engaging in behaviors that are not violations of the GBG rules. Other consequences may be delivered for these, but if they have not broken a rule specific to the GBG, do not give them a mark on the board.
2. Try to be as consistent as possible when delivering marks for disruptive behavior.
3. If a student disputes a mark for a rule violation, try not to attend to or engage with them. When a rule is broken, deliver a mark as you normally would and continue with your lesson. If the student is violating the rules to dispute their mark, this can result in additional marks.
4. If a student refuses to play the game or tries sabotages it (e.g., they are deliberately the breaking rules), they can be placed on their own team. Notify the student that they are now on their own team and allow them a proportional mark threshold. They can be returned to a team with other students after winning individually.
5. Always be sure to deliver rewards to winning students immediately following the end of the game. If you do not give them the reward they have earned or deliver the reward later than you originally stated you would, it may reduce the effectiveness of the procedure.
6. Review these steps frequently to ensure that you are not leaving anything out of the game.

Fig. 47.5 Basic guidelines for GBG implementation from Joslyn and Vollmer (2020) for an example of items that may be included in a treatment integrity checklist). Scoring accuracy compares the number of points delivered to the number of observed rule violations (Donaldson et al., 2011; Joslyn and Vollmer 2020; Sy et al., 2016). Previous researchers have found that the GBG was effective even when treatment integrity was low (Joslyn & Vollmer, 2020; see Figs. 47.6 and 47.7). Sy et al. (2016), who measured scoring accuracy during the GBG, found that the intervention was still effective at reducing target responses even when scoring accuracy was as low as 8.5%. However, further research is needed to examine the extent to which treatment integrity may be reduced while maintaining effectiveness in suppressing problem behavior. In addition, scoring accuracy only takes into consideration only one component of the GBG procedures (accuracy of point delivery); it is unknown what impact errors of omission in other GBG features may have on levels of effectiveness. For example, withholding the reward may have a more detrimental effect than low scoring accuracy on the effectiveness of the intervention.

Mechanisms of Behavior Change

Because the GBG is a multicomponent intervention, it is likely that there are several mechanisms responsible for student behavior change.

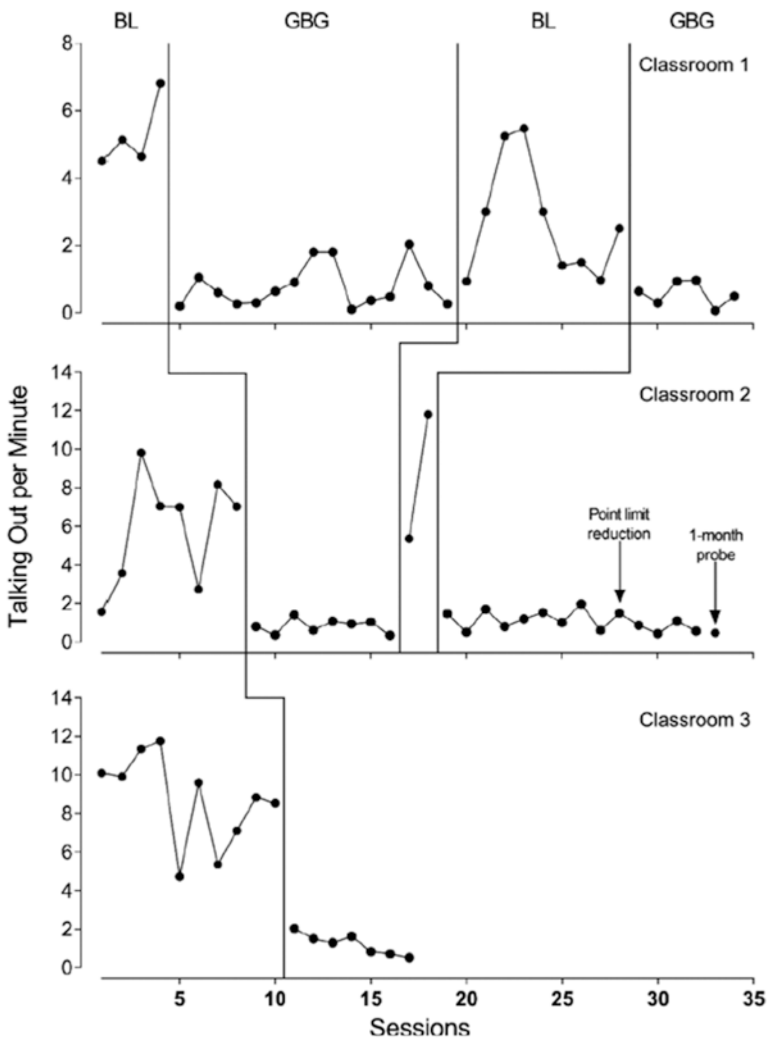


Fig. 47.6 Student behavior from Joslyn et al. (2020)

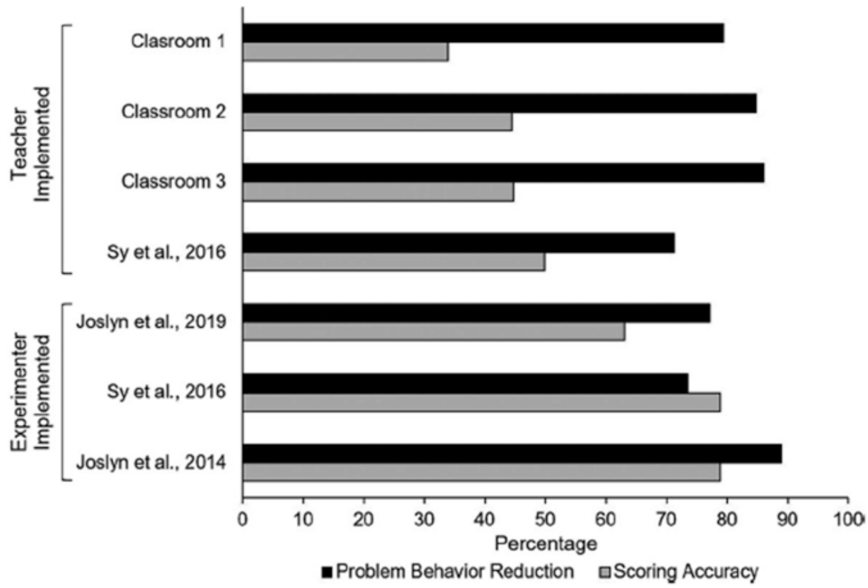


Fig. 47.7 A comparison of mean problem behavior reduction and GBG scoring accuracy values when implemented by experimenters and teachers from Joslyn and Vollmer (2020)

Although research specifically examining the mechanisms of the GBG is limited, examining the findings of specific GBG studies and applying the conceptual systems of applied behavior analysis (ABA) to the GBG allows us to consider its primary means of behavior change. First, we will address potential mechanisms for the short-term effects, followed by the long-term effects.

Short-Term Mechanisms

The GBG likely affects behavior through multiple mechanisms. One key component of the GBG is the clear and specific rules that are provided to students before and throughout each session. Providing students with these rules and explaining the consequences for breaking them likely leverages rule-governed behavior, which may contribute to the immediacy of effects. This is evidenced by the fact that student behavior often reduces immediately upon implementation of the GBG (i.e., on the first day), before students receive points for rule violations or rewards for winning. As students experience the game and contact contingencies for rule breaking, their behavior becomes contingency shaped.

Differential reinforcement is another mechanism potentially responsible for short-term improvements in student behavior. The GBG is a full-session differential reinforcement of low rates of behavior (DRL) procedure, and the CBGG variation utilizes differential reinforcement of alternative or other behavior (DRO or DRA). In DRL, students gain access to rewards contingent on engaging in fewer than a prespecified number of certain instances of behavior (e.g., calling out) throughout some specified time interval (e.g., 30 minutes). In the CBGG variation, students earn points for engaging in specific behaviors (i.e., DRA) or refraining from rule violations (i.e., DRO), depending on how the procedure is designed. Points delivered throughout the game may serve as a signal to students indicating the availability or unavailability of putative reinforcement depending on the number of points they have accumulated relative to the established point threshold.

Through repeated exposure to the GBG, points may also become conditioned as mild punishers or reinforcers (depending on the variation being implemented) due to their correlation with access to rewards. For example, Wiskow et al. (2018) found that vocal feedback (i.e., point delivery) was required to maximize GBG effectiveness with preschool students. However, research has also shown that points may not function as punishers in some cases. For example, Joslyn et al. (2019a) reported that in one high-school classroom, students' behavior was insensitive to point delivery but sensitive to the number of points they had accumulated relative to the point threshold. Students freely violated the rules until they were near the point threshold, then collectively stopped engaging in problem behavior, remained below the threshold, and were able to consistently win the game and access rewards. The experimenters then lowered the point threshold and the students' rule breaking matched the new threshold. Either or both of these mechanisms (i.e., stimulus control and conditioned punishment or reinforcement) could affect student behavior, which may contribute to the robustness of the GBG. Behavior analysts concerned about the use of punishment in this context should consider the "big picture" of the GBG; it is a reinforcement-based procedure that students enjoy playing. Consistent findings of strong student preference for the GBG indicate that the procedure is not typically aversive to students in either the traditional or CBGG arrangement (Joslyn et al., 2019b).

In addition to the programmed contingencies that shape student behavior, peers may also influence their behavior as an indirect effect of the game. Because of the interdependent group contingency, students earn rewards if both they and their peers follow the rules. Therefore, students may encourage one another to follow classroom rules and provide social consequences for doing so. This may also explain why the GBG is so generally effective, as students who are not motivated by teacher praise or the rewards available for winning the game may be motivated by peer-mediated contingencies. For example, a student who is unmotivated by 5 minutes of free time may be more likely to participate in the game if their friends want to win the game. Although one might assume that the GBG has the potential to cause bullying or harassment between students, particularly when implemented with students who engage in severe problem behavior or struggle with prosocial interactions (e.g., students with emotional and behavioral disorders), research has indicated that students engage in more positive peer interactions and fewer negative interactions while the game is being played when compared to the standard classroom contingencies (Groves & Austin, 2019).

The conceptually systematic nature of ABA allows us to hypothesize that the above mechanisms are primarily responsible for changes in student behavior during the GBG. However, it is worth noting again that there are few studies that have explicitly examined mechanisms of the GBG. It seems likely that there are multiple, layered mechanisms that synergize to produce such robust and consistent effects. If this is the case, contextual factors (e.g., student age, setting) can influence which components of the GBG are most salient in changing behavior. For example, older students with longer histories of rule following and stimulus control in the classroom may be more sensitive to their score than to the delivery of points, while younger students with less experience in classrooms and less proficiency in math and counting may be more sensitive to the delivery of points than to their score. Additional research on the mechanisms responsible for short-term effects will elucidate which of the above mechanisms are the most important given certain scenarios (e.g., implementation with younger vs. older students). This, in turn, will allow school practitioners to emphasize these components when appropriate and remove or de-emphasize them when they are not needed and may reduce implementation effort for teachers.

Long-Term Mechanisms

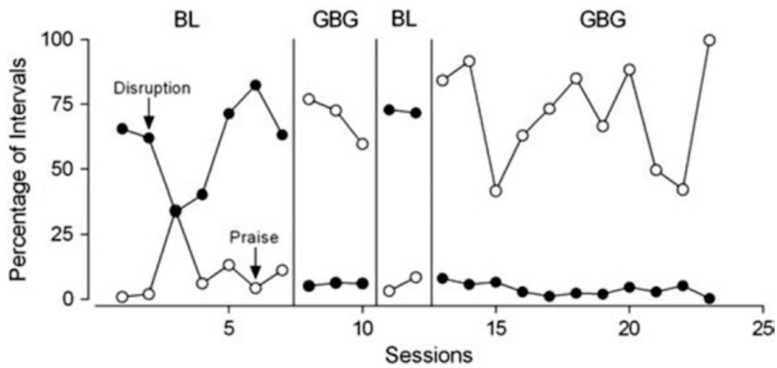
As mentioned earlier, longitudinal research has indicated that there may be long-term benefits to students who are exposed to the GBG at a young age, such as decreased rates of substance abuse disorders and incarceration for violent crimes (Kellam et al., 2008, 2011, 2014). One can hypothesize the primary mechanisms of short-term change by examining the arranged contingencies during the GBG, but the processes involved in these long-term effects are less clear. The matter is further complicated by the fact that empirical research indicates that the immediate effects of the GBG do not generalize to other times and settings in school (Donaldson et al., 2015; Pennington & McComas, 2017); student behavior only improves during the period in which the game is in effect. However, from a behavioral perspective, there are at least two potential mechanisms for these long-term effects that are supported by the literature and ABA conceptual systems: a) the benefits provided by intervening when students are young, and b) exposing students to delays to reinforcement.

In the frequently cited longitudinal research indicating long-term effects, students are usually fairly young (i.e., in first or second grade; Kellam et al., 2011). Given that many consider these ages to be critical periods for academic and social development, the GBG may foster the successful acquisition of key skills during this time. Utilizing an intervention that promotes classroom rule following, enriches the classroom environment, promotes prosocial interactions, and increases academic engagement could affect an array of student behavior important for long-term success in school and life. In terms of academics, students who remain at grade level for a longer period of time or do not fall behind at all as a result of the GBG may be exposed to fewer aversive events throughout their academic career (e.g., struggling with academics, receiving poor grades, disciplinary issues related to escape-maintained behavior). These same students may also be more likely to contact natural reinforcers in school (e.g., teacher praise, good grades, parent approval). Delaying or reducing the number of students falling behind academically can have a strong effect on their academic trajectory, which is correlated with various quality of life outcomes later in life (Prince et al., 2018; Reid et al., 2004).

In terms of social effects, the GBG has been indicated to increase prosocial student interactions and increase the extent to which teachers deliver praise relative to reprimands (Groves & Austin, 2019; Rubow et al., 2018). See Fig. 47.4 for data from Groves and Austin (2019) showing changes in peer interactions during the GBG and Fig. 47.8 for data from Rubow et al. (2018) demonstrating changes in teacher praise relative to reprimands during the GBG. These immediate effects on peer and teacher interactions enrich the school environment for students and may lead to long-term changes in the relationships between students and their peers and teachers. However, the long-term effects of the GBG on student-peer and student-teacher relationships have not been fully addressed by the literature.

A consistent finding in the longitudinal GBG research is that many of the long-term behavioral outcomes relate to impulsivity (i.e., choosing smaller, sooner reinforcers over larger, later reinforcers; Rung et al., 2019). Substance abuse and violent crime, for example, are correlated with steep delay discounting (a measure of impulsive behavior indicating how much value reinforcers lose as they become more delayed; Rung et al., 2019). These behaviors may result in immediate reinforcement (e.g., effects of alcohol, gaining access to money) at the cost of access to more potent and higher quality reinforcers later (e.g., good health, freedom from incarceration). Behavioral research with laboratory animals has indicated that rats engage in fewer impulsive behaviors after delay exposure training (i.e., being repeatedly exposed to increasing delays to reinforcement over time; e.g., Stein et al., 2013). Conceptually, the GBG could be viewed as a variation of delay exposure training in which students are presented with opportunities to obtain larger later reinforcement by abstaining from impulsive behavior. For example, students may avoid engaging in talking out or off-task behavior that results in low quality, immediate reinforcement (e.g., brief interaction with a peer, momentary escape from academic demands) if they can access larger reinforcers later (e.g., 10 minutes of free time in which they can access high quality social reinforcers and escape academic demands for a longer period of time) by doing so. Over repeated exposures to the GBG,

Fig. 47.8 Student disruption and teacher praise data from Rubow et al. (2018)



students may become less likely to make impulsive choices.

All of the above hypotheses of behavioral mechanisms come with a caveat; they have not been explicitly examined by empirical research. As we will discuss later in this chapter, mechanisms of behavior change are in need of more research. By learning more about the primary mechanisms responsible for change in the GBG (both short- and long-term), we may be able to develop more interventions that are as robust and generalizable as the GBG. Although longitudinal studies are uncommon in behavioral research, they may be necessary to examine the outcomes of our interventions with more detail.

Future Directions for the Good Behavior Game

Although the GBG has a substantial literature base, there are still areas in need of additional research. Addressing unanswered questions about the GBG will allow for more precise clinical direction, clarify the utility of different variations, and contribute to the development of more effective classroom management interventions. Below, we will discuss key areas in which more research is needed and describe the implications of expanding our understanding in each area.

The GBG has been repeatedly demonstrated to be effective in improving student behavior in a range of school settings and activities (Bowman-Perrott et al., 2016; Flower et al., 2014a; Joslyn et al., 2019b; Tingstrom et al., 2006). However, there have been few applications of the GBG or its variations in non-school settings. Given the consistency of effects and hardiness of the GBG, it is likely that it would be effective in other settings familiar to behavior analysts. For example, the GBG could be adapted for implementation in autism treatment clinics to address a variety of client behavior. Practitioners may see success in targeting problem behavior for reduction, increasing appropriate social interactions between clients, or even in increasing the variety or quality of food consumed during lunch. Other settings in which the GBG would be well-suited for adapted implementation could include the workplace, the home setting (e.g., improving behavior among a group of siblings), or other areas in which the behavior of multiple individuals could be improved. Although individual, function-based interventions are a key component of effective behavioral treatment, group contingencies like the GBG are currently underutilized in ABA.

Improving the dissemination of the GBG (and behavior analysis in general) is another important area for future research. The GBG is a "success story" of ABA and behavior analysts are becoming increasingly common in schools, but the GBG remains a largely untapped resource for teachers. Research on the rates of GBG implementation is rare, but what information we have indicates that many teachers have never heard of the GBG. In a survey of 239 teachers across five school districts, 91% of teachers reported never having heard of the GBG (Stormont et al., 2011). Although the GBG's popularity has only increased since this study was published, researchers should examine ways in which we can increase the visibility and implementation rates of the GBG. There are multiple potential approaches to this task. First, despite the GBG being most frequently implemented to reduce problem behavior in the classroom, it is also effective in increasing desirable behaviors in the classroom. Research exploring the upper limits of what GBG implementation can produce in terms of class participation, positive peer interactions, academic engagement, and other desirable or prosocial behaviors could further establish the GBG as a powerful and versatile procedure. This would likely hasten its dissemination particularly for teachers who may not struggle with problem behavior per se, but would embrace a procedure that increases specific, desirable student behavior. Second, research that streamlines the implementation of the GBG by reducing implementation effort or removing aversive procedural components to improve contextual fit without sacrificing effects would make dissemination easier. Researchers have reported that teachers find aspects of the procedure to be problematic, likely decreasing the likelihood that they will sustain the intervention or adopt it in the first place (e.g., Joslyn et al., 2019a). For example, teachers have reported that the delivery of points in both the GBG and CBGG variation can be disruptive or distracting when they are delivering instruction (Wahl et al., 2016). Existing component analyses of the GBG have indicated that most or all components are necessary for effectiveness, but these analyses have only been conducted with preschool students (Foley et al., 2019; Wiskow et al., 2019). Given the various mechanisms responsible for behavior change, it is likely that certain components are more or less relevant given certain factors, but there is insufficient available research to draw conclusions or provide treatment recommendations.

The GBG is a notable intervention for its versatility and robustness, but it is not a panacea. Researchers should further explore the limits of the GBG. Treatment failures are rare in GBG research, but that could be a function of non-effects being difficult to publish rather than the invulnerability of the GBG. As practitioners, both authors of this chapter have seen scenarios in which the GBG does not produce its characteristic effects and required procedural variation and troubleshooting. It is likely that there are prerequisite conditions that must be met for the GBG to be effective. For example, teachers must exhibit some degree of instructional control in order for the GBG to even be presented to students. In addition, it must be possible for teachers to be able to present rewards for winning the GBG that compete with reinforcers available for problem behavior (e.g., peer attention, escape from academic demands). Qualitative features of the teacher or classroom that may be predictive of intervention success or failure should be further explored in behavioral education research generally, as well as in relation to the GBG.

Finally, the hardiness of the GBG makes it a useful model for studying classroom management and other aspects of school-based interventions such as teacher training, treatment integrity, and behavior measurement. Exploring these aspects of education can be challenging due to difficulties conducting research and demonstrating experimental control in unpredictable applied settings like schools. However, using the GBG as an intervention to explore areas like teacher training methods can reduce the challenge of demonstrating intervention effects when focusing on dependent variables other than student behavior. Class-wide procedures like the GBG may also prove to be valuable both as prevention approaches and as indicators of a need for more targeted interventions. When interventions like the GBG fail to address the behavior of particular students in a class, it could be indicative of the need for individualized behavioral interventions (i.e., a screening tool; Donaldson et al., 2017).

Chapter Summary

The GBG is an effective classroom management procedure with over 50 years of empirical support in various settings and contexts. Typically implemented with elementary-aged students in general education, researchers have effectively extended and adapted the GBG to a wide range of education settings and populations (e.g., pre-school students, alternative education, college classrooms, students with intellectual disabilities; Joslyn et al., 2019b). Further, the GBG is effective outside of the context of problem behavior in the classroom; it has been demonstrated effective in increasing physical exercise and academic engagement, improving behavior in the cafeteria, and increasing class participation (Joslyn et al., 2019b). The GBG has also improved long-term outcomes for students (Kellam et al., 2008, 2011, 2014).

The versatility and robustness of the GBG are made possible by the numerous procedural variations and underlying behavioral mechanisms. In addition to versatility across environment and population, the GBG remains effective when implemented with poor treatment integrity and with substantial modifications to its procedures (Joslyn et al., 2019b). The GBG likely leverages some combination of rule-governed behavior, differential reinforcement, conditioned reinforcement and/or punishment, stimulus control, and peer-mediated contingencies. The synergy of these mechanisms may maintain effects when procedural variation, poor treatment integrity, or setting or population characteristics render one or more of these mechanisms ineffective or irrelevant. Long-term effects of the GBG may be due to the crucial age at which students were exposed in longitudinal research and its potential function as a delay exposure training variation, decreasing the likelihood of impulsive behavior in students.

Although it is a robust and relatively simple procedure, care should be taken when implementing the GBG to maximize the likelihood of immediate and strong effects, teacher motivation to implement it, and its sustainability over time. Researchers have not yet examined every potential variation or implementation consideration but have established general recommendations for practice. Consistent findings in the behavioral literature have elucidated ways to optimize aspects of the GBG such as rule selection, team size, data collection methods, clinical decision-making, and teacher training methods. Researchers continue to explore ways to optimize and disseminate the GBG.

Important areas for future research on the GBG include extension and adaptation to non-school settings (e.g., the workplace, autism clinics), improving dissemination and sustainability, and exploring the boundary conditions of GBG effectiveness. The GBG can also be conceptualized as a model for studying classroom management and other school-based interventions due to its consistency in producing effects. Researchers interested in exploring research methodology in schools (e.g., behavior measurement), teacher training approaches, or other topics sometimes challenging to study in schools may benefit from using the GBG as a model intervention due to its apparent low likelihood of treatment failure.

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Part VIII

Academic Skills

Compliance Training

48

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Compliance Training

Generally, compliance is understood as the extent to which an individual behaves in accordance with a proposed request, demand, or expectation of the social environment. On the surface, some practitioners and researchers may view the concept of compliance pejoratively as it suggests the removal of autonomy and control by another individual. However, both children and adults encounter a plethora of situations where compliance behaviors are commonplace. For children, opportunities to engage in compliant behaviors with parent and teacher instructions occur on a daily basis. In many cases, these requests or demands are intended to increase academic and social skills and to ensure the safety of the child. Likewise, adults enrolled in higher education, those who are employed, and law-abiding citizens are also required to follow the rules and requests of other individuals and institutions. For individuals diagnosed with autism and other developmental disabilities, compliance is a basic skill required for both the assessment and treatment of other behavior. Failure to comply with requests in these circumstances may produce delays in learning, development, integration, and health. Continued compliance issues may result in diagnoses such as oppositional defiant disorder, conduct disorders, or attention deficit hyperactivity disorder and may be associated with social and legal issues into adulthood (American Psychiatric Association, 2013).

In this light, the need to formally address compliant behavior often occurs as a result of noncompliance, which is paraphrased by Lipschultz

This chapter was supported in part by a salary award from the Fonds de recherche du Québec—Santé (#269462) to the first author.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_48

and Wilder (2017) as "doing anything other than what has been requested by a parent or other adult authority figure within a specific time frame" (p. 263). Noncompliant behavior can be a common challenge for caregivers of individuals with and without disabilities. Oftentimes, behavior that occurs in place of compliance is undesirable and problematic, and typically consists of challenging behavior that occurs after the instruction has been delivered (Cook et al., 2019). As such, professionals in the field of applied behavior analysis have been at the forefront of developing effective methods to enhance compliance skills.

Within this research area, compliance is designated as either active or passive. That is, the compliant behavior of interest may involve the occurrence of a specific behavior or the absence of a specific behavior. With respect to active compliance, common examples include following instructions and completing tasks, without engaging in other problematic behaviors. More specifically, if a parent asks a child to make their bed, the child engaging in the behaviors required to make the bed would be considered active compliance. Noncompliance often occurs together with many forms of challenging behavior, such as physical aggression or self-injury. Frequently, the behavior exhibited is part of the same functional response class (i.e., maintained by the same outcome). For example, aggression and self-injury may be negatively reinforced by removing or delaying demands after those behaviors occur, thus leading to noncompliance. Therefore, one strategy to increase compliance is implementing procedures that target the undesirable behavior that is associated with noncompliance (Cook et al., 2019).

Concerning passive compliance, a parent may ask a child to keep their knit cap on outside in the winter. In this example of passive compliance, the child is expected to passively keep their knit cap on their head. Some common examples of passive compliance include participating in a dental examination (e.g., Cuvo et al., 2010a), receiving haircuts (e.g., Schumacher & Rapp, 2011), and wearing a heart monitor (e.g., Dufour & Lanovaz, 2020). Given the potentially detrimental effects of noncompliance, compliance is often central for practitioners of behavior analysis. The purpose of this chapter is to review behavior analytic practices in the assessment and treatment of compliance. Specifically, this chapter will first review preliminary assessments to conduct before treatment and then examine both antecedent-based and consequence-based interventions. This chapter ends with practical considerations to ensure a rigorous approach to compliance training with different populations.

Assessment

To begin, practitioners and researchers should identify the contingencies preventing the emergence of compliance. The first step in this process is to identify whether the lack of compliance is the result of a skill deficit. This issue may be addressed by way of a skill assessment. If noncompliance is not the results of a skill deficit, a functional behavior assessment should then be conducted to determine the contingencies maintaining the undesirable behavior, as well as preference assessments to evaluate effective reinforcers to target compliance (Lipschultz & Wilder, 2017).

Skills Assessment

Prior to selecting a treatment to increase active compliance, practitioners should first determine whether this lack of compliance is due to a skill deficit. In layperson's terms, the question is whether the person *can't* or *won't* engage in the behavior. The former would lead to straightforward skills training as the issue is not noncompliance, but rather a limited behavioral repertoire. In this case, we recommend that the reader consult the subsequent chapters on teaching (see Chaps. 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, and 62). In contrast, this chapter focuses on those individuals who have the behavior or skill in their repertoire, but that fail to engage in it when required. Therefore, the emphasis is on increasing the frequency or duration of compliance rather than teaching.

Assessing whether the lack of compliance is due to a skill deficit remains a challenge because noncompliance may lead to the individual failing to engage in the skill during the assessment even when the skill is in their repertoire. To increase the probability of responding, the practitioner may provide choice during the assessment, deliver high-density and high-quality reinforcement, and alternate the skill being evaluated with skills that the child already complies with regularly (Lerman et al., 2004). For example, a task analysis may divide the skill into smaller units and reinforcement provided for each unit rather than the task as a whole (e.g., Lalli et al., 1995). This procedure may increase responding and facilitate differentiation between skill deficit and noncompliance. Furthermore, the trainer may provide reinforcement for any attempts at responding to the discriminative stimulus (rather than following correct responses only) to evoke responding in the individual during the assessment. Finally, the assessment may embed the skill at the end of a high-probability request sequence (see section "Antecedent-Based Interventions" for details on procedures) to increase the likelihood that the individual will respond (Mace et al., 1988).

Functional Assessment

Because individuals avoid or escape something when they engage in noncompliant behavior, the most common behavioral function for noncompliance is escape (Hong et al., 2018). However, attention in the form of guided compliance may also maintain engagement in challenging behavior (Kern et al., 2002; Rodriguez et al., 2010). Given that both functions may lead to different treatment selections, we recommend that practitioners conduct a functional assessment before the onset of compliance training (see Chaps. 26, 27, 28, 29, 30, and 31 for details).

Beyond identifying the behavioral function of noncompliance (e.g., attention and escape), practitioners may also use functional analyses to identify idiosyncratic variables that may affect responding to demands or tasks (Carey & Halle, 2002; Cooper et al., 1992; McComas et al., 2000). The trainer may manipulate variables such as task duration, task difficulty, number of tasks, type of task or demand, or the presence or absence of other stimuli (e.g., music). This type of assessment involves comparing at least two conditions: one condition involves the presence of the potentially evocative stimulus and the other condition is its absence while the trainer provides escape contingent on noncompliance or other challenging behaviors.

As an example, assume that a child refuses to follow parental demands. Some demands may be more effortful than others. The practitioner could set up two conditions: one with less effortful demands (e.g., bring me the phone) and one with more effortful demands (e.g., emptying the dishwasher). In each condition, the parent could make 10 demands of each type and then examine whether the different types of demands evoke differential responding. This functional analysis would not only lead to the identification of motivating operations, but may also support the practitioners when setting treatment parameters (e.g., high-probability request sequence, demand fading).

Preference Assessments

Trainers should always conduct a preference assessment prior to the implementation of interventions that involve the delivery of preferred stimuli or reinforcers. Conducting a preference assessment may increase the effectiveness of the intervention being implemented (Kang et al., 2013; Simonian et al., 2020). Apart from reminding the reader of the importance of preference assessment prior to compliance training, we will not review detailed procedures here. For those readers unfamiliar with preference assessment, we refer them to Chap. 21 on this topic. In sum, skill, functional, and preference assessments remain essential preliminary steps preceding the selection and implementation of treatment for noncompliance. These assessments should increase the probability that the treatment will produce the expected outcomes with the individual targeted by the practitioner.

Treatment

Antecedent-Based Interventions

Antecedent-based interventions involve the manipulation of stimuli that precede the behavior. In other words, the trainer manipulates the antecedents (i.e., what occurs before the behavior) independent of engagement in a specific behavior. Examples of antecedent-based interventions for compliance include manipulating demand and task parameters, the high-probability request sequence, graduated exposure, noncontingent reinforcement, and self-monitoring.

Manipulating Demand and Task Parameters

When demands and tasks fail to evoke compliance, the first step is often to examine the demand or task itself. For example, ambiguous demands are difficult to follow for anyone regardless of the presence of any noncompliance issues. Researchers have found that delivering clear, concise, and feasible demands increases the probability of compliance (e.g., Bouxsein et al., 2008; Browning, 1974; Matheson & Shriver, 2005). In an observational study, Christenson et al. (2011) found that elderly patients receiving long-term care were more likely to comply with demands that were clear, concise and feasible than with demands that were ambiguous, interrupted or unfeasible. These results suggest that nursing staff should be trained to modify their demands to increase compliance rate. The advantage of modifying the demands or tasks to make them clearer is that this type of intervention requires low response effort. That said, the intervention may produce insufficient changes, especially in those individuals who show persistent noncompliance under diverse environmental conditions.

A second intervention that involves manipulating demand and task parameters is demand fading. In demand fading, the trainer reduces the number of demands presented to the individual and then gradually increases them (Pace et al., 1993). For example, Pace et al. (1994) reduced verbal obscenities in an adult with brain injury by initially reducing the number of demands below baseline levels. Then, the authors reintroduced demands gradually until the person complied with the same number of demands as were presented during the initial baseline while engaging in zero rates of challenging behavior. Although the intervention may function as a standalone treatment, researchers have repeatedly used demand fading in combination with other interventions to increase their effectiveness or reduce their side-effects (e.g., Gerow et al., 2020; Ringdahl et al., 2002; Shillingsburg et al., 2019; Zarcone et al., 1993a). That is, implementing demand fading along with other interventions may reduce engagement in challenging behaviors associated with demands. Similar to modifying demands, reducing the number of demands or tasks is simple to implement for practitioners. The main drawback being that the demands must be initially faded, which may be unrealistic in certain contexts or when the staff-to-client-ratio is too low.

Choice

Another low effort intervention to improve compliance is the use of choice. Researchers have shown that different types of choice may increase responding following demands (e.g., DeLeon et al., 2001; Dunlap et al., 1994, Harding et al., 2002; Kern et al., 2001; Lory et al., 2020; Peck et al., 1996). For example, Kern et al. (2001) examined the effects of choosing the sequence in which multiple tasks could be completed in three children with attention-deficit hyperactivity disorder, intellectual disability, or both. Their results indicated that having the child choose the sequence of tasks not only increased engagement with the tasks (i.e., compliance), but it also reduced engagement in challenging behavior. In a more recent example, Lory et al. (2020) provided instructional choices to children with autism and found that it increased compliance with tasks. Another type of choice involves selecting the reinforcer that will be provided contingent on compliance. In such an implementation, Peck et al. (1996) reported that choice-making may improve compliance while reducing engagement in challenging behavior in young children. Providing choices has the advantage of promoting self-determination with individuals who may experience limited opportunities for making decisions on their own.

High-Probability Request Sequence

The high-probability request sequence is an intervention derived from behavioral momentum theory (see Mace et al., 1988). During the high-probability request sequence, the trainer delivers a rapid succession of high-probability requests followed by a low-probability request (Bross et al., 2018). The high-probability requests are requests with which the individual is highly likely to comply (i.e., 80% or more of the time) whereas the low-probability requests are those with which the individual is unlikely to comply (i.e., less than 50% of the time). The trainer should provide praise contingent on compliance with each type of request and consider providing tangible reinforcement for compliance with the high-probability request (Cooper et al., 2020). Whenever possible, the intervention should involve varying the high-probability requests as much as possible because invariant requests (i.e., always the same) may reduce the persistence of the observed effects (Davis & Reichle, 1996).

Researchers widely consider the high-probability request sequence as an empirically supported intervention for improving compliance (Banda et al., 2003; Brosh et al., 2018; Maag, 2019). Humm et al. (2005) have shown that parents may effectively implement the high-probability request sequence with minimal training, which is an advantage of the approach. In a recent application, Planer et al. (2018) compared the effects of high-probability requests that were relevant or irrelevant to the low-probability requests in children diagnosed with autism spectrum disorder. Their findings indicated that more relevant high-probability requests typically led to better compliance. One benefit of using the high-probability request sequence is that the intervention does not require the implementation of extinction. On the other hand, practitioners may struggle in identifying high-probability requests with individuals who engage in challenging behavior or fail to comply following many types of requests.

Graduated Exposure

Graduated exposure involves gradually and systematically subjecting individuals to stimuli that they are attempting to avoid (Jones, 1924). Although mainly used for the treatment of phobias, researchers have also applied graduated exposure to both improve passive and active compliance (Carter et al., 2019; Cromartie et al., 2014; Ellis et al., 2006; Rapp et al., 2005; Schmidt et al., 2013; Szalwinski et al., 2019). In an example of active compliance, Schmidt et al. (2013) trained a 16-year-old adolescent with autism and intellectual disability to comply with requests to participate in activities in different rooms in a school. The researchers gradually increased the duration of time spent in these rooms as well as the duration spent engaging in activities. This gradual exposure led to the adolescent complying with the requests despite low levels of reinforcement. In an example of passive compliance, Cromartie et al. (2014) taught a woman with intellectual disability and schizoaffective disorder to comply with blood draws by gradually exposing to different steps involved in the procedure. The previous examples show how practitioners may use graduated exposure in situations where the individual exhibits avoidant behavior related to the stimuli they must be engaged with for compliance. The systematic nature of graduated exposure is also its main weakness: the gradual transition from one step to another may make progress slow and take a lot of time.

Noncontingent Reinforcement

Noncontingent reinforcement (NCR) is a procedure that delivers preferred stimuli on a time-based schedule that is independent of the behavior. Put differently, a trainer provides the individual with a preferred stimulus on a regular or continuous basis regardless of the occurrence of behavior. This method alters engagement in the behavior by reducing the motivation to access the reinforcer (Cipani, 2018). Behavior analysts widely accept NCR as an empirically supported intervention to reduce undesirable behavior in individuals with developmental disabilities (Carr et al., 2009). In this population, noncompliance often occurs concurrently with the undesirable behavior; hence, NCR shows promise as a compliance training treatment procedure.

Researchers have shown that NCR interventions are effective at increasing compliance with wearing medical devices in children with developmental disabilities (DeLeon et al., 2008; Nipe et al., 2018; Richling et al., 2011). For example, Richling et al. (2011) have increased passive compliance with wearing prostheses by providing noncontingent access to preferred stimulation (e.g., music, tangibles, attention) to two children with multiple disabilities. In an example of active compliance, Ingvarsson et al. (2008) reported that NCR (e.g., noncontingent delivery of an edible item) alone was sufficient to increase compliance and reduce the rate of challenging behavior in a demand context. In situations where the target behavior is maintained by negative reinforcement (e.g., escape from tasks), a break from tasks can be delivered independent of behavior, which is termed noncontingent escape. Kodak et al. (2003) examined the effects of noncontingent escape in reducing challenging behaviors and increasing compliance in children with disabilities and showed that providing a brief break from tasks reduced challenging behavior and increased active compliance. Interventions based on NCR are relatively simple to implement and changes in the target behavior can occur quickly. A drawback with the intervention is that specific replacement behavior (i.e., compliance) is not taught using NCR; therefore, this procedure is often used in combination with other interventions designed to teach specific functionally matched replacement behavior (Cook et al., 2019).

Self-Monitoring

In behavior analysis, one common form of compliance is treatment adherence (Allen & Warzak, 2000; Dunbar-Jacob & Mortimer-Stephens, 2001). Treatment adherence generally refers to a patient or caregiver correctly following and implementing the recommendations of a professional (i.e., compliance with treatment). One method to improve adherence is the use of self-monitoring, which involves measuring or recording one's own behavior (Kanfer, 1970). Researchers have shown that self-monitoring may improve compliance with treatment in a population with a variety of problems such as asthma, acquired immunodeficiency syndrome (AIDS), and cardiac illness (e.g., Burke et al., 2011; Janson et al., 2009; Oldridge & Jones, 1983; Safren et al., 2001). In a behavior analytic example, Wadsworth et al. (2015) showed that students diagnosed with developmental disabilities could learn to self-monitor their compliance with requests. The results of the study suggested that self-monitoring may have facilitated the maintenance of compliance over time. As with choice, one of the strengths of self-monitoring is that the intervention encourages self-determination. That said, some researchers have suggested that self-monitoring alone is insufficient to maintain changes in behavior in some populations (Fritz et al., 2012).

Consequence-Based Interventions

Consequence-based interventions typically involve increasing the future occurrence of compliant behavior by manipulating stimuli that follow its occurrence. That is, the behavior change agent manipulates events or stimuli contingent on engagement in a specific behavior. Examples of consequence-based interventions include differential reinforcement of alternative behavior, differential reinforcement of other behavior, functional communication training, guided compliance, escape extinction, and public posting.

Differential Reinforcement of Alternative Behavior

Differential reinforcement of alternative behavior (DRA) involves "Providing greater reinforcement, along at least one dimension, contingent on the occurrence of one form or type of behavior, while minimizing reinforcement for another form or type of behavior" (Vollmer et al., 2020, p. 2). During DRA for compliance, the trainer typically provides a reinforcer to an individual contingent on the occurrence of a compliant behavior and minimizes reinforcement for noncompliance. Although often combined with escape extinction (see section on the same topic below), a recent review by Trump et al. (2020) concluded that DRA without the use of extinction is an effective treatment option.

Researchers have recognized DRA as a well-established treatment to increase compliance during mealtimes (food acceptance) in individuals with developmental disabilities who exhibit challenging behavior (Petscher et al., 2009), and have shown that DRA procedures continue to be effective without an extinction component (Athens & Vollmer, 2010; MacNaul & Neely, 2018). Recently, Briggs et al. (2019) indicated that robust treatment effects can be developed using DRA without the use of extinction by manipulating a combination of magnitude and quality of reinforcement for active compliance, and these effects can be maintained with reasonably lean schedules of reinforcement. Thus, DRA procedures may be easily implemented by caregivers because durable effects can be achieved even when destructive behaviors continue to occasionally result in a functional reinforcer and reinforcement for compliance is thinned (Briggs et al., 2019; Dowdy et al., 2018).

Functional Communication Training

A common variation of DRA is functional communication training (FCT). In FCT, the trainer teaches and reinforces an alternative communication response. If a student does not respond to instructions delivered by the teacher in order to escape from demands, an example of FCT could involve teaching the student to ask for a break instead of running away when they are asked to complete their work. FCT was initially defined by Carr and Durand (1985) and continues to be a valuable, well-established treatment for problem behavior (Kurtz et al., 2011; Petscher et al., 2009). The emphasis in many research studies is to increase appropriate communication without extinction (Johnson et al., 2004; Schindler & Horner, 2005). Although FCT has been shown to produce immediate effects, less research has examined the generalization and maintenance of this intervention over time (Neely et al., 2018).

Differential Reinforcement of Other Behavior

Differential reinforcement of other behavior (DRO), also referred to as differential reinforcement of zero occurrences or omission training, involves delivering a reinforcer in the absence of the specified target behavior within a predetermined interval (i.e., whole-interval DRO) or at a specific moment (i.e., momentary DRO). If an undesirable behavior occurs, the interval restarts and reinforcement is withheld. The duration of intervals continues to increase as long as the individual refrains from engaging in the target behavior until the terminal time interval is reached.

Researchers have used DRO interventions as part of medical treatment packages (Cuvo et al., 2010a, b; Shabani & Fisher, 2006) and alone (Carton & Schweitzer, 1996; Dufour & Lanovaz, 2020) to increase passive compliance with medical procedures (e.g., dental examination, blood draws, wearing heart rate monitors, and physical examinations). A DRO procedure may be useful for instances where noncompliance evokes challenging behavior (e.g., self-injury, aggression), when response blocking or escape extinction is unrealistic, or when NCR alone is unsuccessful (Dufour & Lanovaz, 2020; Hagopian & Toole, 2009). As with NCR, one of the main disadvantages of DRO is that the procedure does not specifically teach an alternative behavior (especially in the case of active compliance). Moreover, individuals untrained in behavior analysis may find DRO under dense schedules challenging to implement.

A variation of DRO that uses a functional reinforcer rather than an arbitrary reinforcer is differential negative reinforcement of other behavior (DNRO). When using DNRO procedures, the aversive stimulus is removed (i.e., negative reinforcement) contingent on the absence of the target behavior for a specified time period. A DNRO procedure allows the individual to avoid an unpleasant event by engaging in a range of behaviors if the target behavior does not occur. Researchers have shown that DNRO interventions are effective at increasing passive compliance with wearing medical devices (e.g., medical alert bracelet) in children with developmental disabilities, reducing challenging behavior in the presence of aversive music, and improving behavior during haircuts (Buckley & Newchok, 2006; Cook et al., 2015; Schumacher & Rapp, 2011; Wheatley et al., 2020). The DNRO intervention provides regular access to escape throughout the intervention; however, the procedure requires constant monitoring for occurrences of challenging behavior, and expertise in schedule thinning (Geiger et al., 2010). Since access to escape is unlikely to be under the individual's control, DNRO is most appropriate for increasing passive compliance to an aversive event (e.g., an invasive medical procedure).

Guided Compliance

Guided compliance involves systematically providing more intrusive prompts in response to noncompliance (Lipschultz & Wilder, 2017). Typically, the trainer implements a least-to-most prompting procedure, which has been evaluated as effective for children with and without developmental delays (e.g., Tarbox et al., 2007; Wilder & Atwell, 2006). The traditional three-step prompt hierarchy (i.e., vocal, model, and physical) is often used in guided compliance interventions to increase active compliance. The procedure begins with the delivery of a verbal prompt (e.g., an instruction) and more intrusive prompts are methodically introduced if noncompliance persists. Next, the trainer provides a gestural or model prompt, culminating with a physical prompt when necessary in which the individual is physically guided through the task.

Teachers, caregivers, and researchers have successfully implemented this intervention (Reisener et al., 2014; Smith & Lerman, 1999; Wilder et al., 2012b). While the three-step guided compliance procedure is effective, Wilder and Atwell (2006) also found that the effectiveness of the procedures may largely depend on individual characteristics. Wilder et al. (2012a) found that modifications to the procedure may be required to reach acceptable levels of compliance for some children. These modifications included omitting the model prompt and decreasing the inter-prompt interval, and the use of differential reinforcement in the form of delivering a highly preferred item contingent upon compliance with the first vocal prompt (Wilder et al., 2020). Guided compliance, like other compliance training procedures, can be an effective intervention, but the function of noncompliance must be first identified. If the function of noncompliant behavior is to gain access to social attention, guided compliance may cause an increase in undesirable behaviors (Kern et al., 2002; Wilder et al., 2008) and may be more difficult to implement because the procedure may require the use of prompt fading to lessen the dependence on prompts from others (MacDuff et al., 2001).

Escape Extinction

Extinction generally involves withholding a reinforcer contingent on engagement in a target behavior that was previously reinforced by this same reinforcer (Cooper et al., 2020). If the behavior is maintained by escape (which is often the case with compliance issues), the procedures are referred to as escape extinction. For example, the implementation of escape extinction to increase compliance may involve preventing an individual from escaping an activity, task, or demand. The trainer maintains the activity, task, or demand until the individual complies. Escape extinction has been successfully applied as part of a multi-component treatment package to treat selective and inadequate food intake in children (Bachmeyer, 2009) and is often an addition to compliance training for individuals with developmental delays who exhibit challenging behavior (Cook et al., 2015; DeLeon et al., 2008; Iwata et al., 1990; Piazza et al., 1997; Zarcone et al., 1994). For example, Zarcone et al. (1993b) observed no improvement in compliance or challenging behavior maintained by escape from tasks until extinction was implemented.

A benefit of escape extinction is that it can be combined with other procedures (e.g., demand fading, DNRO) used during compliance training to improve outcomes (Geiger et al., 2010; Lipschultz & Wilder, 2017). The use of extinction may lead to a temporary increase in challenging behavior (i.e., extinction burst) or evoke aggressive behavior (Lerman et al., 1999). The implementation of escape extinction often requires high effort, which may result in lower treatment integrity. Thus, appropriately trained professionals are needed to confirm the maintaining variables, carry out the treatment, and ensure the safety of the individuals involved (Cook et al., 2019; Geiger et al., 2010; McConnachie & Carr, 1997).

Group Contingencies

In all previous interventions, the trainer delivered (or withheld) the consequence contingent on engagement in individual behavior. An alternative to this approach is the implementation of group contingencies, which involve the delivery of reinforcing stimuli for the behavior of the group (Hayes, 1976). Three types of group contingencies exist: independent, dependent, and interdependent (Cooper et al., 2020; Theodore et al., 2004). In independent group contingencies, the trainer implements the same contingency for all members of the group, but only those members who contact the contingency receive reinforcement. In dependent group contingency, the whole group receives reinforcement contingent on the performance of an individual or of a subgroup. In interdependent group contingencies, all members of the group must achieve the criteria set out in the contingency for the group to access reinforcement.

Researchers have repeatedly shown that group contingencies may be an effective method to improve compliance with rules within a group setting (Joslyn et al., 2019; Pokorski et al., 2017). In an example of interdependent contingencies, Swiezy et al. (1992) required that preschool children cooperate in pairs; each child in the pair had to meet a different criterion and reinforcement was contingent on both children achieving their criterion. The intervention increased instruction-following in all participants. In a more recent example of group contingencies, Deshais et al. (2019) compared the effects of independent and randomized dependent contingencies on compliance with academic tasks. The randomized dependent contingency involved randomly and anonymously selecting the subgroup of participants whose behavior controlled the contingency. Although both group contingencies were generally effective, the researchers found that independent contingencies were typically equally or more effective than randomized dependent contingencies to increase compliance. Group contingencies have the advantage of being more easily applicable to a larger number of students. In contrast, practitioners must remain wary of potentially stigmatizing effects when a single individual systematically prevents others from accessing the reinforcer.

Public Posting

Public posting is a consequence-based strategy used to increase compliance or performance of a skill. During public posting, the trainer provides a consequence in the form of feedback about a behavior (e.g., score, graph, and chart) that is posted in a public area where others may see (Nordstrom et al., 1991). Researchers have demonstrated the efficacy of public posting to treat compliance or adherence issues in multiple settings, such as improving student and teacher behavior in school settings (Gross & Ekstrand, 1983; Holland & McLaughlin, 1982), improving employee behavior (Hutchison et al., 1980), increasing compliance (e.g., hygiene) in individuals with developmental disabilities (Blount & Stokes, 1984), and increasing citizen compliance with laws (e.g., obeying speed limits; Ragnarsson & Bjorgvinsson, 1991; Van Houten et al., 1980). The benefits and drawbacks of public posting are similar to those described for group contingencies: this type of intervention is easy to implement with groups of individuals but carries the risk of stigmatization. To address this issue, public posting should be used for participants of a similar level or the goal should be adapted so that it is based on the individual rather than the group.

Practical Considerations

For clarity, the treatment section of this paper presented each antecedent-based intervention and each consequence-based intervention separately. Researchers in behavior analysis often test interventions individually so that they can isolate their specific effects (Cooper et al., 2020). In practice, behavior analysts often combine interventions in a treatment package to increase the likelihood the treatment will produce the desired change in behavior. For example, Lalli et al. (1995) showed that a treatment package involving the manipulation of the antecedents, functional communication training, and extinction increased compliance with tasks in children and adolescents diagnosed with developmental disabilities. When choosing which components to include in a treatment package, practitioners should carefully consider the advantages and disadvantages of each.

A second practical consideration is the effort and resources required for training individuals who will be implementing compliance training. Simply explaining the procedures to the trainee is often insufficient to teach others (e.g., caregivers, teachers) to implement behavioral interventions to increase compliance (Miles & Wilder, 2009; Reisener et al., 2014). Behavior analysts must implement systematic procedures to teach others to implement behavioral interventions with high integrity (Brock et al., 2017). Compliance is no exception and we refer the reader to Chap. 24 to monitor treatment integrity as well as Chaps. 35 and 36 to learn more about how to conduct effective training with both caregivers and staff.

Finally, the practice of behavior analysis involves continuous monitoring of the intervention to examine whether the individual is making progress (Cooper et al., 2020). Behavior analysts should bear in mind that they can never perfectly predict whether an intervention will be effective to improve compliance for a given individual prior to its implementation. Rigorously monitoring the effects of the intervention using valid measures of behavior (Chap. 19) and the use of single-case designs (Chap. 20) appears essential when adopting an evidence-based practice. The implementation of the assessments and interventions should systematically rely on the previous approach to determine whether compliance training was effective in producing socially significant changes for the individual receiving treatment.

Conclusion

Researchers have validated the effects of multiple antecedent-based and consequence-based interventions to support practitioners in conducting compliance training. These studies have applied compliance training in a variety of populations including children with and without disability, adolescents in residential juvenile facilities, workers in employment, elderly patients, and citizens in general. These applications show the breadth and contribution of applied behavior analysis to solving issues related to compliance. Behavior analysts have numerous options at their disposal to treat compliance. Although the advantages and disadvantages of each intervention should guide selection, the main criterion to judge the effectiveness of a treatment for a given individual remains the direct implementation and assessment of its effects within a single-case design. By using a systematic approach to compliance training, behavior analysts may not only improve their practice and research, but also promote the learning, health, social inclusion, and well-being of those who benefit from their services.

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49 On-Task Behavior

Amarie Carnett and Christopher Tullis

> We may have taught many social skills without examining whether they actually furthered the subject's social life…many on-task skills without measuring the actual value of those tasks; and, in general, many survival skills without examining the subject's actual subsequent survival.—Baer et al., 1987

Developmentally, the beginnings of on-task behavior begin around 6 months of age with initial eye-contact (Novak & Pelaez, 2004). This step, in a relatively complex chain of responses, has been indicated as an initial marker of potential future developmental delays or disabilities (e.g., Fragile X syndrome, autism spectrum disorder (ASD); Hall et al., 2006; Clifford & Dissanayake, 2008). Although a relatively simple operant response, eye contact has been a key dependent variable in early behavior analytic research focusing on attending skills and compliance with instructional cues (Foxx, 1977; Hamlet et al., 1984). Additionally, this early skill may be conceptualized as the basis or early emergence of more complex on-task responding or sustained attention that is typically developed in increasing complexity during the first 4 years of life (Grazino et al., 2011). These types of sustained interactions with stimuli have been positively correlated with problem solving, intelligence quotient (IQ), and communication skills (Choudhury & Gorman, 2000; NICHD, 2003).

On-task behavior, or the extent to which a person engages in sustained attention and allocates the majority of their responding toward specific stimuli, is a key determinate of success in a number of educational and social environments (Greenwood et al., 2002). Although the definition of on-task behavior may be further refined to specific, environmentally relevant responses (e.g., math problem completion, scanning an array of materials to complete a task) for the purpose of this chapter we will broadly define it as responding that requires sustained behavior specifically allocated to one stimulus or a set of stimuli. Overall, students in classroom contexts are on task between 77% and 89% of the instructional day (McConaughy et al., 1988; Weisz et al., 1995). Additionally, evidence from the literature supports the assertion that sustained on-task behavior is required for academic success regardless of educational environment or diagnosis (Greenwood, 1991).

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_49

Defining and Measuring On-Task Behavior

On-task behavior is a commonly targeted response across typical and atypical development, and the definition of this specific response varies from engaging with stimuli visually to complex reading comprehension tasks. For general analysis, it may be useful to view "on-task" behavior as a class of responses versus one specific response topography. In doing so, defining individual instances of on-task behavior requires an evaluation of contextual variables within specific environments, such as discriminative stimuli, and specific chains of responses that are classified as "on-task." As stated previously these may vary widely depending on current environmental expectations, specific participant/learner skill level, and task complexity (see Table 49.1 for definition variations). For example, Slattery et al. (2016) operationally defined on task responding for participants without an intellectual or developmental disability diagnosis in terms of engagement with environmental stimuli either passively (e.g., reading a book) or actively (e.g., asking questions) when specified routines were presented. In comparison, Li et al. (2019) defined on task responding in terms of task completion and use of a self-monitoring strategy.

As a response or response class, on-task behavior may be classified as a continuous responding. Stated differently on-task behavior is not a class of responses that necessarily has a discrete beginning and end. Given the somewhat fluid nature of what is termed "on-task" behavior in the literature, it seems that measurement systems based in temporal extent (Cooper et al., 2019). These types of measurement systems are focused on the duration or length of time a response or response class occurs during a set period of time/session, or the amount of time a response or response class occurs during one episode. See Table 49.1 for examples of various measurements that correspond to various on-task behaviors.

A number of introductory texts in applied behavior analysis (ABA) outline various measurement systems appropriate for responses that

Table 49.1 Example definitions of on-task behavior defined in the literature

Study	Operational Definition	Measurement	Activity/Task
MacDuff et al. (1993)	(a) Visually attending to any appropriate play or work materials, (b) looking at their photographic schedules, (c) manipulating play or work materials appropriately (i.e., as they were designed to be used), or (d) in transition from one scheduled activity to another.	60 s momentary time sampling	6-item activity schedules across academic work and leisure tasks (e.g., handwriting worksheet, blocks, snack, TV).
Warren et al. (2019)	Eyes oriented toward instructor, task materials, reinforcers, or AAC device, and complying with task demands	10 s momentary time sampling	Visual activity schedules across low preferred and high-preferred tasks
Axelrod et al. (2009)	Actively (e.g., writing notes) or passively (e.g., reading homework materials) attending to martials, and asking relevant questions about homework materials	10 s partial interval recording	Homework tasks
Xu et al. (2019)	Engaging in an academic task, looking at the instructor or instructional materials, and refraining from engaging in challenging behavior	1 min whole interval recording	Academic tasks
Kim et al. (2018)	Meaningfully participating in reading activities (e.g., asking/answering questions, reading aloud, writing)		
Hume and Odom (2007)	Visually attending to materials, manipulation of materials, or moving from one task to another		
Carnett et al. (2014)	Sitting with buttocks on ground, head oriented towards teacher, and absence of challenging behavior		

are continuous in nature, and a full explanation of each is beyond the scope of this chapter. From the literature, it seems that duration per session or time-sampling may be appropriate if a leaner is engaged in on-task responding during a set instructional period and the purpose of the intervention is to increase the percentage of time during instruction the learner is on-task (e.g., Warren et al., 2021). When the environment is not as controlled or easily observed as a classroom or clinic context, duration per occurrence or time sampling may be more appropriate as well as feasible (Boden et al., 2018).

Pre-requisite Skills

In populations of people that deficits in skills related to on-task responding, the behavior analytic literature contains a number of teaching demonstrations that target specific and related behaviors. For example, Legge et al. (2010) demonstrated the impact of a self-management intervention with three children diagnosed with autism spectrum disorder. The self-management intervention consisted of a MotivAider that vibrated at preset intervals, which prompted participants to engage in self-evaluation of whether or not they were on-task. Increases in on-task responding were observed across all participants that maintained after the self-monitoring procedure was withdrawn.

Although the literature is rich with suggestions for interventions to teach on-task behavior, the prerequisite skills necessary to engage in or effectively learn responding related to on-task behavior is absent. In behavior analytic assessments (VB-MAPP, Sundberg, 2008; ABLLS-R, Partington, 2006), some of the components or prerequisites are reflected in specific skill areas that may be assessed and targeted for intervention. For example, in the VB-MAPP (Sundberg, 2008) contains assessment elements for attending to stimuli, attending to an instructor, responding to instruction, and visual attention.

It would seem that on-task behavior would require developed skill in three specific areas. First, learners would need a strong repertoire of attending skills that would include but are not limited to sustained attention, as well as the ability to switch briefly from on element of a task to another in the case of more complex types of tasks (e.g., taking notes in a lecture). In a recent review, Markelz and Taylor (2016) provide some support for attending as a prerequisite skill, reporting that praise for attending responses was correlated with increases in on-task responding for people with emotional and behavioral disabilities. For more impacted populations of learners, several investigations have supported the implementation of pairing procedures to increase visual attending and manipulation of educational materials (Singer-Dudek et al., 2011; Longano & Greer, 2006), and attending to voices during group instructional periods (Greer et al., 2011). Although these studies did not specifically assess the extent to which the presence or absence of attending skills impacted "on-task" behavior, the targeted dependent variables (e.g., object manipulation, attending to voices) may be conceptualized as responses that define whether or not a learner is on-task, lending further support to the assertion that basic attending skills may be a prerequisite skill.

Second, for more complex responses, learners may need a repertoire of self-monitoring or self-evaluation to determine how close or far away they are from the terminal goal or termination of present activities. One type of academic of self-evaluation that is often employed within some special education classrooms is strategy instruction (Whitby et al., 2009). Strategy instruction may be used in a number of curricular areas, and generally includes teaching flexible skills, as well as specific rules, that may be utilized somewhat uniformly within a curricular area. These strategies include self-evaluation of responding against established strategies as well as learned rules to determine if the response matches.

Last, in the event that tasks themselves are not fully in the learner's repertoire (i.e., are unmastered or novel), repertoires related to asking for assistance, recruiting reinforcement, or delivering self-reinforcement for related responses may be necessary. Stated differently, when novel tasks are present, learners may require repertoires that allow others in the environment to mediate their on-task responding. For example, for a learner that has not fully mastered a math or reading task, a repertoire of asking for assistance may need to be taught. For example, Germer et al. (2011) demonstrated the utility of a function-based treatment package that included a component acquire teacher assistance during independent seatwork. Results of this investigation reflected an increase in on-task responding when the antecedent intervention targeted at requesting assistance was implemented.

The prerequisites for on-task behavior are not as well established, but results from a number of investigations (e.g., Greer et al., 2011) in combination with descriptive information from developmental literature (e.g., Grazino et al., 2011) may help provide some possible examples for further empirical study. It should be noted that specific prerequisites may vary across populations of people. For example, a person with autism spectrum disorder (ASD) may require more intensive intervention related to intervening behavior (e.g., stereotyped hand movements) before intervention for a prerequisite for on-task responding may be targeted (Morrison & Rosales-Ruiz, 1997). Similarly, someone with a social aversion may require supports to lessen the aversiveness of social approach before teaching to ask for assistance with a novel task (Spain et al., 2017).

Contexts, Populations, and Relevance

On-task behavior is a class of responses that may be observed and required across a number of environmental contexts that include academic, vocational, and social situations where sustained interaction with environmental variables may be necessary for success (Gettinger & Stoiber, 1999). For example, a student in a general education setting would need to engage in some level of on-task responding to access educational materials and learning opportunities (Christle & Schuster, 2003). Similarly, a student in a college classroom or lecture hall would need to engage in a level of on task responding to fully engage with presented materials. Given the range of contexts in which on-task behavior is relevant for an individual's repertoire, it is often targeted within individualized interventions to help increase the number of learning opportunities. Further, for most children, the amount of time spent engaging in academic tasks are predictive of overall academic achievement (Gettinger & Stoiber, 1999). Thus, further highlighting the importance of on-task behaviors within an individual's repertoire.

Strategies for Teaching On-Task Behavior

A variety of intervention strategies related to increasing on-task behaviors have been cited in the literature across a variety of disability populations. Some commonly utilized intervention components include the use of reinforcement procedures (e.g., Tarbox et al., 2006), prompts/visual cues, and the use of technology. The following sections of this chapter review several of the commonly reported strategies and treatment packages used to teach on-task behaviors. An overview is provided in Table 49.2.

Reinforcement

One of the most frequently used intervention components to promote on-task behavior involves the use of reinforcement procedures. Although for most interventions that target increasing on-task behaviors include reinforcement procedures, consideration of reinforcer type, and delivery schedules play a critical role in an intervention's effectiveness. (For review of concepts related to reinforcement see Cooper et al., 2019; Hackenberg, 2018).

Conditioned reinforcement, such as the use of token reinforcement or specific praise statements, has been evaluated in the context of teaching on-task behavior. For example, Tarbox et al. (2006) evaluated the use of token reinforcement on attending (i.e., making eye contact with the instructor) during discrete trail training sessions.

Table 49.2 Review of intervention strategies

Intervention strategy	Description	Literature examples
Reinforcement	Consequence variable (within the response/consequence functional relation) use to reinforce the future likelihood of on-task behavior(s) under similar conditions. Reinforcers are idiosyncratic and include both conditioned (e.g., token economies) and unconditioned (e.g., food).	Carnett et al. (2014)
		Diaz de Villegas et al. (2020)
Choice and preference	Antecedent-based strategies used to account for motivational effects (establishing operations) to increase the behavioral evocative effects for increasing on-task behavior(s).	Morrison and Rosales-Ruiz (1997)
		Watanabe and Sturmey (2003)
Self-management	A range of activities (i.e., both cover and overt behaviors) that an individual engages in to increase appropriate (targeted) behavior(s).	
Prompting and visuals schedules	A supplementary stimulus used (e.g., visual cue) for evoking behavior or a series of behaviors related to preforming an on-task behavior(s). Visual schedules are often used within the context of self-management plans.	Hume and Odom (2007)
		Bryan and Gast (2000)
Technology	Equipment used as an intervention component, ranging from touch screen devices, computers, and watches, to help increase on-task behavior(s). Technology is often utilized within self-management interventions.	Mechling et al. (2006)
		Romans et al. (2020)
Self-management interventions	A general term related to a range of behaviors both overt and covert, that increase the probability of on-task related behavior(s).	Axelrod et al. (2009)
		Harris et al. (2005)

Findings of this study indicate that the use of token reinforcement was successful for increasing attending behavior. Additionally, Carnett et al. (2014) evaluated the effects of two types of token economy systems (i.e., traditional vs. perseverative interest-based) for on-task behavior for a child with ASD. During both conditions, on-task behavior (i.e., sitting, orienting toward the teacher, absence of disruptive behavior) was reinforced in the context of a read-a-loud literacy activity (group instruction). Although results showed both token systems were effective at increasing on-task behavior. Higher rates of on-task behavior during the perseverative interest-based token economy sessions were observed, compared to lower rates in the traditional token economy sessions. Further, these results also generalized to an inclusion classroom, indicating the quality of secondary reinforcers may have an effect on rates and generalization of on-task behavior for some children.

More recently, research has compared reinforcement schedules to evaluate the effects on on-task behavior. Specifically, Diaz de Villegas et al. (2020) compared the use of a synchronous-reinforcement and accumulated reinforcement conditions and the effects for on-task behavior for preschool aged children. During the synchronous reinforcement condition the child was provided access to reinforcement (i.e., preferred song and social attention from the experimenter) while they engaged in the targeted on-task behaviors. However, if the child stopped engaging in on-task behaviors for 2 s the experimenter stopped providing reinforcement (i.e., the song was paused, and social attention was discontinued). Comparatively, during the accumulated reinforcement condition, the delivery of reinforcement was yoked to the duration of on-task behavior during the session, meaning the total duration of time on-task was equivalent to the duration of reinforcement provided at the end of the session. One unique aspect of this study was the evaluation of participant preference for the two types of reinforcement delivery. Results indicated that participants on-task behavior increased during both reinforcement conditions, compared to baseline levels of responding. However, the synchronous reinforcement condition was more effective for increasing on-task behavior. And further, when assessed for preference of the two types of conditions, participants indicated this condition was also the most preferred condition.

Although reinforcement of behavior is a critical component of any intervention that aims to increase or teach a new behavior, each of the studies mentioned above also point out the importance schedules and delivery of reinforcement. For example, for complex behaviors it may be disruptive to use synchronous schedules, and within many environments, a dense delivery schedule may be impractical, thus consideration should be made with regard to schedule thinning and would typically occur within the natural environment (Trump et al., 2018). Thus, careful assessment and consideration of reinforcement type, delivery, and schedules should be planned within any intervention to promote acquisition or increases in on-task behavior.

Choice and Preference

In addition to consequence-based strategies, such as reinforcement, research has also evaluated antecedent-based strategies, such as evaluating the effects of preferred materials and activities when targeting on-task behaviors. In some populations, such as individuals with ASD, interfering behaviors (e.g., stereotypy) may cause a barrier to engagement and correct responding during academic tasks, which can limit the amount of learning opportunities of a child (Cook & Rapp, 2020). One general method to increase a variety of responses, including on-task behavior, is the inclusion of assessments of preference for environmental stimuli, and the provision of choice based upon results from such assessments (Tullis et al., 2011). Research has evaluated procedures to identify the effects of differential preferred objects on rates of stereotypy and correct responding academic-related tasks. Specifically, Morrison and Rosales-Ruiz (1997) evaluated choice and preference of object sets used in the context of a counting activity. Object sets were evaluated in a preference assessment and ranked as low, medium, and high preference. Results of this study indicated that correct responding and low rates of stereotypy were observed when using low- and medium-preferred items, as compared to high-preferred items. Thus, evaluation of materials used may be especially important when incompatible behaviors, such as stereotypy, are observed and are likely to be evoked by certain materials.

Further, effects of preference (via choice) have also been evaluated within the literature for increasing on-task behavior. For example, Watanabe and Sturmey (2003) evaluated the effects of increasing choice-making embedded within activity schedules for adults with ASD working in a community vocational setting. Specifically, during the choice phase, participants wrote down their choice of task order for their schedules, from a list of tasks assigned by their supervisor. Results indicated higher rates of on-task behavior during the choice condition indicating the potential value of choice to help contriving a learner's motivation to engage in on-task behaviors.

Similarly, research has also evaluated preference and choice of activities and materials used for increasing on-task behavior in children with ASD (Keen & Pennell, 2015; Ulke-Kurkcuoglu & Kircaali-Iftar, 2010; Warren et al., 2019). For example, Ulke-Kurkcuoglu and Kircaali-Iftar (2010) compared the effects of choice of activities and materials on the on-task behavior for four boys with ASD. During the activity choice condition, the children were provided with two activity options (via clear plastic boxes) and able to select which activity they would complete. And during the material choice condition, the teacher would select an activity (e.g., matching colors activity or matching shapes activity) for completion, but the participants were provided two different sets of materials and instructed to select one (e.g., colored pencils or crayons). Each participant had higher levels of on-task engagement during the choice conditions compared to baseline (no choice) condition. However, there was little differentiation across types of choice provided (activity versus materials) in respect to rates of on-task behavior. Thus, indicating that providing choices in general may help to increase on-task behavior, which can provide more flexibility for the types of choices that are conducive and feasible for specific learning environments.

The studies reviewed in this section highlight the utility of providing choice to help decrease interfering behaviors while increasing on-task behaviors. In other words, when an individual finds a task unappealing, there may be a higher likelihood that lower rates of on-task behavior occur (low-probability), compared to situations in which an individual finds the task, materials, or choices provided appealing (high-probability). Thus, the reinforcing function of items, tasks, or choice may play in important role for interventions aimed at increasing on-task behavior.

Prompting and Visual Schedules

When individuals struggle to attend to the natural discriminative stimuli within an environment that should signal behavior, prompts are often used to evoke the targeted behavior. However, some individuals may come to rely on their therapists, teachers, or caregivers to initiate or complete a task, rather than the natural cues in the environment (Oppenheimer et al., 1993). One type of visual prompting strategy (cues) used to prevent dependency on verbal prompts or instructions is known as activity schedules. This specific type of visual support involves the sequential representations of task steps or of individual tasks, where each visual representation serves as a discriminative stimulus for specific behavior (Koyama & Wang, 2011). The use of a sequenced discriminative stimulus can help enable participants to complete the steps in a complex task or to change tasks independently (Miguel et al., 2009). Thus, to teach a range of related on-task behaviors, prompts and visual cues, such as activity schedules, are often used as a part of intervention programs (Koyama & Wang, 2011).

Several studies have focused on the use of activity schedules to provide a visual cue to help promote independence and increase occurrences of on-task behaviors (e.g., Bryan & Gast, 2000; Koyama & Wang, 2011; MacDuff et al., 1993; Mattson & Pinkelman, 2020). A varieties of activity schedule formats (e.g., pictures, symbols, written word) across various populations have been cited in the literature, and correspond with age, complexity (i.e., number of steps/behaviors needed to complete the task), developmental functioning, and targeted tasks/activities. Generally, this type of system consists of a binder or posted schedule, where an individual is taught to look at the picture symbol (in a set order) and respond with the corresponding behavior(s) associated to the task (MacDuff et al., 1993; Miguel et al., 2009).

Over time, the derived control of the behaviors associated to each visual within the activity schedule can develop a complex behavior chain needed to complete a task or activity. As such, activity schedules are often selected as an intervention component to help improve on-task behavior targets. For example, MacDuff et al. (1993) used graduated guidance prompting procedures to teach four boys (ages 9–14 years old) with ASD, who had dependence on verbal prompts, to follow a six-item picture-based activity schedule to increase on-task and on-schedule behaviors. Results of this study indicated an increase for all participants for on-task behaviors (e.g., visually attending to any appropriate materials, looking at their activity schedule, using materials as designed). Replication of these results were reported by Bryan and Gast (2000), who also utilized graduated guidance to teach four children with ASD to use of an activity schedule to develop independence in the context of a literacy activity within a resource-based special education class. Further, data were also collected on generalization of skills to a novel activity where assessments were made indicating high rates of on-task behavior in the context of the untrained activity.

Recently, research has continued to evaluate the use of visual schedules to promote on-task behavior within the general education environment. Specifically, Macdonald et al. (2018) evaluated the use of visual schedules within the context of a structured work systems for four children within an inclusive school setting. Results showed increases in on-task behaviors (e.g., writing or typing using a workbook or computer) after visual schedule implementation. Most recently, consistent findings were reported by Mattson and Pinkelman (2020) for the use of activity schedules to increase on-task academic behaviors (e.g., orientating toward work materials, manipulating work materials as designed) and on-task schedule behavior for middle school students with specific learning disabilities and attention deficit hyperactivity disorder (ADHD), showing increase rates of on-task behavior for each participant, with similar increases reported in the generalization setting (i.e., language arts classroom).

Although the studies reviewed in this section highlight the utility and ease of visual picture schedules within educational settings, prerequisite skills should also be evaluated prior to use. Specifically, attending to visual stimuli, the correspondence of picture/object to the related task skill represented by the visual image should be assessed prior to implantation of a visual cue or schedule system to ensure the participant has the needed prerequisite skills to maximize the effectiveness of this type of intervention (MacDuff et al., 1993).

Technology

As mentioned in the previous sections outlining interventions to support a child's on-task behaviors, the use of technology as an intervention component is often utilized. A variety of technology can be used to help promote on-task behavior, ranging from touch screen devices and computers (Carlile et al., 2013; Soares et al., 2009; Xin et al., 2017) videos (Schatz et al., 2016; Mechling et al., 2006) and watches (Legge et al., 2010). For example, Carlile et al. (2013) used a digital activity schedule to promote increased on-task behavior by programming an iPod Touch with pictures of activities (each embedded with a small image of the clock application) within the photo album. Upon seeing the picture related to the activity with the schedule, the participant would exit the photo app and set the timer application (preset) to indicate when to progress to the next activity. Following the timer, the participant would navigate back into the relevant schedule (photo album) and use the arrows or swipe the screen with their finger to advance to the next activity within the schedule.

Further, research has also investigated the use of technology to reinforce on-task behavior. For example, Mechling et al. (2006) evaluated choice of high-preference video stimuli compared to tangible reinforcement (as a reinforcer for on-task behaviors and task completion for two middle school students with ASD who received instruction in a self-contained classroom. Results highlighted the effects of reinforcer quality for improving rates of task completion for the participants.

Technology has also been utilized to help individuals self-monitor to improve rates of on-task behavior (e.g., Soares et al., 2009; Romans et al., 2020; Rosenbloom et al., 2019). For example, Romans et al. (2020) used a web-based self-monitoring system to increase on-task behavior in the context of an academic tasks (i.e., essay writing and pre-algebra) for high school students with ASD. Specifically, this study utilized I-Connect self-monitoring, which is a web-based application that can be installed on smart devices (i.e., phones and tablets) to help monitor on-task behaviors. Results of this study indicate an immediate increase in on-task behaviors for both participants, although a functional relation, with regard to academic accuracy, was not observed for the participant engaging in an essay writing task. This study highlights the utility of increasing on-task behavior with digital self-monitoring systems; however, perhaps levels of fluency and acquisition of skills should be a considered prior to use. Another example of the use of app-related technology is provided by Xin et al. (2017). Researchers in this study utilized iPads installed with the application "Choiceworks," which is an app that allows for images, photos, and video to be used to customize a child's daily schedule and routines. In the context of the present study, it was used to help provide support for self-monitoring. Specifically, video models of on-task behaviors with vocal descriptions of the behaviors were programed into 30s clips and saved into the app. Each participant watched the video clips at the beginning of their class. At the end of each class the participants were required to self-assess if they had engaged in that behavior. On instances where one of three target on-task behaviors (e.g., paying attention, sitting in their seat, working on their assignment) did not occur, the participant would discuss it with their teacher and watch the relevant video clip for review. If all the targeted behaviors occurred, then access to a preferred activity was provided. As such, all participants were reported to have shown increases in on-task behaviors.

Although one might argue the availability and ease of many forms of technology exist within our daily lives, considerations of use specific promote on-task behavior should be made prior to the inclusion within an intervention. Similar to previously discussed prerequisite skills for the use of visual systems (e.g., correspondence, attending to the stimuli) should also be considered for technology-based systems. And although many children have previously developed technology repertoires, such as the ability to activate touch screens and navigate within the device, some children may require explicit instruction on these behaviors (Carlile et al., 2013). Further, clear instructional parameters of use would need to be established prior to the inclusion of technology, otherwise the potential for unrelated and possibly interfering behaviors (e.g., using an app to play games rather than engage in the self-management app) may occur. In summary, assessment of the skills needed to properly engage with the technology should be completed prior to the selection and inclusion of technology within a treatment program.

Self-Management Interventions

Self-management, or as described by Skinner (1965) as self-control, involves controlling one's response(s), and generally includes range of behaviors that increase or decrease the probability that desired behavior occurs (Mace et al., 1987; Thoresen et al., 1974). Stated in another way, self-management is the personal application of behavior change components that produce desired improvement of targeted behavior(s). Research has evaluated the use of self-management components with a variety of populations, both typically developing (Bodenheimer et al., 2002; Donaldson & Normand, 2009) and with diagnoses of intellectual disability and/or ASD (Axelrod et al., 2009). Self-management interventions are often utilized within high-incidence disability populations and people with low-incidence disabilities with lower support needs, such as individuals with learning disabilities (LD), attention deficit hyperactive disorder (ADHD), conduct disorder (CD), emotional and/or behavioral disorder (EBD), and ASD often are taught as part of an individualized program to promote autonomy and independence (Briesch & Briesch, 2016).

Further, self-management includes several components, including self-monitoring and self-evaluation. Self-monitoring (also termed self-recording or self-observation) can be defined as a procedure in which an individual observes and reports (e.g., occurrences vs. nonoccurrences) their own behavior (Harris, 1986). Self-monitoring is often associated to on-task-related behaviors. Several studies have evaluated procedures to teach self-monitoring related to on-task behavior (e.g., Holifield et al., 2010; Stasolla et al., 2014; Wolfe et al., 2000). For example, Wolfe et al. (2000) evaluated the use of self-monitoring to promote on-task behavior for children with ASD with lesser support needs, finding an increase in on-task behavior and reduction of stereotyped behaviors. Further, similar results were reported when using self-monitoring for a writing task with elementary students with LDs.

Result of this intervention indicated both an increase in on-task behaviors and some moderate increases in written performances. A greater increase in writing progress occurred with the introduction of a change in criterion with a public posting condition. Additionally, research has also evaluated self-monitoring in the context of on-task behavior and academic accuracy (see Reid, 1996 for a review). Harris et al. (2005) noted the potential for differential effects on on-task and academic (i.e., spelling task) behavior, and thus highlight need to monitor both related types of on-behavior (i.e., attention to task and task performance). Along those lines, accurate reporting is a critical feature of an effective management program. Research has evaluated interventions targeted to develop accurate self-monitoring to help decrease problem behavior (e.g., Cavalier et al., 1997; Wills et al., 2019) increase academic performance (e.g., Hudson, 2019; Scheithauer & Kelley, 2017) and general task completion (e.g., Lee et al., 2018; Li et al., 2019).

In sum, self-management interventions can be utilized across a wide variety of skills and populations. As an intervention, self-management interventions have been successful in encouraging on-task responding, with durable effects. Additionally, the nature of self-monitoring programming may be unique in that the effects may be easily generalized across settings because of the portability of the intervention components (e.g., reminders, data collection). Although the ultimate goal of self-management interventions is independence, some populations of people may not easily learn this relatively expansive system, which may then require more intensive teaching procedures. Regardless of learner skill, practitioners should implement systematic teaching procedures for each component with careful planning and evaluation of each intervention component.

Treatment Packages

In some cases, multiple intervention components may be useful for addressing on-task behavior. As such, several studies related to increasing on-task behavior utilize treatment packages that include intervention components previously discussed in this chapter (e.g., reinforcement, prompting, visuals schedules, technology). For example, King et al. (2017) use a treatment package called "On-Task in a Box," which is a manualized intervention that incorporates self-monitoring and video modeling for school settings. Participants were trained using the manualize procedures and the use of a MotivAider watch to self-monitor their behavior. Results of this treatment package indicated increased levels in on-task behavior (similar levels to classroom peers) for the participants.

Further, research has also evaluated the use of structured teaching to promote on-task behaviors. For example, Park and Kim (2018) evaluated the effects of the TEACCH structured teaching program on on-task independent works skills for individual with severe disabilities. Specifically, this treatment package utilized the guidelines of structured teaching (see Mesibov et al., 2005) visual schedules, work systems, and task organization. Results of this study indicate increases in on-task behavior, thus supporting the utility of treatment packages, such as structed teaching to help promote on-task behavior. Further, treatment packages, such as "The Good Behavior Game" (GBG), have also been cited in the literature to have positive effects for increasing on-task behaviors. For example, Pennington and McComas (2017) evaluated the effects of the GBG across classroom context for three children with EBD. Results showed that when the GBG was implemented in one context (e.g., morning meeting, math class) on-task behavior increases were not observed in the other contexts until the GBG was implemented. These findings highlight the need to program for generalization of behavior across various contexts (environments).

General Recommendations for Practice

Specific considerations for various treatment procedures have been mentioned throughout this chapter. Although this chapter does not provide an exhaustive review of the literature, there are several overarching considerations that have been identified to help guide the development of interventions that target on-task behaviors and warrant further discussion.

First, when evaluating an intervention to promote behavior change, an initial starting place is to first assess the learner's current repertoire. As mentioned in previous sections, utilizing an assessment that clearly evaluates the parameters and abilities of the learner will help to ensure the learner's identified target behavior is appropriate in terms of their current abilities. Next, it is important that a precise definition of the behavior of interest is developed, and considers made for how it would most accurately be measured (see Cooper et al., 2019 for defining and measurement behavior). As such, the actual value of the targeted on-task behavior should be of equal weight when making intervention plans. These variables are subjective and individualistic, and when evaluated within assessment and treatment development, can help to ensure the intervention provided ascribe to the values of concept of social significance within the field of ABA (Wolf, 1978; Snodgrass et al., 2018).

Next, given the variety of behavioral definitions within the literature for on-task behaviors (see Table 49.1), consideration of the context and learner abilities should be reflected when defining the targeted on-task behavior(s). A clearly developed definition of the targeted behavior will help to ensure accurate measurement procedures are implemented, and that data-based decisions can occur to guide future program decisions. Along these lines, considerations should also be made related to the accuracy and fluency of other responses, or those where a desired increase is anticipated. When defined in a general sense of the concept, being on-task might be mutually exclusive to accurate responding. For example, if on-task behavior is defined as paying attention to an academic task, this may not mean that accuracy of the task was observed. Thus, consideration should also be given to the accuracy, fluency, and/or amount of the task that was completed. Specifically, if the targeted on-task behavior is aligned with a general goal for promoting independence, it would be important that the task selected for the intervention was a previously mastered skill, perhaps selected from a maintenance program.

Lastly, any behavior change intervention should actively program for generalization of a targeted skill (Carnett, Sigafoos, & Neely, in press; Osnes & Lieblein, 2003; Stokes & Baer, 1977). However, this often does not occur within intervention planning or in the context of research. Thus, we encourage both practitioners and researchers to program and evaluate generalization of on-task behavior and considered critical elements, such as appropriate environments, contexts (e.g., skills, activities, tasks), and the use of maintenance program to help ensure relevant and lasting behavior changes. When generalization is actively programmed for within a behavior change intervention, we can ensure the lasting effects of the intervention occur (Carnett, Sigfoos, & Neely, in press; Osnes & Lieblein, 2003; Stokes & Baer, 1977). As discussed by Osnes and Lieblein (2003) it is critical when considering generalization of behavior change that we continue to raise the bar with our efforts as part progression within research and practice.

Summary and Conclusion

The ultimate goal for acquisition of on-task-related behaviors seems to be functionality, autonomy, and independence. On-task behaviors can range in complexity, topography, and are subjective to the contextual variables within the environment. The current research reviewed in this chapter supports this conceptualization and indicates the potential need for refinement in our behavioral definitions for "on-task," as evaluation of collateral effects of these various interventions. Regardless, research on this topic indicates this category of behaviors can be pivotal for providing learning opportunities and the development of fluent repertoires. Thus, consideration should be made of contextual variables that help generalize behaviors to gain autonomy and independence across the life span.

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50 Teaching Play Skills

Angela Persicke, Elizabeth Meshes, Adel C. Najdowski, and Emma I. Moon

Teaching Play Skills

Play skills are an integral part of child development in facilitating repertoires, such as exploration of functions of objects (Bruner, 1973), motor skills (Ozaydin, 2015), leisure interests (Barton, 2010), language, problem-solving (Boutot et al., 2005), sharing (Ginsburg, 2007), initiation (Zanolli et al., 1996), making choices, following rules (Vidoni & Ward, 2009), compromise (Francis et al., 2019), cooperation, negotiation (Gibson et al., 2017), creativity, flexibility (Bateson, 2005), coping skills (Hess & Bundy, 2003), awareness of others' thoughts and emotions (Barton & Pavilanis, 2012), entering others' play activities, managing conflicts (Ladd, 2005), building relationships (Hirsh-Pasek et al., 2009), school readiness, and literacy (Roskos & Christie, 2001).

In children of typical development, play skills tend to develop through natural reinforcers and require little teaching from adults (Lovaas, 2003), whereas children diagnosed with autism spectrum disorder (ASD) present with deficits in play skills and do not receive the natural benefits from play in the same ways that their typically developing peers do (Boutot et al., 2005). In addition to the benefits of play outlined above, children with ASD and other developmental disabilities (DD) are more likely to successfully integrate with typically developing preschoolers when they demonstrate proximity to peers, engage in social interactions, and play (Nelson et al., 2007). Moreover, positive behaviors related to play are correlated with social engagement (Hobson et al., 2013) and improvement in a child's social standing as it relates to their peers, which might be particularly helpful for children who suffer from peer exclusion (Rubin et al., 2007).

Research has demonstrated that interventions based in applied behavior analysis (ABA) can improve play skills (Lang et al., 2009). This chapter aims to provide practitioners with evidence-based behavioral strategies for teaching play skills.

Developmental Age and Types of Play

To lay the foundation and context for teaching this repertoire, the types of play and when they emerge in typical child development are described in Table 50.1 with approximate developmental age and available literature. Because the domain of play consists of a wide variety of behaviors and involves a wide range of complexity, the majority of studies teaching play skills identify

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_50

Table 50.1 Approximate developmental age and types of play

Age of emergence	Type of play	Definition	References
0–10 months	Sensorimotor	Consists of indiscriminate and simple actions with objects, including physical manipulation, looking, picking up, dropping, banging, grasping, mouthing, etc., sometimes in a repetitive fashion; appears to serve a sensory function—No functional relationship between manipulation of the object and the object itself	Casby (1992), Lifter et al. (2011), Lydon et al. (2011), Nelson et al. (2017)
Occurs at all ages	Solitary	Consists of independent play, with and without toys	Salkind (2002), Nelson et al. (2017)
10–12 months	Relational	Emerges as non-functional manipulation involving the association of objects that are not functionally related (e.g., hitting two blocks together); develops into manipulation of objects that are functionally related (e.g., stacking blocks, pretending to comb hair, bouncing/rolling a ball, etc.)	Casby (1992), Lydon et al. (2011), Nelson et al. (2017), Patry and Horn (2020)
9–12 months	Functional pretend	Consists of manipulation of objects in a conventional manner (e.g., pushing a toy car, feeding a baby with a bottle, pretending to drink tea from a teacup, etc.); early pretend play is typically self-directed	Lifter et al. (2011), Lillard (2015), Lydon et al. (2011), Lee et al. (2017)
18–24 months	Symbolic pretend	Involves the manipulation of objects that represents some other action, often in the context of a play scheme and usually reality oriented; play sequences become more complex with chains of events and increased levels of planning (e.g., hosting a pretend tea party, playing house, etc.); object substitution emerges (i.e., using arbitrary objects as items related to the play sequence)	Boutot et al. (2005), Casby (1992), Lifter et al. (2011) Lillard (2015), Patry and Horn (2020)
24–36 months	Parallel	Consists of independent play in close proximity to peers that are playing in a similar fashion; includes referencing or acknowledging others and peers' actions	Francis et al. (2019), Nelson et al. (2020)
24–48 months	Associative	Children begin to interact during play more frequently while engaging in common activity, though there is a segregation of duties and a lack of organization (e.g., playing dress-up, doing crafts, building adjacent Lego structures, etc.)	Nelson et al. (2017)
30–48 months	Sociodramatic pretend	Play sequences with greater complexity including fantasy and dramatic play—Children pretend to be things outside of reality; imaginary objects are used and reliance on language to narrate play schemes; several play schemes are often linked together with multiple participants	Lillard (2015), Nelson et al. (2017), Patry and Horn (2020)
36–48 months+	Cooperative	Consists of more organized group play involving communication to achieve a common goal (e.g., building a fort, acting out a prolonged play sequence, creating a dance, etc.)	Nelson et al. (2017)
36–48 months	Constructive	Involves the assembly of objects to create something else (e.g., playing with blocks, building sandcastles, shaping clay, etc.)	Lillard (2015), Nelson et al. (2017), Salkind (2002)

(continued)

Table 50.1 (continued)

Age of emergence	Type of play	Definition	References
May emerge around 12 months, most prominent between 48 and 60 months	Physical/Rough & Tumble	Includes activities such as climbing, swinging, jumping, chasing, pretend fighting/wrestling accompanied with smiles and laughter	Lillard (2015) Nelson et al. (2017)
60 months	Games with rules	Characterized by commonly known procedures and rules that are either predetermined or spontaneously derived within the group	Lillard (2015), Nelson et al. (2017), Salkind (2002)

the broader category of play and provide operational definitions relevant to the skills targeted for each intervention. Although this is a good strategy when researching these topics, conceptual accounts may assist in the future direction and research of play. A behavioral conceptual account of all forms of play is not available as far as we are aware, outside of one article that proposes a behavioral perspective specific to symbolic play (see Lee, Qu, et al., 2020b). Conceptual accounts of the types of play listed in Table 50.1 may be beneficial for a more comprehensive account of these behaviors and the identification of effective teaching strategies to promote the full range of play skills.

Research on Effective Play Strategies

The following sections review the empirical basis for behavior analytic intervention strategies related to teaching play skills. An overview of each approach is provided, along with the current state of the research and considerations for implementation.

Structured Versus Naturalistic Instructional Approaches

There are several prominent instructional approaches to teaching play skills that are supported by behavior analytic research. These range from structured approaches (e.g., discrete trial teaching, video modeling) to less structured, naturalist approaches (e.g., pivotal response training, peer-mediated interventions). The various approaches and teaching strategies supported by research are outlined below for teaching skills categorized as play.

Discrete Trial Teaching (DTT)

Discrete Trial Teaching (DTT) is a structured approach with materials selected by an adult implementer, clear directions, prompting, shaping, and contrived reinforcement (Tarbox & Najdowski, 2008). It has effectively taught early play responses, including extended play sequences using task analyses (Oppenheim-Leaf et al., 2012a) and teaching from simple object manipulation to complex play themes (Lifter et al., 2011). DTT is effective in conditioning toys and play as reinforcers and correlates with decreases in stereotypical behavior among learners with ASD (Eason et al., 1982). Procedures have been embedded in DTT programs to enhance the efficacy of instruction, such as embedded instructive feedback and modeling (Grow et al., 2017). Additionally, research has shown that DTT is an efficacious approach to maintain and generalize established play skills (Eason et al., 1982).

Promoting Creativity, Variability, and Generative Responding. A concern of structured intervention strategies such as DTT is that some interventions do not always establish responses that look natural, or the interventions result in limited novel or creative responding. However, research indicates that increasing variety in play can reduce stereotypy and improve indices of happiness (Lang et al., 2014). Procedures to enhance variability and generalization of skills are often incorporated into DTT play interventions. These include self-management of token delivery for variable responding (Newman et al., 2000), lag schedules of reinforcement to enhance creativity (Galizio et al., 2020), and extinction of previously reinforced play behavior to promote novel responding (Lalli et al., 1994).

Another approach to teaching a generalized repertoire of play skills, as opposed to teaching specific isolated play behaviors, involves matrix training, which refers to a generative instructional approach wherein skills with overlapping components are arranged in a matrix allowing various recombination of each of the component skills (Goldstein, 1983). This approach focuses on teaching a small subset of component play skills, followed by tests for generalization to other scenarios and skill sets to determine if the learner responds to novel combinations of the trained skills (see Curiel et al., 2020 for a review). For example, Hatzenbuhler et al. (2019) used matrix training to teach one of four character–action–vocalization combinations and demonstrated generalization to novel character–action pairs. Responding to untrained pairs in this manner is referred to as *recombinative generalization* (Goldstein, 1983). Several studies have shown that matrix training is an effective and efficient approach to training independent and interactive pretend play skills (Dauphin et al., 2004; Hatzenbuhler et al., 2019; MacManus et al., 2015) and can be combined with other evidence-based teaching strategies.

Matrix training may be useful when intervention time or access is limited and a generalized behavioral repertoire is ideal, such as during pretend play activities that require a broader and more flexible repertoire. In contrast, this approach may not be appropriate for play activities in which specific rules should be followed, such as card and board games, sports, or other structured activities. Although only a few studies have specifically evaluated matrix training for teaching play skills, the results are encouraging for the use of this approach.

Pivotal Response Training (PRT)

Pivotal response training (PRT) is an instructional approach that enhances motivation and generalization of skills, especially when implemented with learners with ASD (Pierce & Schreibman, 1995). PRT focuses on teaching behaviors considered critical to the development of other complex behavioral repertoires, referred to as *pivotal behaviors,* including responsivity to multiple cues, motivation, self-management, and child initiations (Carrero et al., 2014). A play intervention based on PRT would enhance motivation for a play activity by using a child-directed approach and allowing the learner to choose the toy or activity of interest. For example, reciprocal imitation training based on PRT has been effective in spontaneous object imitation, and learners with ASD have demonstrated collateral improvements in language, pretend play, and joint attention (Ingersoll & Schreibman, 2006). Additionally, natural forms of reinforcement are provided for any correct attempt related to the target play behaviors; therefore, the child accesses reinforcement at a higher rate compared to other intervention strategies (Stahmer, 1999). Research shows that PRT-based interventions are effective for teaching manipulative play (Malone & Langone, 1999), pretend play (Lydon et al., 2011), symbolic play (Stahmer, 1995), and sociodramatic play (Thorp et al., 1995), with generalization demonstrated across toys/activities and people.

PRT may be beneficial, especially early in treatment, when levels of motivation are low and high levels of maladaptive behaviors may disrupt treatment gains related to play skills (e.g., Hart et al., 1968). Additionally, this approach may be beneficial when access to opportunities to generalize skills is limited, for example, with learners who are not in inclusive settings and may not have access to peers or siblings outside of treatment. For learners who are somewhat isolated from social interaction, enhancing opportunities for generalization of these skills is critical to future success in general education settings or other inclusive environments. Additionally, PRT strategies may help supplement other structured approaches to enhance the acquisition of play skills.

Comparing DTT and PRT

Comparisons between DTT and PRT have mixed results on their efficacy of teaching play skills. For example, Strauss et al. (2014) showed that a flexible, as opposed to a structured, approach resulted in higher play and more appropriate engagement with peers. Lee et al. (2020a) showed the emergence of symbolic play in only one of three participants in free play observation (i.e., a naturalistic setting) following teaching specific symbolic play actions (i.e., structured trials). Jobin (2020) directly compared PRT and DTT in skill acquisition for early learners with ASD and found that both intervention approaches led to improvement of various skills. Results showed that the same participant might respond differently based on skill and dimension, which supports the idiosyncratic nature of ASD. A more structured teaching strategy may be necessary to teach initial play skills before expanding to more stimuli, expanded trials, or more naturalistic settings (Wong et al., 2007).

Peer- and Sibling-Mediated Play Interventions

Peer-Mediated Interventions. Peer-mediated intervention (PMI) refers to the inclusion of typically developing, similar-age peers trained in intervention strategies. PMI is effective for teaching play to individuals with ASD (Dueñas et al., 2019), DD (Garfinkle & Schwartz, 2002), visual impairment (Ozaydin, 2015), and socially isolated peers in educational settings (Milam et al., 2020). Several recent studies have investigated PMI combined with other evidence-based interventions, such as the system of least prompts (SLP; Barton et al., 2018), progressive time delay (PTD; Francis et al., 2019), video modeling (Dueñas et al., 2019), self-monitoring (Shearer et al., 1996), PRT (Pierce & Schreibman, 1995), and matrix training (Hatzenbuhler et al., 2019). These studies resulted in gains in target play skills and generalization to untrained play scenarios. In addition, two PMI treatment packages, *Stay, Play, Talk* (van Rhijn et al., 2019) and *Keys to Play* (Nelson et al., 2007), are effective interventions to teach play to early learners.

Many successful interventions can be embedded in a PMI format while maintaining or increasing efficacy. For guidance on PMI, several resources are available within the literature. Terpstra et al. (2002) provided recommendations for utilizing various effective strategies, including PMI, into specialized and inclusive classrooms. Further, it is important to consider the type of play and materials required as the availability of toys may promote or deter isolated versus collaborative play (Watkins et al., 2017). Patry and Horn (2020) provided guidance on considerations for selecting toys, identifying and preparing appropriate peers, and determining the appropriate level of adult guidance when using PMI (Wolfberg, 2003 as cited in Patry & Horn, 2020). Furthermore, recommendations for effectively training typically developing children to promote play skills can be found in Oppenheim-Leaf, Leaf, Dozier et al. (2012b).

The general conclusions are that PMI is not only effective but can also: be used in inclusive educational settings, promote generalization and maintenance of target skills, and result in positive social validity ratings from stakeholders (see Chan et al., 2009 or Watkins et al., 2015 for reviews). Additionally, several studies have utilized larger-scale implementation and evaluations of these interventions through group-comparison research designs providing additional evidence that PMI is effective even when scaled (see Chang & Locke, 2016 for a review).

Sibling-Mediated Interventions. Due to the positive effects of PMI to teach social and play skills, several studies have investigated the benefits of using typically developing siblings as trainers to prompt and reinforce appropriate behaviors with promising results (Akers et al., 2018; Oppenheim-Leaf et al., 2012b).

There are several benefits to including siblings in play interventions, especially in early childhood and with siblings close in age. First, siblings may be more available to participate within the home setting than attempting to schedule play dates with typically developing peers. This is pertinent if the learner is in a specialized education setting or private placement having little contact with peer models. Second, siblings may be more willing to participate in these interventions because they are motivated to learn how to better interact with their siblings. Third, these interventions may maintain skills because the siblings will have more access to the learner than a peer would due to living in the same house and likely having similar schedules. Fourth, when a sibling or peer is paired with a high magnitude of reinforcement, it may increase the likelihood of the child with ASD to engage rather than play alone (Hoch et al., 2002).

Interventions Utilizing Visual Strategies and Supports

Video Modeling

Video modeling (VM) refers to an intervention strategy that utilizes pre-recorded videos of individuals (e.g., adults, peers, learner) engaging in the target behavior. VM has been used across a variety of behaviors and settings and is one of the more prominent methods for teaching play skills, especially with learners with ASD because they often require visual modifications and visual supports to facilitate learning outcomes (Fragale, 2014). Additionally, it removes the social interaction requirement often involved with in vivo modeling, which some researchers attribute to its success at enhancing motivation to attend to and engage in the behaviors modeled through this medium (Cardon & Wilcox, 2011; Charlop-Christy et al., 2000). VM has a reasonably large evidence base in the behavior analytic literature and has been used across a variety of skills (see Park et al., 2019; Shukla-Mehta et al., 2010 for reviews).

Specific to teaching play skills, VM has been used to increase independent toy play (Paterson & Arco, 2007), game play (Charlop-Christy et al., 2000), and play-based language, including initiations and responses (Ezzeddine et al., 2020); however, the majority of VM studies focus on teaching pretend play (Akmanoglu et al., 2014; Dueñas et al., 2019; Hine & Wolery, 2006; Lee, Qu, et al., 2020b; Lydon et al., 2011; MacManus et al., 2015). VM also enhances learning outcomes related to play skills when combined with other intervention strategies, including PMI (Dueñas et al., 2019), activity schedules (Blum-Dimaya et al., 2010), matrix training (Dauphin et al., 2004; MacManus et al., 2015), and errorless learning strategies, such as graduated guidance (Akmanoglu et al., 2014).

VM interventions may have several benefits over in vivo intervention strategies with research supporting that VM may be more efficient and efficacious for some learners (Charlop-Christy et al., 2000; Cardon & Wilcox, 2011). Although research on VM has faced some criticism related to inconsistent results for promoting maintenance and generalization of acquired play skills (Lee, Qu, et al., 2020b), recent studies have demonstrated that VM interventions are effective, cost efficient, can be implemented with a variety of learners across a variety of settings, promote generalization, and can be easily combined with other intervention strategies to promote play skills (Hine & Wolery, 2006; Lee, Qu, et al., 2020b). For example, incorporating multiple exemplar training into VM interventions enhances generalization (Dupere et al., 2013). Furthermore, generative learning instructional strategies, such as matrix training combined with VM, have demonstrated that generalization is possible with this approach (Dauphin et al., 2004; MacManus et al., 2015).

Activity Schedules

Activity schedules involve pictures that provide steps needed to complete a behavioral chain related to tasks. They have been prepared using photographs/pictures, symbols, and text (McClannahan & Krantz, 1999) presented in either a notebook, checklist format (Bryan & Gast, 2000; Cuhadar & Diken, 2011; MacDuff et al., 1993; See Rehfeldt et al., 2004 for how to make activity schedules), or electronically (e.g., Brodhead et al., 2018; Kurkcuoglu et al., 2015). Common prompts to use activity schedules include graduated guidance (Bryan & Gast, 2000), least-to-most prompts (Pierce et al., 2013), and progressive time delay (e.g., Carlile et al., 2013), with the goal to fade prompts when possible (e.g., Akers et al., 2016). Reinforcement is usually provided for completing the activity schedule (Kimball et al., 2004). Often, activity schedules can teach learners to combine previously mastered play skills into lengthier play sequences (e.g., coloring, building with blocks, and putting together a puzzle) when given one discriminative stimulus such as, "Check your schedule" (McCollow et al., 2016). Activity schedules can also teach play skills that learners do not have in their repertoire by including each step of the play activity (Cuhadar & Diken, 2011). Systematic reviews of studies conducted with individuals with ASD (Knight et al., 2015) and intellectual disability (ID; Spriggs et al., 2016) have found activity schedules to effectively teach leisure or play skills. Additionally, a meta-analysis has found activity schedules to be effective for improving leisure skills of individuals with ID (van Dijk & Gage, 2019).

Low-tech photographic activity schedules have been used to: (a) increase playground activities (Akers et al., 2016; Machalicek et al., 2009); (b) teach the steps necessary to play with toys (e.g., blocks, Mr. Potato Head, bowling; Cuhadar & Diken, 2011); (c) get learners to engage in a sequence of activities (e.g., memory game, blocks, art, dollhouse, kitchen (MacDuff et al., 1993; Morrison et al., 2002); (d) play hide-and-seek with peers (Brodhead et al., 2014); and (e) teach peers with ASD who could already follow activity schedules independently to use a joint activity schedule to play previously mastered games (e.g., Don't Break the Ice®) together in a classroom (Betz et al., 2008).

High-tech activity schedules are useful for teaching various play skills to individuals with ASD. Computer-mediated activity schedules, combined with video modeling, have been used to increase play bids (Kimball et al., 2004). The iPod Touch® has been used to increase play skills (e.g., basketball, frisbee golf) in a classroom (Carlile et al., 2013). Video-based matrix training has been combined with an activity schedule notebook to teach sociodramatic play (Dauphin et al., 2004). Computer-assisted activity schedules with photographs on PowerPoint® have increased functional pretend play (e.g., dolls, cars, setting a table; Kurkcuoglu et al., 2015). And, activity schedules on an iPad® have increased the varied game play of the iPad's applications (Brodhead et al., 2018). One advantage of presenting activity schedules through electronics is that children with ASD may prefer instruction delivered by a computer over a human (Romanczyk et al., 1999). Since computers are difficult to carry around, activity schedules implemented on computers should be transferred eventually to a folder (see Kimball et al., 2004 for an example) or a smaller device.

Prerequisites for teaching learners to follow activity schedules include object and picture matching/sorting, discrimination of an object when placed on a background (McClannahan & Krantz, 1999), and picture-location identification (Brodhead et al., 2014). A beneficial feature of activity schedules is that choice-making can be embedded into creating them (Stromer et al., 2006). Unfortunately, in some cases, when the activity schedule was removed, responding did not maintain (e.g., Betz et al., 2008; Brodhead et al., 2014).

Script Training

Script training involves the use of written (visual) or audio-recorded scripts of various lengths that include phrases that the learner should say during a social interaction (Barnett, 2018). This intervention has been deemed evidence-based by a recent systematic review (Akers et al., 2016). Script training is sometimes embedded into activity schedules (Akers et al., 2018) and is often used in classrooms (Barnett, 2018). It has been used with children with ASD to increase social interactions during toy play (Akers et al., 2018; Groskreutz et al., 2015; Wichnick et al., 2010), art activities (Krantz & McClannahan, 1993), board games (Hundert et al., 2014), and sociodramatic play (Hundert et al., 2014). Script training has mostly been used to teach initiations; however, it is also used to teach responding to others' initiations (Wichnick et al., 2010). Although, overall effective, the research shows inconsistent results in generalization and maintenance of play skills acquired using script training; therefore, it is necessary to incorporate strategies to promote generalization and maintenance when utilizing this intervention strategy.

Script training alone has improved the variability of responding in social communication (Betz et al., 2011). Likewise, when script training has been combined with lag reinforcement schedules, it has improved the variability of conversational language (Lee & Sturmey, 2014). With advances in technology, some researchers are investigating methods to mainstream visual interventions, such as script training, to digital formats (Murdock et al., 2013) with generally positive outcomes. As technological applications of these interventions become more widely available, further research should evaluate and compare these methods to determine best practices.

Social Stories

A Social Story™ typically includes a combination of written and visual information depicting a social situation, scenario, or problem, along with a description of appropriate behaviors that the learner engages in given the situation in context (Gray & Garand, 1993). Numerous studies have investigated the extent to which interventions incorporating social stories play a role in establishing new behavior and reducing challenging behavior. Some researchers report benefits or moderate efficacy, and others recommend that more research is necessary to consider this an efficacious intervention strategy (Karkhaneh et al., 2010; Test et al., 2011; Wahman et al., 2019). The current state of the research on social stories shows variable results (Zimmerman & Ledford, 2017); however, social stories continue to be widely utilized to promote appropriate social behavior, especially in special education settings.

In regard to promoting play skills, several studies have incorporated this strategy in the acquisition of skills-related game play (Quirmbach et al., 2009) and independent and interactive play (Barry & Burlew, 2004). The results of studies using social stories to teach play, although reporting positive outcomes, should be interpreted with caution. With any study, it is necessary to evaluate the intervention strategies based on the level of rigor, demonstration of experimental control, and if inclusion of other treatment strategies confounds the results without analyzing the individual treatment components.

Due to the overall inconsistent results within the literature on the efficacy of social stories, practitioners and educators should utilize other evidence-based approaches for teaching play, as described in this chapter, as primary intervention strategies. If social stories are included, it is recommended to use them as an additional component to well-established interventions until more research emerges on the use of social stories to teach play behavior.

Treatment Packages

Treatment packages are common behavioral interventions that involve multiple components such as prompting, task analyses, reinforcement procedures, and so on. Treatment packages have been utilized to teach various types of play, such as pretend play (Barton & Wolery, 2010), symbolic play (Lee et al., 2017), parallel and dramatic play (Nelson et al., 2017), as well as diversity in play (Frey & Kaiser, 2011). Treatment packages have been effective in increasing components in peer play such as identifying peers' play preferences during cooperative play (Najdowski et al., 2018), sharing (Bryant & Budd, 1984), and generalization of pretend play skills (Barton, 2015).

Formally developed and manualized treatment packages to teach play are available. Three such treatment packages are *Joint Attention Symbolic Play Engagement and Regulation* (JASPER; Kasari et al., 2014), *Advancing Social-Communication and Play* (ASAP; available digitally, Watson et al., 2011), and *Play20* (Sipila-Thomas et al., 2020). All of the interventions focus on play and the social aspects associated with play. ASAP is developed from JASPER with some key differences: ASAP is targeted across a year while JASPER spans 3 months (Boyd et al., 2018). ASAP has a stronger emphasis on what to teach rather than how to teach it.

This allows for more independence for interventionists. However, it does not include the interventionist coaching embedded in JASPER (Boyd et al., 2018). JASPER has been effective within-participant (Lawton & Kasari, 2012), and both ASAP and JASPER are supported by randomized control trials (Boyd et al., 2018; Chang et al., 2016). Research on Play20 shows that it was effective with three participants, but research is still emerging (Sipila-Thomas et al., 2020).

Several studies have conducted component analyses to determine which elements of a treatment package increase efficacy. Adding an abolishing operation to a treatment package can increase functional play and decrease stereotypy (Lang et al., 2010). A verbal description before modeling an action can increase play imitation (Jahr et al., 2000). Santarcangelo et al. (1987) found that differential reinforcement of alternative behavior (DRA) alone was insufficient for increasing appropriate toy play and required a task analysis and prompting. A multi-component intervention that included the concurrent presentation of modeling and prompting was more effective for teaching independent play of block constructions than modeling or prompting alone (Quigley et al., 2018). There are no findings that any sole intervention or component is most effective for teaching play. Further, findings on maintenance and generalization for treatment packages are mixed, with some studies reporting maintenance and generalization (Barton & Wolery, 2010; Stahmer & Schreibman, 1992) and others showing low maintenance levels and mixed results with novel responses for symbolic play targets at a 10-month follow-up (e.g., Lee et al., 2017).

Conclusion

In summary, play skills are critical to many areas of development. There is a plethora of research on the use of various applied behavior analytic intervention strategies to enhance play skills as described throughout this chapter ranging from naturalistic interventions in inclusive settings incorporating peer models to structured interventions and manualized treatment packages. Although there is a fairly strong evidence base for a variety of intervention strategies for increasing play skills, the broad range of skills within this repertoire requires continued attention from researchers and practitioners alike to identify the most effective strategies for various populations based on the type and complexity of play targeted for intervention.

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51 Teaching Social Skills

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Social skills are a complex class of responses that relate to one's communication and interactions with other people in a common environment (Little et al., 2017; Ulrich et al., 1966). Although there is no explicit definition, many responses may be categorized as social. This class of behavior may be best conceived of as those responses that increase the likelihood of producing positive consequences with other people, while minimizing negative consequences (Gresham & Elliott, 1984). For example, eye contact, prosody of speech, gestures, affect, language and interactions, joint attention, and play behavior are all important responses that can affect environmental outcomes. The extent to which one displays each, or a combination of these responses can contribute to the likelihood with which that person will function competently in society (Vener et al., 2017). Social skills are vital to one's development and correspond with the likelihood of success in various avenues of life including academics, vocations, and peer relationships (Mayer et al., 2012). Many individuals with developmental disabilities demonstrate deficits in one or more areas of social behavior.

When a person displays a deficit in one or more of these responses, the probability of a positive outcome may be compromised. Nevertheless, evidence-based practices in the field of applied behavior analysis have demonstrated success in teaching social skills and increasing the likelihood of social reinforcement. Effective teaching strategies have included differential reinforcement, modeling, incidental teaching, discrete-trial teaching, script fading, and self-management, among many others. Although not an exhaustive review of the literature, this chapter does address the different components of social behavior and training procedures used in behavior-analytic research.

Research on Social Skills

As outlined by Baer et al. (1968), one of the core dimensions of applied behavior analysis is that the research is *applied* and relates to behavior that is important and socially significant to the person and consumers of the behavior. By definition, social skills satisfy these criteria. Applied behavior analysts have dedicated a vast amount of research to determining effective interventions to teach these skills.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_51

Some of the earliest research on social skills analyzed the relationship between the broad concept of social competence and treatment outcomes of patients with various diagnoses including schizophrenia, manic depression, and personality disorders. These studies concluded that patients with lower social competency were associated with a "poorer prognosis," or less desirable outcomes, than those with higher social competency skills. Patients of the latter were associated with more favorable psychiatric outcomes, such as shorter hospitalization times or a lesser number of hospital readmissions (Zigler & Phillips, 1961; Zigler et al., 1979).

As researchers continued to focus on the study of social skills, the components of social behavior were operationalized, quantified, and measured in a more discrete manner. For example, Bornstein et al. (1977) conducted a study that taught social skills to four unassertive children. The children were between the ages of 8 and 11 years, and displayed deficits in eye contact, speech duration, speech volume, and requests. The authors presented role-play scenarios to the participants that were similar to their typical encounters in school. For example, a scenario may have been that a classmate cut the participant in the lunch line, or that a classmate broke the participant's pencil after borrowing it. The authors used instructions, modeling, feedback, and rehearsals to teach the four participants to engage in social skills appropriate for each scenario. The results indicated a systematic change in overall assertiveness across the four participants. Moreover, the findings demonstrated generalization across untrained scenarios.

Subsequent behavior-analytic studies have targeted social behavior such as eye contact, prosody of speech, gestures, affect, joint attention, language and interactions, and play behavior. Moreover, studies have included analyses of the effectiveness of specific independent variables on such social behavior, such as discrete-trial teaching, in vivo and video modeling, incidental teaching, script-fading procedures, and self-management, among many others. The results of such research have provided important information that can be used to improve social competency.

Eye Contact

One of the most fundamental responses crucial to social behavior is eye contact with other people. Eye contact is a pivotal response that is an important component in conversational behavior, direction-following skills, and in responding to social cues (Jeffries et al., 2016). One of the earlier studies on eye contact was conducted by Foxx (1977) to increase the extent to which three children with autism displayed eye contact with an instructor. The authors used an overcorrection avoidance procedure to teach participants to engage in eye contact when provided the instruction, "Look at me." When the participant emitted eye contact within 5 seconds of the instruction, an edible reinforcer and praise were delivered. If the participant did not engage in eye contact within 5 seconds, then the overcorrection procedure was implemented, during which instructors would manually prompt the participant to engage in repeated head orientations. The authors found a systematic increase in the percentage of trials with eye contact. Essentially, participants increased eye-contact responses to avoid the aversive alternative. The authors did indicate that this strategy should be considered as a last-resort option when other positive-reinforcement procedures prove ineffective.

Eye contact also may be taught by using differential reinforcement. Differential reinforcement consists of the reinforcement of responses that adhere to a specified property, while withholding reinforcement for those responses that do not (Catania, 1998). To differentially reinforce eye contact, instructors would deliver reinforcers contingent upon the occurrence of appropriate eye contact, and withhold reinforcer delivery when the learner is looking away from the instructor. Several researchers have demonstrated the effectiveness of differential reinforcement in modifying eye-contact behavior. For example, Carbone et al. (2013) conducted a study in which differential reinforcement was used to teach eye contact to a 3-year-old boy with autism. Access to preferred stimuli was granted when the participant emitted appropriate mands in conjunction with eye contact to the instructor, whereas access was denied when mands were emitted without eye contact. This use of differential reinforcement produced an increase in the percentage of mands accompanied by eye contact.

Jeffries et al. (2016) conducted a similar study and found the use of differential reinforcement to be a more effective strategy to teach eye contact to three children with autism than the use of a tablet application. By withholding reinforcers until eye contact was established during manding opportunities, the authors observed a systematic increase across all three participants.

Similarly, shaping can be used to effectively modify eye-contact behavior. Shaping consists of the modification of behavior by differentially reinforcing successive approximations to a target response (Catania, 1998). With successive shifts in reinforcement contingencies, responding gradually transforms until it resembles the desired terminal response (Cooper et al., 2020). With eye contact as the targeted terminal response, the instructor may initially reinforce a learner's orientation to the general direction of the instructor. As this behavior is reliably emitted, the instructor may then decide to withhold reinforcer delivery for these responses, and only deliver for learner orientation to the instructor's face. Finally, as this form of responding is steadily emitted, only eye contact to the instructor's eyes may occasion reinforcer delivery. This procedure, of course, may involve many more detailed steps in the shaping process, as well as careful and systematic measures. For example, Fonger and Malott (2019) used a shaping procedure to teach three young children with autism to emit eye contact with an instructor for a duration of 3 seconds. The researchers presented and removed preferred stimuli within the participants' environment. Initially, reinforcers were delivered contingent upon the orientation of the participants' eyes to the instructor's body. Once this response occurred reliably, reinforcers were only delivered contingent upon eye orientation to the instructor's face. Subsequently, any occurrence of eye-to-eye contact occasioned reinforcer delivery, regardless of duration. Thereafter, the criterion for reinforcement shifted such that eye contact was required to occur for a duration of 1 second, then 2 seconds, and finally 3 seconds. The data demonstrated a functional relation between the shaping procedure and the occurrence of eye contact across the three participants. Moreover, the authors found that initial occurrence of eye contact and the use of prompting were not required to produce this behavior.

Prosody

Prosody consists of various characteristics of speech, including volume, intonation, and rhythm. People with developmental disabilities may display speech that is monotonic, lacks volume control, and presents inappropriate quality or stress patterns (Brown & Poulson, 2009; Paul et al., 2005). All of these aspects of speech play an important role in one's interactions with other people, and a deficit in any single one can impact the outcome of a given interaction. Fortunately, behavior-analytic strategies have proven effective in modifying prosodic responses.

Voice volume is one important characteristic of prosody that can clearly impact social behavior. Researchers have successfully modified voice volume by employing various behavior-analytic procedures. Schwartz and Hawkins (1970) used a delayed reinforcement procedure to increase the voice volume of a 12-year-old "maladjusted" girl. The participant was videotaped during her regularly occurring math and spelling classes at school. At the end of the school day, she reviewed this video with the experimenter. If her voice volume had satisfied a specified criterion for volume, the participant would earn poker chips to be exchanged for preferred items. The authors found that this delayed-reinforcement strategy caused an increase in her voice volume and generalized to an untrained class in school.

Fleece et al. (1981) used a shaping procedure to increase the voice volume of two 4-to-5-year-old children with developmental delays. The participants recited nursery rhymes with the experimenter in a sound-proof room. A voice-activated relay with adjustable sensitivity was used to activate a display of red and green lights contingent upon the occurrence of a predetermined voice volume. During intervention, the sensitivity of the voice-activated relay was modified to shape increases in volume. During baseline, participant voice volumes ranged from inaudible to below-normal levels. With the introduction of the shaping procedure, participant voice volume increased systematically to levels which would be considered "normal." Furthermore, the authors observed a maintenance of increased voice volume at one- and four-month follow-up sessions.

Another important component of prosody is intonation, or pitch. Intonation refers to the rise and fall of one's speech and has been systemically modified using behavior-analytic strategies. For example, Daou et al. (2014) used a discrete-trial teaching package to teach children with autism to emit the appropriate affective behavior, one component of which consisted of vocal intonation. When presented with scenarios from various affective categories, including absurdities, empathy, excitement, and gratitude, the participants were taught to emit appropriate verbal responses in conjunction with appropriate vocal intonation. Through the use of in vivo modeling, instructions, and reinforcement, the authors observed a systematic increase in the percentage of correctly emitted vocal intonation for all three participants. Responses also generalized across untrained scenarios presented by the experimenter.

Similarly, Charlop et al. (2010) used video modeling to modify intonation among three boys with autism as one of four components targeted in teaching socially expressive behavior. The participants were presented with video scenarios which occasioned forms of intonation such as loud/authoritative or exclamatory. During baseline, none of the participants displayed appropriate intonation. With the introduction of the video-modeling procedure, however, the percentage of correct intonation responses increased systematically across participants, and demonstrated generalization across untrained settings, stimuli, and people.

Although incidental teaching (Hart & Risley, 1975, 1980) and script-fading procedures (Krantz & McClannahan, 1993, 1998) are primarily used to teach language and conversational skills, these strategies also may embed the modeling of prosodic characteristics of speech. Reinforcement contingencies may be modified such that appropriate voice volume, intonation, and/or rhythm are required to occasion the delivery of reinforcers.

Gestural Behavior

Gestures are an important aspect of social and communicative behavior. They are hand movements that add meaning to speech and convey information that otherwise would not be present during speech alone (de Marchena et al., 2019; McNeill, 1992). For example, a person who is describing a toy might hold up two hands with palms facing each other, two feet apart. The conversation partner would understand that the toy was quite large without the speaker having to say it. Similarly, gestures can link the physical environment to spoken language, such as when a parent says, "it's almost time for dessert," while pointing to the empty dinner dishes on the table.

In addition to supporting and enhancing information conveyed by speech, greater comprehension is found when speech is accompanied by gestures than when speech is not accompanied by gestures (Hostetter, 2011). Gestures can signal emphasis, uncertainty, and convey meaning. A friend who says, "the movie is still on," while placing her index finger to her lips is clearly stating that one should stop talking. Gestures are also beneficial in situations in which the quality of spoken language is weakened and/or the listener is less verbally proficient. For example, if the environment is noisy, a listener has less verbal skills than the speaker, and/or speech is unclear, gestures can perhaps clarify spoken meaning.

Evidence suggests that gestures are important in the initial stages of the development of communication (Volterra et al., 2006). Gestures develop prior to the development of speech and are later used in conjunction with spoken language (Morford & Goldin-Meadow, 1992). Between the ages of nine and 13 months, gestures such as give, show me, and point emerge and begin to express communicative intent. For example, a baby might reach toward an object or point to a desired toy. Pointing is the most frequently used gesture and is later correlated with the onset of one's first word (Volterra et al., 2006).

McNeill (1992) described gestures as iconic, metaphorical, deictic, beat, and/or emblem. Iconic gestures are gestures that describe physical characteristics, such as size or shape or size. Metaphorical gestures illustrate information in a more abstract manner, such as moving a hand outward and upward to describe a skill. Deictic gestures are pointing gestures that identify a specific object in the environment. Beat gestures are rhythmic hand movements presented in close temporal synchrony with targeted words or phrases. Emblem gestures are gestures that are culturally defined. For example, one's palm facing away from speaker's body, pointer and thumb in a circle, with the other three fingers pointing up to indicate, "OK." Other culturally defined gestures include clapping hands to show approval, bringing hand to mouth to express hunger, or bringing the hand to the ear to represent a telephone. These gestures represent reliably consistent meaning and can be interpreted without contextual reference (Volterra et al., 2006).

Bavelas et al. (1992) included interactive gestures to the list of gestures presented by McNeill (1992). An interactive gesture makes reference to the conversational partner or the conversation. For example, a speaker might point to an individual when referencing something that he or she said earlier, or gesture along with specific word or phrase to signal importance.

Individuals with autism rarely use gestures as a means of communication (Ingersoll et al., 2007; Loveland et al., 1988). Nevertheless, if they do use gestures, they use iconic more than other gesture types (Medeiros & Winsler, 2014). This finding suggests that individuals with autism predominantly use gestures for concrete as opposed to abstract function. In addition to an insufficient use of co-speech gestures, individuals with autism speak at a rate slower that typically developing peers, are slower to respond than typically developing peers, and use more unusual vocalizations during pauses more often than typically developing peers (Parish-Morris et al., 2016).

Because individuals with autism are less likely to use gestures during social interactions, they have difficulty participating in social situations. Buffington et al. (1998) conducted a study with four children with autism who used little or no gestural communication prior to intervention. Following the introduction of a modeling, prompting, and reinforcement treatment package, all four children emitted verbal and gestural responses during social interaction opportunities. These findings suggest that by learning to use gestures in combination with vocal behavior, children with autism can begin to develop a repertoire needed to engage in social interactions. The authors assessed generalization in the presence of novel stimuli and novel settings. The results showed an increase in the use of gestural communication during probe assessments. Social validity data suggested that the children's communication was rated as more expressive during treatment than baseline, suggesting that teaching children with autism to use gestures leads to improvements in the quality of their social communication.

Similarly, Duker and Van Lent (1991) stated that individuals with developmental disabilities may engage in a low variation in gestures. Five individuals with severe to profound mental retardation between the ages of 13 and 30 participated in the study. During baseline, each gesture emitted was reinforced with access to the requested object. Gestures were ranked according to frequency of use. During treatment, access was withheld from 2 to 3 of the high-frequency gestures. Low-frequency gestures were differentially reinforced. Results showed an increase in previously used gesture requests. By increasing the variation in gestures used, the ability to engage in meaningful social communication increases.

In an attempt to increase gestures in five young boys with autism, ages 3–4, Ingersoll et al. (2007) used a reciprocal imitation training strategy to increase spontaneous use of descriptive gestures during play. During free play during baseline, the experimenter modeled a descriptive gesture accompanied by a corresponding verbal statement. For example, while placing a doll in a bed, the experimenter placed her finger over her lips and said, "Sh, baby sleeping." During intervention, the experimenter followed the child's lead, imitated child actions and vocalizations, and commented on the actions that the child performed. In addition, the experimenter modeled gestures and verbal statements corresponding to the child's actions. Rather than targeting specific gestures to criterion, multiple gestures were taught that were relevant to the play actions initiated by the child. If the child imitated the gesture, praise and access to play materials were provided. If the child did not imitate the gesture, manual prompts were provided and praise delivered. The authors found that all children increased their imitation of descriptive gestures in the training setting and in an untrained setting.

Overall, co-speech gestures assist the speaker in conveying meaning. People with developmental disabilities may display considerable impairment in their spontaneous use of meaningful gestures. Across the studies reviewed, imitation training, modeling, contingent reinforcement, and prompting are promising procedures to address these deficiencies.

Affective Behavior

Affective behavior consists of various categories of responding such as facial, verbal, gestural, and postural responses (Gena et al., 1996). From as early as infancy, affective behavior serves as an important social behavior and form of communication with others. For example, the reciprocation of smiles with parents (Dawson et al., 1990) and demonstration of empathic responding to others' distress (McDonald & Messinger, 2012) are notable differences between children with developmental delays and their typically developing peers. The display of appropriate affect, however, has a large impact on the development of relationships with others across a person's lifespan.

Several studies have demonstrated that components of affective behavior can be successfully modified using operant conditioning procedures. For example, DeQuinzio et al. (2007) used a treatment package consisting of modeling, manual prompts, reinforcement, and error correction to teach three children with autism to imitate various facial models. Facial models included responses such as smiling, frowning, and a surprised face. Prior to teaching, the participants did display some imitative responding, although performance was variable and inconsistent. The introduction of the treatment package, however, produced a systematic increase in the imitation of facial models, and responding generalized across an untrained angry facial model.

Gena et al. (1996) used modeling, verbal prompting, and reinforcement to teach four youths with autism to emit appropriate affective behavior across various categories. The authors taught the participants to emit contextually appropriate verbal and facial responses to scenarios concerning sympathy, appreciation, dislike, preferred items, and absurdities. For example, the experimenter may have stated, "I have a headache," to which an appropriate affective response would include a serious facial expression and a statement of sympathy, such as, "I'm sorry to hear that." The data demonstrated that the intervention produced a systematic change in affective behavior across the participants for three or four of the targeted categories. Moreover, responding generalized across untrained scenarios within a given affective category.

In a study by Schrandt et al. (2009), a treatment package consisting of pretend play with manual prompts, auditory prompts, behavior rehearsals, and reinforcement was used to teach four children with autism to emit vocal and motor responses of empathy in the presence of a verbal stimulus. During a given session, the experimenter presented a vignette by using a doll or puppet. For example, the experimenter may have had the doll bump its leg on a table and exclaim, "Ouch!" Empathic responding was taught across three affective categories including sadness/pain, happiness/excitement, and frustration. The experimenters used manual prompts to teach the participants to emit empathic motor responses, such as patting the doll's arm. An auditory prompt, consisting of a recorded script on a Language Master © card, was used to teach participants to emit empathic verbal responses, such as, "Are you okay?" During the baseline condition, participants emitted few or none of the appropriate empathic responses. With the introduction of the treatment package, however, empathic responding increased systematically across the affective categories for all participants. Moreover, responding generalized for two of the participants from the pretend-play stimuli to untrained people in an untrained setting.

Gena et al. (2005) used in vivo modeling, video modeling, verbal prompts, and gestural prompts to teach three children with autism to emit appropriate affective behavior during pretend play. Affective categories included sympathy, appreciation, and disapproval. Affective behavior was scored as correct if the participant emitted verbal responses, vocal intonation, and facial expressions that were appropriate for the given category. The authors observed a systematic increase in the percentage of appropriate affective responding emitted by the three participants with the introduction of the treatment package. Furthermore, responding generalized to untrained stimuli and people.

Similarly, Charlop et al. (2010) taught three children with autism to emit affective behavior across scenarios during a play session, such as denying access to tickling, being shown a preferred toy, making a basket, and being shown a large toy. For each scenario, the researchers used video modeling to teach the children to emit the appropriate verbal statement, intonation, gesture, and facial expression. For example, when shown a preferred toy, the children may have been taught to say, "That's cool!" while using an exclamatory voice with positive valence, raising their eyebrows at least ¼" from resting position, and pointing with their index finger or full hand toward the object. The results demonstrated that the video-modeling procedure led to a systematic increase in the percentage of correctly emitted affective components. Moreover, results generalized across people, settings, and stimuli.

A study by Daou et al. (2014) used a discrete-trial teaching package to teach children with autism to emit the appropriate verbal responses, vocal intonation, and facial expressions when presented with scenarios from various affective categories including absurdities, empathy, excitement, and gratitude or appreciation. Through the use of in vivo modeling, instructions, verbal prompts, script fading, and reinforcement, the authors observed a systematic increase in the percentage of correctly emitted affective components for all three participants. Responses also generalized across untrained scenarios presented by the experimenter.

Finally, Argott et al. (2017) taught four children with autism to display empathetic responding across the affective categories of joy, frustration, and pain. The authors used a prompting sequence that progressed from video modeling, to in vivo modeling, to manual prompts, and then to verbal prompts. During sessions, the instructor presented an affective stimulus from the given category. For example, within the category of joy, the instructor might have held up a puzzle and exclaimed, "I finished my puzzle!" A correct empathetic response consisted of a statement of empathy emitted with appropriate intonation, an appropriate gesture, and a corresponding facial expression. In this example, a correct response included a statement such as, "That's great!" emitted in a high pitch while also smiling and offering a high five to the instructor. During baseline, the participants displayed none, or inconsistent levels, of the targeted empathetic responses. Correct empathetic responding increased systematically across participants for the three affective categories when treatment was introduced. In addition, responding generalized across untrained people and across untrained affective stimuli within each of the categories.

Joint Attention

Joint attention is a significant developmental milestone and an underlying component in language acquisition and social skills development. Joint attention refers to the mutual attention between two people toward an object in the environment (Bakeman & Adamson, 1984). It is a skill that typically develops during infancy and is a pivotal response that can lead to the acquisition of other important behavior (Jones & Carr, 2004). A deficit in joint attention is one of the core criteria in the diagnosis of autism (American Psychiatric Association, 2013). Given the impact of joint attention on various other social skills, intervention aims at teaching this skill as early as possible and has been successful through the use of behavior-analytic methods.

Whalen and Schreibman (2003) used shaping and prompt-fading procedures to teach five children with autism to initiate and to respond to bids for joint attention. To teach responding to joint-attention bids, the experimenters conducted six levels of training. During all levels, the participant was playing with a toy, but the response requirement successively shifted. At the first level, the experimenter manually prompted one of the participant's hands onto a different toy. If the participant looked at or played with this different toy, then the response was scored as correct. During the second level of training, the experimenter tapped on a different toy, and responding to joint attention was scored as correct if the participant looked at or engaged with that toy. During the third level, the experimenter showed a toy to the participant, and responding was correct if the participant looked at or engaged with the toy being shown. At the fourth level of training, the participant was now required to engage in eye contact with the experimenter. During the fifth level, the participant was required to first engage in eye contact with the experimenter and to orient their head toward an object at which the experimenter pointed. Finally, at the sixth level of training, the participant was required to orient to an object toward which the experimenter shifted their gaze, without the presentation of a pointing response. To teach initiations for joint attention, Whalen and Schreibman (2003) using a prompt-fading procedure while the participant was playing with a toy. Initially, the experimenters provided manual prompts to teach the participant to hold the toy with which they were playing and to orient their head until eye contact was established. The experimenters delivered the verbal prompt, "Show" in conjunction with gestural prompts to their eyes to teach a gaze shift between the toy and the experimenter. Experimenters faded prompts from full physical with verbal, to partial physical with verbal, to gestural with verbal, to verbal prompts only, and finally by removing all prompts. The results demonstrated that their shaping and prompt-fading procedures systematically increased the percentage of correct responses to joint attention for all five participants and increased the percentage of correct initiations for joint attention for four of the five participants.

Taylor and Hoch (2008) used a least-to-most prompting procedure to teach three children with autism to initiate and respond to bids for joint attention. The researchers targeted three components of joint attention including a shift in eye gaze between an object in the environment and an adult's eyes, a vocal response to a bid for joint attention, and a vocal initiation as a bid for joint attention. Sessions were conducted in a room containing novel or unusually placed toys. To teach responding to bids for joint attention, the instructor presented a bid for joint attention, such as pointing to a toy and exclaiming, "Wow!" Initially, if the participant did not orient to the item, the instructor provided a gestural prompt from the participant's orientation to the toy. If the participant still did not gaze with the delivery of this prompt, then the instructor used physical prompts to turn the participant's head toward the toy. The instructor then modeled a comment for the participant to emit about the toy. Gestural and verbal prompts were then used to teach the participant to shift their orientation from the toy to the instructor. A similar prompting procedure in conjunction with verbal prompts was used to teach the participants to initiate bids for joint attention. The results demonstrated that their least-to-most prompting procedure was effective in teaching the participants to engage in the three targeted components of joint attention.

Kryzak et al. (2013) taught three children with autism to respond to bids for joint attention by using the participants' intense interests in specific topics in conjunction with a most-to-least verbal-prompt-fading procedure. While the participants were engaged with their object of interest, the experimenter gazed and pointed at the object while emitting an exclamatory statement (e.g., "That's cool!"). The experimenter used verbal prompts to teach the participant to shift their eye gaze to the object by stating the participant's name or the direction, "Look." After a specified criterion of responding was achieved, the verbal prompt was faded to the initial sound of either the participant's name of the direction to look. Subsequently, a constant 4-second prompt delay was used to teach responding. Experimenters reinforced correct responses to joint attention with verbal praise statements. The findings demonstrated a systematic relation between the prompt-fading procedure and the percentage of correct responses to bids for joint attention. Moreover, data suggested generalization across untrained stimuli. Kryzak et al. (2013) suggested that the use of the participants' intense interests with their prompt-fading procedure may be a successful starting point for teaching joint-attention skills.

MacDuff et al. (2007) used a script-fading procedure and manual prompts to teach three young children to emit bids for joint attention. The experimenter walked the participant through a hallway containing various different pictures and toys. Voice-over-recording devices with the recorded script, "See" were placed upon the stimuli. Instructors used manual prompts to teach the participants to press the recorders and to orient to the experimenter while emitting the scripted statement. Correct responding was reinforced with a token motivational system and edible snacks. The recorded script and voice-over-recording device were faded systematically as the participants reliably emitted independent bids for joint attention. The data demonstrated a systematic increase in number of correct bids for joint attention emitted across the three participants. In addition, as the scripts were faded, participants began to emit unscripted initiations, such as object labeling. The findings also demonstrated generalization across untrained settings and stimuli.

Language and Interactions

There is an expansive breadth research on behavioral interventions that have demonstrated effective changes in language and interaction skills. The review that follows consists of some of the fundamental studies in this area in the field of applied behavior analysis.

One of the earliest studies on language and behavior-analytic methodologies was that conducted by Rheingold et al. (1959). The experimenters analyzed the effects of reinforcement on the vocal behavior of 3-month-old infants. Prior to intervention, the experimenter displayed a neutral affect while orienting to the infant over the crib. During intervention, the experimenter delivered social praise in the form of smiling and tickles to the infant when the infant had vocalized. The experimenters then withdrew intervention and returned to a baseline condition. They found that the infants vocalized at a higher rate during the experimental condition than in the baseline conditions. Nevertheless, it was possible that the delivery of social praise served to elicit, rather than evoke, the observed vocal behavior.

Todd and Palmer (1968) compared the effects of auditory social reinforcers (e.g., a human voice) with the adult present versus the adult being absent from the environment on the frequency of infant babbling behavior. Although the authors observed an increase in babbling under both conditions, they noted a markedly higher frequency of babbling by infants for whom an adult was present when delivering auditory reinforcers.

Other research on language and reinforcement by Ramey and Ourth (1971) found that the rate of infant vocalization behavior increased only with the presentation of immediate reinforcer delivery, rather than reinforcer delays of 3 or 6 seconds. A later study by Reeve et al. (1992) found a systematic relation between infant vocalizations and delayed social reinforcement. These studies helped to establish that language, as early as in the infant stages of life, can be modified using operant conditioning procedures.

Incidental Teaching Evidence-based research continued to demonstrate the operant nature of language and effectiveness of behavior-analytic methods on language acquisition. Incidental teaching is the process by which language is acquired in a naturalistic setting. A child initiates a verbal or nonverbal interaction with an adult that indicates a want or need for a given stimulus. For example, a child may reach for an item that is too high, or may emit a request for a desired item, activity, or information. The child's want or need is then used as an opportunity to teach language. The adult interrupts access to the desired stimulus and waits for the child to emit appropriate language, or provides a verbal prompt to emit appropriate language in the given context. Access to the desired stimulus is then granted contingent upon the occurrence of the targeted language (Hart & Risley, 1975). Hart and Risley (1975) demonstrated the effectiveness of incidental teaching in their seminal study that increased the use of compound sentences by preschool age children to their teachers.

McGee et al. (1985) conducted a study that compared the effectiveness of traditional and incidental teaching procedures to teach the use of prepositions by three children with autism. During the traditional procedure, an instructor used items at a desk to demonstrate the targeted preposition and asked, "Where is the (item)?" The instructor used verbal prompts to teach correct preposition responses. During the incidental teaching procedure, items used to teach prepositions were placed upon shelves in a manner to demonstrate targeted prepositions. When the participant emitted a request for a given item on the shelf, the instructor presented the question, "Where is the (item)?" Access to the requested item was granted contingent upon responses that contained the correct preposition (e.g., "The car is under the box"). The authors found that the incidental-teaching procedure produced a greater extent of generalization across settings and stimuli, and promoted a greater likelihood of spontaneous speech.

McGee et al. (1992) also used incidental teaching to promote reciprocal peer interactions to three children with autism. In this study, the authors trained three typically developing children to serve as peer tutors for incidental teaching to the participants in a socially integrated classroom. The peer tutor was seated with a given participant in the classroom as well as a bucket containing items identified as highly preferred by the participant. The child peer tutor was taught to wait for the participant to initiate to the bucket, to provide a verbal prompt for language (e.g., "Say duck"), to provide access to the toy contingent on the occurrence of the language, and to deliver behavior-specific praise for the language response. Data were collected on the percentage of 10-s intervals within a 5-min observation period that each participant emitted a reciprocal peer interaction. During the baseline condition, the mean percentage of intervals during which the participants emitted the targeted interactions ranged from 0% to 7%. With the introduction of the incidental-teaching procedure, data increased systematically across the three participants, with the percentage of intervals during which reciprocal peer interactions occurred ranging from 13% to 35%.

Similarly, Farmer-Dougan (1994) used incidental teaching delivered by peers to increase the requesting behavior of adults with developmental disabilities. The experimenter used incidental teaching during the typically occurring lunch-making routine in the participants' group home. When a participant attempted to gain access to one of the necessary lunch-making items, the item was placed out of reach, and the participant was prompted to emit a request for the item. Participants were granted access to the items contingent upon the appropriate request. The results demonstrated a functional relation between the number of appropriate requests and the use of the incidental-teaching procedure.

Video Modeling Researchers have also used video-modeling procedures to teach language and social interaction skills. Video modeling is a strategy by which desirable responses are displayed through video presentation. The participant views the modeled behavior and it is anticipated that observational learning and an imitative repertoire contribute to the successful performance of the desired behavior (Bellini & Akullian, 2007). Video modeling can include peers, family members, and adults, and the medium of this technique allows for it to be practiced in virtually any context.

Charlop and Milstein (1989) used a video-modeling procedure to teach conversational skills to three children with autism. Each participant viewed a videotaped conversation three times. The conversation consisted of a series of questions and statements between two familiar adults about a given topic, such as school, toys, or sports. Subsequently, the participant was presented with the opportunity to engage in the same conversation with an instructor. Correct conversational targets included the three lines presented in the video and were reinforced with praise and edibles. If the participant did not emit the three targeted lines from the video, then the video was again presented for a single viewing, and the conversation was again attempted. This sequence repeated until the participant emitted the three targeted lines for a specified topic. The findings of the study indicated a functional relation between the video-modeling procedure and the display of the targeted conversational behavior. Moreover, performance demonstrated generalization across untrained topics, conversation recipients, and settings.

In a study by Maione and Mirenda (2006), the authors used a video-modeling procedure to teach a young boy with autism to emit peer interactions during three play activities. Three exemplars of 1-minute vignettes were recorded for each of the play activities, and depicted two adults talking to one another while playing. The participant viewed the three vignettes for a given activity 30–60 minutes prior to a play session with a peer. The authors analyzed the effect of their video-modeling procedure on the total number of verbalizations emitted by the participant, on the content of his verbalizations, including whether the verbalizations matched or varied from the model, and on the frequency of initiations and responses. During baseline, there was considerable variability in the verbalizations emitted by the participant. With the introduction of the video-modeling procedure, the authors observed an increase in social language across two of the three activities. For the third activity, the authors introduced feedback on the participant's recorded sessions as well as verbal prompts to increase the targeted language responses.

Finally, Scattone (2008) used Social Stories ™ in conjunction with video modeling to modify the conversational skills of a boy with Asperger's Disorder. In addition to other dependent measures such as eye contact and smiling, the authors analyzed the effectiveness of their video-modeling procedure on the percentage of 10-second intervals during which the participant emitted initiations to a conversation partner in a 5-minute session. The video-modeling intervention consisted of three different narrated Social Stories ™ that targeted eye contact, smiling, and initiations, as well as the modeling of an appropriate conversation by two adults. The authors found that the video-modeling intervention effectively increased the percentage of 10-second intervals with initiations from about 0.8% during the baseline condition to about 33% after intervention. Moreover, the authors observed generalized behavior change across untrained peers in school.

Scripts and Script Fading Script fading is another behavior-analytic procedure that can be used to teach language and interaction skills through the process of stimulus fading. A script is a written or recorded word, phrase, or sentence that serves as a model to teach conversation. The core dependent measures when using this procedure include both scripted and unscripted interactions. Scripted interactions are defined as verbal productions that match the original scripts provided in teaching, whereas unscripted interactions are those that differ from the original scripts by more than verb tense, conjunctions, articles, prepositions, or pronouns (Krantz & McClannahan, 1993). As the participant reliably emits the scripted interactions, the scripts are systematically faded, and the number of unscripted interactions should increase correspondingly as scripted interactions decrease (McClannahan & Krantz, 2005). This procedure has proven effective in many studies aimed at teaching language and interaction skills.

In their preliminary study on the script-fading procedure, Krantz and McClannahan (1993) used written scripts to teach four children with autism to emit peer initiations during art activities. The authors provided each participant with a sheet of paper that contained a cue to talk and a list of ten different scripts pertaining to the stimuli present in the environment. The authors faded scripts by deleting words one at a time from the end of each script, until all scripts were blank. At the final fading step, only the blank sheet of paper with the cue to talk was present. The number of unscripted initiations emitted by the participants increased systematically as scripts were faded out. Moreover, responding generalized across an untrained setting and stimuli.

Krantz and McClannahan (1998) embedded Language Master© cards into activity schedules to teach three children with autism to emit initiations to adults. The authors attached written scripts, such as “Look” and “Watch me,” to photographs of objects in the activity schedules. The children were taught to obtain the object and to initiate a response to an adult by emitting the script that was attached to the pertinent photograph. Scripts were faded out by removing words one at a time from the end of each script. The authors observed a systematic increase in the number of unscripted social initiations as the scripts were faded. In addition, the authors indicated the behavior change generalized across untrained activities and in the presence of an untrained conversation recipient.

Similarly, Betz et al. (2008) also used script-fading procedures within activity schedules to teach social interactions among children with autism. The researchers presented an activity schedule to be shared between two children. The activity schedule consisted of various games for the children to play together. On each page of the schedule, a textual script was superimposed upon the game to be played. Scripts consisted of statements that would initiate the game-playing behavior, such as “Let’s play ____.” As scripts were faded, the authors observed a systematic increase in the number of unscripted social interactions emitted by the children.

Sarokoff et al. (2001) used script fading with stimuli that naturally contained textual print to teach two children with autism to engage in conversation with peers. For example, the authors used the script, “Gummi Savers© are my favorite” with a package of Gummi Savers©. The text that naturally appeared on the package was incorporated into the script. As scripts were systematically faded, the text that naturally appeared on the package remained at the final fading step. As a result, the package acquired discriminative control for engaging in conversation. The authors observed a systematic increase in the number of unscripted initiations to peers with the introduction of their script-fading procedure.

Brown et al. (2008) used a similar stimulus-fading strategy to transfer the discriminative control of social interactions from scripts to naturally occurring stimuli in the environment. The authors used a textual script-fading procedure to increase the number of social interactions among three children with autism. The authors attached textual scripts directly onto stimuli in the participants’ environment. Stimuli included items commonly found in a convenience store, such as candy bars, in a sporting-goods store, such as a football, and in a video store, such as videotapes. These stimuli were presented in a mock store display, as they might typically appear in the community. During script fading, scripts were deleted one word at a time, and were removed progressively from the training stimuli. The authors also changed the location of the scripts on the stimuli with each fading step. As scripts were removed, the environmental stimuli evoked the social interactions. This script-fading procedure produced a systematic increase in unscripted interactions.

Moreover, the effects of the script-fading procedure generalized to untrained stimuli.

Finally, Wichnick-Gillis et al. (2019) used a script-fading package to teach three adolescents with autism to engage in conversation with one another during leisure activities. The activities selected including computer games, model building, and a lunch period. These activities were deemed as appropriate situations during which conversation might naturally occur for their typically developing peers. The authors superimposed five different textual scripts onto various stimuli such as a laptop computer, Lego© model building sets, and items used during lunch (e.g., utensils, cups). Scripts were pertinent to the given activity, and included statements such as, "Check out what I'm building," or "I love this game." The authors observed a systematic increase in the number of unscripted initiations emitted across participants as the scripts were faded. Moreover, generalization was demonstrated across all three participants while engaging in the targeted activities with their siblings.

Play Behavior

Play can enhance mutual communication with others. The American Academy of Pediatrics (2013) acknowledged the importance of play in establishing relationships with others. Play provides opportunity for children to attend to directions, resolve disputes with others, behave appropriately in the presence of others, focus on activities without consistent supervision, and collaborate (Yogman et al., 2018).

There are four types of play: object play, physical play, outdoor play, and social or pretend play. Object play occurs when a child explores an object. An infant may place an object in his mouth. An older child may use a stick as a microphone. Physical play may begin with wheels-of-the-bus, and move to playing catch. Outdoor play provides opportunity for physical exercise. Social or pretend play encourages cooperation, turn taking, and negotiations of guidelines. Imaginary play, dressing up, and make believe are included as social play (Yogman et al., 2018).

Walsh et al. (2006) reviewed "the quality of learning" in 70 classes for children ages 4–5, comparing traditional classroom curriculum with play-based enhanced curriculum. Thirty-eight of the classrooms experienced traditional curriculum that involved structured play, writing, painting, listening to stories, watching television, and song. The curriculum was subject oriented, and emphasized reading, writing, and arithmetic. Thirty-two of the classrooms experienced play-based enriched activities that allowed children the opportunity to choose from a range of play stations such as the sand corner, water station, construction area, and house corner. Activities were structured by the teacher and of shorter duration. Reading activities were conducted using big books, math using puppets and games, and writing focused on creative content as opposed to writing technique. Overall, the authors found that the enriched play-based curriculum led to more opportunities for making choices and engaging in more challenging activities, and an increase in motivation, independence, and social interaction.

Stahmer et al. (2003) identified numerous behavioral approaches used to promote play with children with autism. The following is a sampling of the research-based techniques reviewed, and is by no means an exhaustive review.

Discrete-Trial Teaching Discrete-trial teaching is a highly structured behavioral strategy that focuses on the presentation of clear discriminative stimuli by the instructor. In play-based discrete-trial teaching, play materials are selected by the instructor, and a direction is presented. Reinforcement is delivered contingent upon the production of a correct response. Incorrect responses are followed by specified consequences. Rate of responding is controlled by the given opportunity to emit the response (Cooper et al., 2020).

Discrete-trial instruction is often presented with repetitive, one-step actions (e.g., rolling a ball; pushing a car). In two experiments conducted by Nuzzolo-Gomez et al. (2002), discrete-trial teaching was used to teach play behavior. In the first experiment, a three-year-old boy with autism was presented with a book and given the instruction to look at the book. If the child oriented toward the book, verbal praise and an edible reinforcer were provided. If the child did not orient toward the book, the instructor modeled the desired behavior and/or provided manual guidance. The results showed a functional relationship between the discrete-trial teaching procedure and an increase in orientation toward a book.

In the second experiment by Nuzzolo-Gomez et al. (2002), discrete-trial teaching was used to teach three children with autism to play with toys. Toys were presented and the instruction to play was provided. Correct play responses were following by reinforcer delivery. Incorrect responses were following by modeling and/or physical prompts. The results of the second experiment showed an increase in appropriate toy-play behavior and a decrease in dysfunctional, stereotypical hand movements.

Similarly, when a more complex play sequence is targeted, the discrete-trial procedure can focus on smaller component parts of the play behavior. For example, feeding a baby might involve holding a baby, getting a bottle, placing the bottle in the baby's mouth, and saying "Drink milk." Discrete-trial teaching can target the different components of the sequence in succession using verbal instruction, modeling, and/or manual guidance.

Despite the success of discrete-trial teaching, it does present several limitations. Teachings in highly structured environments: (a) do not necessarily generalize to the natural environment (Lovaas, 1977 as cited in Ingersoll & Schreibman, 2006), (b) are often dependent upon the use of continued reinforcement to maintain newly acquired play responses, and (c) are taught as isolated skills, rather than as part of a social context (Schreibman et al., 1991).

Reciprocal Imitation Training Reciprocal imitation training is another strategy used to promote play. In a study conducted by Ingersoll and Schreibman (2006), five children with autism participated. Prior to intervention, all of the participants displayed deficits in spontaneous imitation of object use by others during play. During intervention, the instructor (a) modeled actions with familiar and novel toys, (b) imitated child vocalization and actions with toys, and (c) commented on child actions. The authors found that imitation training resulted in imitative pretend play. Play responses were also found to generalized across stimuli, locations, and adults.

Stereotyped Behavior to Increase Play It is not uncommon for children with autism to engage in perseverative behavior. In a study conducted by Baker et al. (1998), three children with autism were selected to participate due to their engagement in perseverative behavior with particular items. For example, one child perseverated on Disney© characters. As a result, Disney© characters were incorporated into a playground game. Another child perseverated on maps. As a result, a game of tag was played on a giant outline of a map of the United States. A third child perseverated on movies and movie characters. Laminated photographs of movie characters were placed around a play area and used as "bases" in a game of tag. The authors found that the inclusion of perseverative themes into play activities resulted in an increase in social interactions during the targeted activities and generalized across novel activities.

Similarly, in a study conducted by Koegel, Fredeen, Kim, Danial, Rubinstein, and Koegel et al. (2012), social clubs were based on the perseverative interests of young adolescents with autism. For one participant, the perseverative interest in movies was transformed into a Movie Trivia Club. For the second participant, the perseverative interest in comic books and cartooning was turned into a Comic Book and Gaming Club. For the third participant, the perseverative interest in card games was turned into a Card Game Club. Prior to baseline, all participants remained socially isolated. Following the introduction of themed social clubs, social initiations and appropriate engagement with peers increased.

Pivotal Response Training Pivotal response training (PRT) is a behavioral strategy that has been used to increase motivation to engage in play behavior. In PRT, (a) the child selects materials from a set presented by the instructor (e.g., blocks), (b) discriminative stimuli are presented by the instructor (e.g., instructor gives block to instructor and says, "What do you want to build?"), (c) maintenance tasks are interspersed among tasks targeted for acquisition, (d) modeling is used to encourage turn taking and appropriate pace of interaction (e.g., instructor begins to stack blocks), (e) natural consequences are used to reinforce correct responses (e.g., instructor gives the child the remaining blocks in an effort to reinforce correct responding), and (f) reinforcers are delivered contingent upon attempts to respond (Stahmer, 1999).

Stahmer (1995) conducted a PRT study with seven children with autism to increase play behavior. The children were presented with toys identified as desirable (e.g., the child reached for or oriented toward the toy). If the child did not engage in play, the experimenter played with the toys and modeled symbolic actions. Simplified play responses with the toys were also interspersed and modeled to increase the likelihood of variation in responding. The author found PRT effective in increasing positive responding during play. Moreover, the findings generalized across novel toys and sustained over time.

Self-Management Self-management strategies have been used to teach children with autism to engage in independent play in the absence of a treatment provider. Self-management may rely on self-monitoring, self-evaluation of play performance, and self-reinforcement (Stahmer & Schreibman, 1992). In a study conducted by Newman et al. (2000), two, six-year-old children and one preschool child with a diagnosis of autism were taught to engage in varied play responses with preferred toys. Children were instructed to take a token contingent upon the display of a variation in play behavior. All three children were successfully able to use the self-management system and showed an increase in variability in responding.

In 1992, Stahmer and Schreibman targeted appropriate toy-play in three children with autism using a self-management training package. During training, the experimenter modeled both appropriate and inappropriate toy-play behavior and asked the question, "Is this right?" Following this training, the participants were taught to self-manage their own behavior and to mark a check in a box if they engaged in appropriate play behavior during a specified interval. Access to a reinforcer was provided contingent upon appropriate self-monitoring a toy-play behavior. Over time, the experimenter systematically faded his or her presence from the child. The results showed a functional relationship between the self-management system and an increase in appropriate play in unsupervised settings, along with a reduction in self-stimulatory behavior.

In Vivo Modeling and Play Scripts Researchers have found that children with autism can increase play skills via observation of predictable and repeated sequences. Jahr et al. (2000) compared two in vivo modeling procedures to teach children with autism to engage in play. One procedure provided opportunity for the child to observe two models engage in a scripted cooperative play episode. Following the episode, the child took the place of one of the models and the play episode was repeated. The second procedure was the same as the previously described procedure with one exception. The child participant was taught to verbally describe the modeled play episode prior to taking the place of one of the models. The authors found that modeling, in conjunction with training with verbal description, was effective in evoking play behavior across settings, time, and play partners.

Video Modeling Similar to in vivo modeling, video modeling allows a child with autism to observe repeated and predictable play episodes presented in a video format. In 2002, Schwandt, Pieropan, Glesne, Lundahl, Foley, and Larsson (as cited in Stahmer et al., 2003) used video modeling to teach three- and four-year-old children to engage in play for extended periods of time, to increase variation in play responses, and to emit play-related verbal statements. Each child was provided three repeated opportunities to observe play with target toys. Following the third video presentation, the child was presented with the same toys depicted in the video. Variation in toy play responses and engagement in play were differentially reinforced throughout the play activity. Over time, the videos were removed. The authors found that the children engaged in toy play responses in novel settings with novel toys. Some of the participants emitted verbal toy-related responses similar to those on the video.

Charlop-Christy et al. (2000) conducted a study designed to compare in vivo modeling with video modeling with five children with autism. After viewing the video model twice, the child was provided the instruction, "Let's do the same, just like on TV." After viewing the in vivo model twice, the child was provided the instruction, "Let's do the same, just like they did." The authors found that video modeling was effective in teaching different behavior, including independent and cooperative and social play. Although both in vivo and video modeling were effective in increasing play, video modeling led to faster acquisition and was more time effective than in vivo modeling.

Overall, the importance of play has been well established. The sampling of research reviewed suggests that there are a variety of behavioral approaches used to increase play behavior. Whether one uses discrete-trial teaching, video-modeling with play scripts, or self-management techniques, a systematic approach to the application of the teaching procedure should result in an increase in the desired play behavior.

Conclusion

Social skills are essential in creating relationships with others. Clear verbal expression of one's self, attention to the verbal behavior of others, and cooperation and interest in games and stories with peers are just some of the necessary components of a positive relationship. Over the years, behavioral research has continued to analyze the effectiveness of strategies that teach social skills to those who display deficits. The research reviewed in this chapter demonstrates the operant nature of various components of social skills behavior. Through techniques including differential reinforcement, modeling, incidental teaching, discrete-trial teaching, script fading, and self-management, behavior analysts have been able to teach social skills responses such as eye contact, prosody, gestures, affect, language and interactions, joint attention, and play behavior. As applied behavior analysts continue to examine these functional relations, the lives of many can continue to improve and develop successfully.

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52 Applied Behavior Analysis to Teach Academic Skills

Janet L. Applin

> Behavioral principles offer a wealth of effective and empirically validated practices to offer public education. The research is here. The desire is here.
> Fielding et al. (2013)

The gold standard characteristics or defining principles of Applied Behavior Analysis (ABA) are those provided by Baer et al. (1968, 1987): applied, behavioral, analytic, technological, conceptual, effective, and capable of generalized outcomes. While one typically thinks of ABA in relation to affecting and eliciting desirable behaviors and/or decreasing undesirable behaviors, the principles have also been applied to the teaching of academic skills.

Combining Baer et al. (1968, 1987) ABA principles with teacher behaviors and strategies aligned with ABA principles are at the heart of teaching methods and curriculums utilizing ABA. These teaching methods utilizing ABA are applied, behavioral, analytic, technological, conceptual, effective, capable of generalized outcomes, and may include teachers' use of modeling, prompting and fading, providing frequent active response opportunities, giving performance feedback, using reinforcement contingencies, providing systematic review, and programming for generalization (Joseph et al., 2015).

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This chapter will examine evidence-based strategies which make use of ABA principles to improve academic achievement and learning. First, this chapter provides a historical overview of the use of ABA to teach academic skills. Second, this chapter presents selected ABA principles and strategies as part of an instructional system and critical learning skills. Third, a review of commonly used ABA methods used to teach critical learning skills is presented.

Historical Use of ABA in Teaching Academics

B.F. Skinner

B.F. Skinner, often called the "father of operant conditioning," and credited with introducing the term "reinforcement" into the field, also was creator and patent holder on a "teaching-machine," which used operant conditioning principles to teach academic skills. Skinner (1960) believed if our, then current, knowledge of verbal behavior acquisition and maintenance was to be applied to education, that a teaching machine was needed. Skinner was testing his machine in the late 1950s and was granted a patent in 1961. The ABA principles incorporated into Skinner's teaching machine included frequent feedback, positive reinforcement for correct responses, self-paced practice, and prompting and fading (Skinner,

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_52

1960). One of Skinner's teaching machines is housed at the Smithsonian's National Museum of American History (Smithsonian, NMAH, 2020).

Direct Instruction

Another, now historical but still in wide use, of ABA principles to teach academics was created by Engelmann and Becker (1968) in the late 1960s when they developed comprehensive reading and math programs for young children in historically disadvantaged public-school districts. It was first used with preschoolers in the mid-1960s and showed great success at that time. Engelmann and Becker developed what are now known as Direct Instruction (DI) programs which use explicit teaching methods with tutorials, discussion, recitation, observation, and active learning. DI is known for its scripted curriculum delivered by teachers who have had training delivering the instruction with fidelity. The original goals were to accelerate the progress of students who were disadvantaged and at risk for falling behind their peers in reading and mathematics. After DI's programs were piloted and found to be effective at increasing student learning outcomes, Engelmann and colleagues went further with the development of a formal language, reading, and mathematics program named DISTAR, for Direct Instruction System for Teaching Arithmetic and Reading. DI has been studied extensively and compared to other interventions and, in one large government funded study, was shown to be the only intervention that significantly improved learning. It has been embraced by teachers of children with special needs, those at-risk for learning difficulties, and those without disabilities (Engelmann, 1968; Hattie, 2009; Stockard et al., 2018). One should not confuse Direct Instruction with direct instruction. Programs using the capitalization of DI are referring to specific commercially available Direct Instruction programs such as DISTAR. The strategy of direct instruction (with lower case d and i) incorporates many of the same principles for teaching in an explicit manner yet does not refer to a specific curriculum. While there is criticism of Direct Instruction and direct instruction, notably from Jonathan Kozol (2005) who, in his book *The Shame of the Nation*, believed DI was "excessively dogmatic, utilitarian, and authoritarian," there is no denying the effectiveness of these methods with a multitude of populations and they continue to be effective, updated, and in use today. DISTAR and related products remain commercially available and in wide use today and are offered by McGraw Hill under the names DISTAR Arithmetic I and II (Engelmann & Carnine, 1975), Corrective Mathematics (Engelmann & Carnine, 1982), Connecting Math Concepts (Engelmann et al., 1996), DISTAR Reading, Reading Mastery for grade levels PreK-5 (2008), and Corrective Reading for struggling older students (2008). Critics aside, practitioners have had success with Direct Instruction curriculums to serve and teach many thousands of children over the years and their systematic strategies use many principles of applied behavior analysis such as providing prompts, requiring responses, providing consequences, and monitoring progress systematically.

Precision Teaching

Precision Teaching is another method which incorporates principles of applied behavior analysis and has its roots in free-operant conditioning. In the 1960s Ogden Lindsley shifted his focus from a laboratory at Harvard to special education teacher training. His goal was to introduce free-operant technology into public school classrooms as he theorized that free-operant conditioning could be a powerful enhancement to learning and that frequency recording was superior to the standard recording of percentage correct (Lindsley, 1990). He was correct and documented great success. He developed a standard chart, or celeration chart, for teacher and student recording that, "bases educational decisions on changes in continuous self-monitored performance frequencies displaced on standard celebration charts." These charts may be easily found by googling "precision teaching," and/or "celeration chart." The key to Precision Teaching is not that it tells us "what" to teach or "how" to teach it, but it is a method of evaluating our strategies and curricula to determine effectiveness. The guiding principles of Precision Teaching are to: (a) focus on directly observable behavior; (b) frequency as a measure of performance; (c) the standard celeration chart, and; (d) the learner knows best. Teachers utilizing the method of Precision Teaching must find ways to frame learning objectives into concrete, directly observable behaviors that can be counted and recorded. Next, the frequency of said behaviors is recorded as the average number of responses during each minute of the assessment time on the celeration chart. Last, one determines, from the visual data on the celeration chart, whether or not a student is progressing according to plan. If so, the instructional programming being used may be deemed appropriate for this student. If not, the instructional programming, intervention, curricula, etc. need to be examined and changed because it is not working for said student. Note that all of the Precision Teaching steps are indicative of common applied behavior analysis techniques and principals: applied, behavioral, analytic, technological, conceptual, effective, and capable of generalized outcomes. McGreevy (1983) views Precision Teaching as a five-step process: (1) Select a Task; (2) Set an aim; (3) Count and teach; (4) Develop a learning picture; and (5) Decide what to do. While very effective, it is rare to see twenty-first-century teachers utilizing Precision Teaching and Lindsley's celeration chart; however, they do use many of the same principles that guide Precision Teaching when utilizing various progress monitoring methods such as Curriculum-Based Measurement, Curriculum-Based Assessment (Fuchs & Fuchs, 2004; Hosp & Hosp, 2003) and commercially available progress monitoring tools such as AIMS Web (2020), and University of Oregon's DIBELS, or Dynamic Indicators of basic Early Literacy Skills (2020). There was a journal, *Journal of Precision Teaching*, in active publication from 1980 through 2010 but it was discontinued at that time as the editors "began to shift our focus to more dynamic forms of communication…" (Standard Celeration Society, 2021).

ABA Principles as Part of an Instructional System

Many instructional systems utilize ABA principles as part of the system. In 1962, Robert Glaser described an instructional system as one having five components: Instructional goals (system objectives); entering behavior (system input); instructional procedures (system operator); performance assessments (output monitor); and research and development logistics (analysis and evaluation) (Glaser, 1962). When coupled with the concepts of ABA, instructional systems are similar in that they require goals, specific targets (entering behavior), systematic procedures (instructional procedures), are analytic (performance assessments), and must be effective (research and development analysis).

Applied behavior analysis as an instructional system has been extensively researched in the peer-reviewed literature, not only to modify social behaviors but in teaching academic skills. ABA is often seen as a strategy (or instructional system) for individuals on the Autism Spectrum. However, these same teaching strategies are effective when teaching individuals with other disabilities as well as those with no disabilities.

Given the alarming statistics of proficiency in basic reading, writing, and mathematics performance of children in today's public schools, the focus on best practices of teachers incorporating ABA, and using ABA principles to teach proficiency in language arts (reading and writing), and mathematics has never been more urgent. There is a proliferation of data showing that a large percentage of students tested are not proficient in basic reading and math skills. Data from the 2019 National Assessment of Educational Progress or NAEP show that 40% of students tested performed below NAEP basic which denotes partial mastery of prerequisite knowledge and skills that are fundamental for performance at the NAEP-proficient level (NCES, 2020). It has long been considered urgent to close this achievement gap between marginalized and minority populations of students and their majority peers.

Using ABA principles as part of an instructional system is not only urgent and best practice but is also required by federal legislation governing public education in the United States. The Individuals with Disabilities Education Act (IDEA) (2004), Section 1414 (d)(1)(A)(I)(IV), requires that Individual Education Programs include, "a statement of the special education and related services and supplementary aids and services, *based on peer-reviewed research* to the extent practicable to be provided to the child" [italics added] (IDEA, 2004). In addition, the Elementary and Secondary Education Act, ESEA (United States, 1965) which was reauthorized as the No Child Left Behind, NCLB (United States, 2001) and again as Every Child Succeeds Act, ESSA (2015) has the goal of improving educational equity for students from low-income families by providing federal funds to school districts serving these families such as Title I schools. The ESSA (2015) calls on districts and schools to use evidence-based interventions to ensure that interventions being implemented have proven to be effective in leading to improved student achievement.

Given that both federal laws call for the use of evidence-based interventions in teaching, it follows that ABA strategies and curricula claiming to be evidence-based or based on principles of ABA have seen an increase in use across student populations and levels. A word of caution here: because a commercially available curricular product or new teaching strategy claims to be "research-based" or "evidence-based" or based on ABA principles does not necessarily equal quality or student academic gains. Practitioners should carefully examine products and strategies and search out peer-reviewed research on the product or strategy as a consumer of these products or strategies. In addition, even those products or strategies deemed to have sufficient and robust research supporting their use are not effective if not used with fidelity by the practitioner utilizing the product or strategy to teach critical learning skills and academic content.

Critical Learning Skills

What are critical learning skills? There has been some consensus among educators that have narrowed down the answer to what is known as "the four C's" or critical thinking, creative thinking, communicating, and collaborating. It is believed that the four C's are essential skills that help students learn and experience success in and out of school. The Partnership for twenty-first Century Skills first identified the 4 C's (Plucker et al., 2016). Others might say that you cannot teach the four C's until basic academics such as reading, writing, and arithmetic are mastered. Still others might say that the 4 C's should be taught in concert with the three r's. For the purposes of this chapter, critical learning skills will refer to those skills that are traditionally thought of as basic academic skills, the three r's if you will: reading, writing, and arithmetic. So, how do we make use of applied behavior analysis to teach these critical learning skills? To answer that question, we will examine basic teaching strategies which incorporate principles and methods from applied behavior analysis. It must be noted that many social and behavioral skills are needed to engage in academic instruction, and it is difficult to separate the two. One must be able to attend to a prompt to learn how to read sight words, for example. If one uses an ABA approach to teach the skill of attending to a prompt so that reading may be taught, does that mean that ABA is being used to teach the skill of reading or is it just being used to modify behavior? ABA strategies that have been shown to be effective at modifying academic skills and/or behaviors must be implemented with fidelity to replicate positive outcomes and increased academic achievement.

Explicit Teaching

Explicit teaching has been around for decades and the practice entails having a clear academic focus, or objective of what is to be taught; setting realistic and ambitious goals; progress monitoring of student achievement; and delivering lessons at a brisk pace (Rosenshine, 1986). Similar to procedures associated with Direct Instruction programs and the principles of ABA applied to the strategy of explicit teaching, one can see that the gold standard ABA components of being applied (practitioners apply the strategy in real world classrooms), behavioral (practitioners have clear objectives and academic focus—in other words, what are the students expected to do?), analytic (goal setting and progress monitoring), technological (use of graphic visuals to depict progress), conceptual (adhering to the philosophies of applied behavior analysis), effective (as shown through progress monitoring), and capable of generalized outcomes (providing students with practices in different situations) are in play in Explicit Teaching models. Explicit teaching is also conceptualized as a set of steps in an instructional sequence. At its most basic are five phases: (1) Direct explanation; (2) Demonstration and modeling; (3) Guided practice; (4) Corrective feedback/verification; and (5) Independent practice. Others frame the basic five steps with different verbiage, but basically the same steps. Hudson et al. (2006) offer the following steps: (1) Providing an advanced organizer; (2) Modeling instruction; (3) Providing guided practice; (4) Providing independent practice; and (5) Providing a post-organizer. Regardless of how one labels the steps, explicit teaching always involves clear goals, clear explanations and demonstrations or modeling instruction, guided practice with feedback, independent practice with feedback, and finally providing a summary of what was to be learned.

Explicit teaching practices are included in Hattie's (2009) high-impact teaching practices. Hattie (2009) synthesized over 500,000 studies related to student achievement and concluded that some teaching practices have far more impact than others. Hattie (2009) concluded that student achievement is higher when teachers focus on and are responsive to student learning; are clear about what they want their student to learn and select appropriate curricula and strategies; explicitly explain what students should learn and demonstrate what they need to be able to do; get students to mentally engage with the materials; and give meaningful feedback to their students. Hattie (2009) is adamant that teacher clarity is paramount to improved achievement. Teachers must provide students with clear and explicit goals and objectives of what they are to learn. These explicit teaching practices or strategies clearly encompass applied behavior analysis principles of teachers' use of modeling, prompting and fading, providing frequent active response opportunities, giving performance feedback, using reinforcement contingencies, providing systematic review, and programming for generalization (Joseph et al., 2015).

It is a myth that ABA and its component use for academic instruction is only for those with disabilities such as those on the Autism spectrum. Although ABA procedures to intervene on behavior and their use for academic instruction have frequently been studied for those with autism spectrum disorders (ASD) and individuals with low incidence disabilities which impact educational achievement, the same strategies are effective for many children with high incidence disabilities as well as those children without disabilities. However, according to Dunlap et al. (2001), ABA is especially relevant in special education because of the emphasis on individualization, empiricism, replicable instructional practices, function over form, and the fact that it is a dynamic discipline. Specific strategies discussed here that are clearly ABA procedures used in academic instruction include discrete trial training, differential reinforcement, pivotal response training, antecedent-based interventions, and task analysis (Fielding, et al., 2013). Following is an overview of each of the above ABA techniques and how they have been shown to be effective in teaching academic skills. Table 52.1 provides selected references that demonstrate the efficacy of each of the ABA techniques discussed here: Discrete Trial Training; Differential Reinforcement; Pivotal Response Training; Antecedent Based Interventions; and Task Analysis Interventions.

Evidenced-Based ABA Techniques Utilized to Teach Academics

Discrete Trial Training

Discrete Trial Training or DTT has been in use and studied for over 40 years and has been found to be

Table 52.1 Selected treatment procedure references

Treatment	References
DTT	Lerman et al. (2016); Kitchen and Kraus (2018); Tarbox and Najdowski (2008)
DR	Fiske et al. (2014); Efaw (2021); Vladescu and Kodak (2010)
PRT	Vismara and Bogin (2009); Koegel et al. (1994, 2010)
ABI	Carter (2001); Rispoli et al. (2011); Schilling and Schwartz (2004)
TAI	Spooner et al. (2011); Browder et al. (2007); Courtade et al. (2010)

Notes: *DTT* discrete trial training; *DR* differential reinforcement; *PRT* pivotal response training; *ABI* antecedent based interventions; *TAI* task analysis interventions

effective for remediating academic skills as well as other functional skills, particularly with young children (Lerman et al., 2016). The seminal work of Lovaas (1981, 1987) is the framework for most modern uses of DTT. In DTT, skills are broken down into smaller subskills and are taught using repeated practice. Each small unit of instruction is referred to as a trial. Tarbox and Najdowski (2008) describe DTT as, "instructional units composed of an antecedent, a response, and a consequence." They note that there are five parts to a discrete trial including the antecedent stimulus, a prompt, a response, a consequence, and an intertrial interval. DTT has been shown to be effective at teaching language arts skills (Kitchen & Kraus, 2018) and arithmetic skills (DiGenarro Reed et al., 2011), and is commonly used with individuals on the Autism Spectrum (Leaf et al., 2016).

Differential Reinforcement

Differential reinforcement, also known as Differential Reinforcement of Other Behaviors (DRO), Differential Reinforcement of Alternative Behaviors (DRA), Differential Reinforcement of Incompatible Behavior (DRI), and Differential Reinforcement of Low Rates (DRL), involves reinforcing one behavior while withholding reinforcement for other behaviors. DR is an operant procedure that is typically used to increase the occurrence of desired behaviors and decrease undesirable behaviors (Vladescu & Kodak, 2010). Educators may use DR to shape responses and to reduce dependency on prompts (Fiske, et al. 2014). Reviews of the literature have investigated the impact of differential reinforcement on skill acquisition to determine the most efficient arrangements (Vladescu & Kodak, 2010; Efaw, 2021). These reviews support the use of differential reinforcement for skill acquisition for students with disabilities.

So how can DR be used to teach academic skills? Just as with social behavior, DR is used to reinforce the academic behavior desired and withhold reinforcement for undesired academic behavior. In its simplest form, Differential Reinforcement is particularly useful when teaching fluency and automaticity in sight words or math facts such as basic multiplication facts. Baseline data would be collected on the target skill, reinforcers chosen through knowledge of the student or a preference assessment, and a plan made to determine how the prompts would be provided and faded. Students would be reinforced for correct responses and no reinforcement would be provided for incorrect responses. It might look something like the following scenario:

> Mr. Garcia is working with Tony, a third grader, to build fluency and automaticity on basic multiplication facts. Mr. Garcia has conducted a preference assessment and found that a high preference reinforcement for Tony is to earn tokens that may be traded/cashed-in for prizes at the end of each week. Mr. Garcia uses a software program which flashes multiplication facts on a computer monitor with a touch screen, Tony touches the correct answer from a choice of three, and the next problem flashes on the screen. Once the predetermined number of prompts are completed, Mr. Garcia is provided a report of the number or percent correct and the amount of time it took to complete the predetermined number of problems so that a rate of correct responses may be calculated for progress monitoring. Tony then receives one token for every predetermined number of answers he chose correctly.

The predetermined number would be based on the baseline data and predictions of rate of improvement and is increased as progress is made. So, it is prompt, correct response, consequence. There are no consequences for incorrect responses, only for correct responses. As Tony progresses to meet predetermined goals, the reinforcement will be faded out and the natural reinforcement of mastering the multiplication facts and verbal praise would replace the tokens.

Pivotal Response Training

Pivotal Response Training (PRT) is also known as pivotal response teaching, pivotal response treatment, pivotal response therapy, and pivotal response intervention (Bozkus-Genc & Yucesoy-Ozkn, 2021). PRT applies principles of ABA to teach learners through building on their initiative and interests. PRT integrates principles of child development with those of ABA and considers the learner's developmental levels and progression and cycles through the three-part sequence so common to ABA strategies: antecedent, response/behavior, and consequence (Suhrheinrich et al., 2018). It was developed to enhance pivotal learning variables such as motivation, responding to cues, self-management, and self-initiations. It is thought that these skills are "pivotal" because they are skills that may be used to acquire many other skills. Basic steps of teaching motivation through PRT would include establishing learner attention, using shared control, using learner choice, varying tasks, interspersing acquisition tasks and maintenance tasks, reinforcing response attempts, and using natural and direct reinforcers (Vismara & Bogin, 2009). As noted previously, strategies such as PRT may be used to address behaviors that are pre-requisite academic behaviors such as pointing, staying on task, and responding to prompts. Although widely studied in increasing or improving the "pivotal" behaviors mentioned, PRT has also shown success in academic skills (Koegel et al., 2010). Koegel et al. (2010) conducted a meta-analysis on 34 research studies from 12 different journals and concluded that PRT is effective in teaching a variety of behaviors to children with Autism. The scenario below provides an example of PRT in use based on Suhrheinrich et al.'s (2018) step-by-step guide to PRT.

Ms. Jones is working with Shauna, a 2nd grader who is on the Autism Spectrum, to learn to recognize and read new sight words. Ms. Jones has decided to use Pivotal Response Training or PRT, to increase Shauna's response rate to being prompted with a list of sight words one at a time. Ms. Jones has prepared and planned by identifying the words to be used based on Shauna's developmental level and selected words that can be incorporated into a sight word game. She has chosen preferred games and reinforcers through preference assessments prior to instruction. Ms. Jones knows, for PRT to be successful, Shauna must be motivated to perform the activity (in this case, reading the sight words) and is using materials Shauna prefers, offering choices, and providing reinforcement during the intervention. Ms. Jones has arranged the environment, determined the prompts, and has received training to use PRT. She creates an opportunity for Shauna to respond through first gaining Shauna's attention and providing the first prompt (a sight word). Ms. Jones then pauses and allows Shauna time to process the prompt. If Shauna responds within a predetermined time (5 to 10 seconds, for example), she is rewarded for correct responses through reinforcement. Ms. Jones continues with this process through the predetermined set of sight words, collects data on Shauna's performance, and plans to conduct generalization probes as correct responses increase. Ms. Jones analyzes data collected and makes data-based decisions on whether her chosen intervention is effective or needs to be adjusted.

Antecedent-Based Interventions

Antecedent-based interventions (ABI) are an ABA strategy that modifies an environment to decrease interfering behaviors and can allow the student to attend to academic tasks (Carter, 2001; Rispoli et al., 2011). Examples of interfering behaviors might be repetitive or disruptive and often prevent a child from attending to academic instruction and tasks. The goals of ABI are to modify the antecedent thought to control the interfering behavior so the child may increase their on-task behaviors (Sam & AFIRM Team, 2016). When implementing ABI, teachers should plan through conducting a functional behavior analysis to determine what antecedents are controlling the behaviors that may be interfering with a student's attention to the academic task. An ABI strategy should be chosen that addresses the function of the interfering behavior and then monitor and determine next steps. When interfering behaviors are under control of the reinforcer, students may focus on acquiring academic skills. ABI strategies may include using learner preferences, changing schedules or routines, implementing pre-activity interventions as needed, using choice-making, altering how instruction is delivered, or enriching the environment with sensory stimuli (Sam & AFIRM Team, 2016). The scenario below provides an example of how one teacher might use ABI to address behaviors that are interfering with a child's on-task academic time.

Mr. Kaufmann is teaching a grade 6 social studies unit that most of the students are engaged in and excited about the projects and activities. One student, Kyle, has been disruptive throughout the unit by making unkind, sarcastic remarks about the activities, the teacher, and other students in the classroom. He has been asked to leave the class several times in the past two weeks due to his disruptive behavior and refusal to work on assigned tasks with his group. Mr. Kaufmann has decided to use ABI strategies, in which he has been trained, to address Kyle's behavior and increase his time on task. First, Mr. Kaufmann conducts a Functional Behavior Assessment to determine the function of Kyle's off task behavior. He collects data on the interfering behavior using A-B-C charts to help identify what is happening directly before the target behavior is occurring (antecedent), to describe the behavior in operational terms (behavior), and to determine what happens directly after the behavior occurs (consequence). Once data are collected Mr. Kaufmann analyzes the data to try and understand why Kyle might be engaging in the disruptive behavior which is causing him to lose instructional and academic time. Based on this information and data collected, Mr. Kaufmann makes a hypothesis that the function of Kyle's behavior is to escape the group work which requires him to read materials that may be written at Kyle's frustration level meaning he has difficulty reading and comprehending the material. Mr. Kaufmann decides to alter how the assignment instructions are given to Kyle so that Kyle will not have to read the instructions that are written at his frustration level. Mr. Kaufmann assigns a student teacher to discretely work with Kyle's group and read the instructions with them each day and make sure that the instructions are understood by all. In future lesson planning, Mr. Kaufmann will include pre-activity interventions for Kyle so he will not reach his frustration level and be able to participate. No reinforcement will be provided for the interfering disruptive behavior if it does occur and positive reinforcement in the form of verbal praise will be provided to reinforce desired work behaviors such as engagement and on-task and task completion. Reinforcement will be provided each time Kyle completes an assignment while not engaging in the interfering disruptive behavior. Progress will be monitored, and reinforcement schedules faded as interfering behavior decreases.

Task Analytic Instruction

Task Analytic Instruction, as defined by Spooner et al. (2011), is the "step-by-step" teaching for a chain of responses to complete an activity (e.g., to solve an algebraic equation or make a purchase). Spooner et al. (2011) found that prompting procedures used with task analysis were always combined with methods for reinforcement, usually praise. Spooner et al.'s (2011) examination of 18 studies supports treatment packages that target a chain or discrete responses, use prompting and fading, and provide feedback and correction. Three strategies used with task analysis are forward chaining, backward chaining, and total task presentation. The National Professional Development Center on ASD (2015) provides step-by-step instructions for implementing a task analysis: Plan, Implement, and using task analysis. When planning, one must identify the components of the target skill or behavior and determine methods for teaching using task analysis. When using forward chaining, an adult begins by teaching the steps of the task analysis in order and when each step is mastered, the next step in the chain is introduced. In backward chaining, the steps are taught in reverse order beginning with the final step in the chain. As always, data should be collected on the target behaviors and next steps must be determined based on learner progress (National Professional Development Center on ASD, 2015). Task Analytic Instruction is especially useful for teaching arithmetic that requires multiple steps for solving. The steps of solving the math problem can be task analyzed using forward chaining and students reinforced for each step mastered.

Fidelity of Treatment and Commercially Available ABA Curricula

Note that in each scenario provided throughout this chapter, each fictional teacher had been trained in the ABA strategy they were utilizing to improve academic achievement. Fidelity of treatment refers to ABA strategies being applied exactly as intended or the positive results likely will not be produced. Many teachers have criticized ABA methods over the years thinking that "they do not work." Perhaps it is because they didn't apply the treatments with fidelity, and they didn't have the proper training to use the chosen strategy. Practitioners should have had supervised practice and training before they attempt these evidence-based methods on children, particularly those who may be vulnerable due to their disabilities. All ABA treatments must be used with integrity, fidelity, ethically, and with the well-being of children in mind always.

There are many commercially available curricula incorporating ABA methods and shown to be evidenced-based and effective. There are also many which are not effective and make many claims to be research-based or scientifically based. It is a buyer beware industry and consumers of these products must know what they are looking for and must implement those quality designed products with fidelity. There are many advertisements, websites, and organizations which claim to offer evidence-based materials for academic instruction. Two places to begin a search for reputable, evidence-based, and vetted curricula are the Institute of Education Science, What Works Clearinghouse (n.d.), and IRIS Center Modules (n.d.).

Summary

In education, we like to say what is old is new again. By this we mean that we often take concepts and methods that are effective and update them with new names and phrases but keeping their original intent and implementation. This is also true with using applied behavior analysis in teaching academic skills. We are still using the same basic principles that Skinner used over 50 years ago in his teaching machines: frequent feedback, positive reinforcement for correct responses, self-paced practice, and prompting and fading (Skinner, 1958). We put it in a new package, update the look, update the marketing, if you will, to appeal to a new generation of educators. However, what worked then, still works now. It's what one teacher colleague framed as, "good teaching is good teaching – no matter to whom or by whom – the best practices still work just as they did long ago." The great thing is that we know even more about what works now than we did back when Skinner was pioneering the field of ABA and instruction. As Fielding et al. (2013) said, "The research is here. The desire is here."

This chapter examined evidence-based strategies which utilize the principles of applied behavior analysis to improve academic achievement and learning. Through a historical review, examining ABA principles as part of instructional systems, and reviewing prominent methods used to teach critical learning skills, the basic principles of ABA have been shown to be effective teaching strategies and have been incorporated into many commercially available curriculums and used in many classrooms to manage behavior as well as teach academic skills.

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53 Technology to Increase Vocalizations and Speech

James W. Moore and Alexandra G. Brunner

Approximately 8–9% of young children have difficulty producing vocal speech with roughly 5% experiencing significant trouble with speech (National Institute on Deafness and Other Communication Disorders, 2016). Although many different conditions may cause delays or lack of vocal speech, the cause of most of these problems is unknown (Abadi et al., 2016). Some of these include apraxia, developmental disabilities, brain injury, and intellectual disabilities (Johns Hopkins All Children's Hospital, 2021). Autism spectrum disorder (ASD) is one of the most common developmental disabilities and is highlighted by deficits in language and communication (Center for Disease Control and Prevention, 2020). Many individuals with ASD are slow to develop or fail to develop spoken language skills (Sigafoos, 2005). In a 20-year review of the literature, McNaughton and Light (2015) found that 20% of the interventions involved non-vocal clients with cerebral palsy, 20% with developmental disabilities, 17% acquired disabilities, such as traumatic brain injury, 9% had autism, 7% demonstrated intellectual disability, and 25% showed more than one disability.

Effective communication represents a critical and essential life skill. In the absence of vocal speech, children often develop alternative forms of communication, especially related to obtaining wants and needs. Grunting, eye gazing, reaching, or manipulating the hands or body of another may serve as alternative forms of communication, but can be difficult for others to interpret. Failure to emit even a limited vocal repertoire presents serious challenges and barriers to the development of vocal verbal behavior later in life (Whitehurst et al., 1991). For example, some individuals may develop significant problem behaviors. Problem behaviors such as self-injury, tantrums, and/or aggression become functionally equivalent to the more acceptable ways to communicate their wants and needs (Carr & Durand, 1985; Sigafoos, 2005). Imagine an active child who has not consumed liquids for several hours. A child without impairments in communication and vocal speech may approach their caregiver and say, "may I have some juice?" If a child with limited skills in this area encounters the same situation, they may learn over time that other behaviors, such as those listed above, serve the same function as saying, "may I have some juice?"

Children of typical development often demonstrate a wide variety of vocal responses without the need for explicit teaching or planned intervention. Some have argued that this language acquisition occurs mainly through a combination

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_53

of automatic reinforcement that may not be sufficient to support varied and frequent vocal output in children with ASD (Carbone, 2016) or derived relational responding that is often impaired for those with limited vocal repertoires (Murphy & Barnes-Holmes, 2017). Therefore, the performance of such vocal responses in children with ASD may require the use of contrived and direct contingencies of reinforcement intended to increase the probability of vocal sound production (Tincani et al., 2006).

Applied Behavior Analysis

In contrast to other approaches, behavior analysts view communication as verbal behavior. In the landmark book *Verbal Behavior*, Skinner (1957) posited that language is a learned behavior under the same types of control as non-verbal behavior. Variables such as reinforcement, extinction, and motivating operations shape the way we communicate. Skinner also shifted the focus away from the formal properties of language, such as parts of speech, phonetics, and other topographical views of language, to the functional properties of language. In other words, the sources of reinforcement influence the use of various types of language. Skinner proposed that several verbal operants, as well as different types of speaker and listener behavior, make up an individual's verbal repertoire. Although the unique names Skinner (1957) provided for the verbal operants may seem confusing at first, establishing a child's mand, tact, intraverbal, or echoic repertoire can provide valuable information on how that child communicates and where they might have a deficit (Sundberg, 2007).

Basic Verbal Operants Verbal operants are basic units of language as described by Skinner (1957) and are classified by the antecedents and consequences that control them. The mand is the first type of verbal operant acquired by children and it is essentially a request (Sundberg, 2007). In technical terms, a mand is a verbal operant under the direct control of motivating operations (MO) and specific reinforcement. Deprivation, satiation, and aversive stimulation are MOs directly tied to the evoking of a mand. For example, a child who has not eaten in several hours may put forth more effort to say "eat" when temporarily deprived of food. In such an arrangement, the MO alters the *value* of reinforcement. In this example, the MO is unconditioned (UMO) in that no learning is required to produce an effect. Conditioned motivating operations (CMOs), on the other hand, acquire this value-altering influence through a specific learning history (Cooper et al., 2019). The three kinds of CMOs are surrogate (CMO-S), reflexive (CMO-R), and transitive (CMO-T). CMO-S, through many pairings of neutral stimuli with unconditioned stimuli, creates a surrogacy in which the neutral stimuli now have the same effects as the UMO. The effects of CMO-Ss are debatable (Cooper et al., 2019); however, CMO-Rs have been shown to greatly affect our everyday interactions. The CMO-R is defined as any stimulus that precedes an aversive situation and achieves avoidance of that situation, including how individuals react to mands from others. Cooper et al. (2019) give the example of a stranger asking for directions. By responding to the stranger's request, the individual responding avoids the social awkwardness that would result from a non-response. Similarly, CMO-Ts also affect our everyday interactions. A variable function as a CMO-T when it is related to the presence of another variable and some form of improvement. UMOs also function as CMO-Ts for conditioned stimuli that are paired with unconditioned stimuli. CMO-Ts are important for mand training; an individual wants something, mands for it, and is reinforced by delivery of the item or activity. Unconditioned reinforcers can be used to teach mands, but CMO-Ts allow for unlimited ways to achieve the items. If socks and shoes are required to go outside, the individual would need to mand for "shoes" and "socks" to reap the larger reward of playing outside. The interruption of reinforcement often associated with a CMO-T offers not only an effective instructional tool in basic mand acquisition but also the development of more elaborate and sophisticated mands (Carbone et al., 2010).

Skinner (1957) chose the word mand as a condensed form of words like "command" and "demand." A child's mand repertoire may include words ("cookie, please") or non-verbal communication such as pointing to the item, crying, or hitting as long as a clear relationship exists between the source of reinforcement (e.g., cookies), the behavior (e.g., saying "cookie" or hitting) and the antecedent condition influencing the contingency (e.g., 5 hours of food deprivation, an establishing operation). Many therapists first focus on mand training because problem behaviors can be reduced or eliminated when one is taught other ways to communicate their needs. Additionally, the child reaps the rewards of using the new skill when the item requested is delivered and gains autonomy as the delivery of reinforcement comes under the control of their manding (Sundberg, 2007). The mand is the only verbal operant that directly benefits the speaker.

The tact (Skinner's variation on "contact") shows how a child interacts with their surroundings. Tacting consists of naming things from the environment. Specifically, the presence of a nonverbal stimulus (like a flower) controls the verbal response ("flower!") through a consistent history of generalized conditioned reinforcement, such as praise for tacting (Sundberg, 2007).

When a prior verbal stimulus controls a verbal response that bears formal similarity and point-to-point correspondence (as in repeating the word your communication partner just said), the response is called an echoic. A strong echoic repertoire facilitates mand and tact training. For example, when providing mand training, it would be advantageous for the client to be able to repeat the therapist's verbal prompts in order to gain immediate access to a preferred item for correct responding.

Another type of verbal operant is an intraverbal in which a speaker differentially responds to the verbal behavior of others. Like the echoic, it is evoked by prior verbal stimuli and followed by generalized conditioned reinforcement but lacks point-to-point correspondence. Intraverbals can include answering questions and social responding. These skills may not develop even when mand, tact, and echoic skills are robust. Children with ASD who experience language delays often have weak or non-existent intraverbal skills, perhaps because intraverbals are often not directly assessed and taught the way the other verbal operants are (Sundberg, 2007).

Transcription, also called taking dictation, is another verbal operant even though the verbal behavior is not audible. Transcription consists of writing and spelling words that are spoken by a communication partner. It is a response to a verbal stimulus with point-to-point correspondence but without formal similarity. Similar to the transcription operant, textual operants have point-to-point correspondence with the stimulus and response and no formal similarity. Textual behavior includes the ability to identify a word, but not necessarily comprehend the reading (Sundberg, 2007). For example, a child may be able to read a passage with acceptable fluency (textual behavior) but be unable to answer questions about the passage (intraverbal behavior).

Augmentative Alternative Communication

Although vocal responses remain the goal of intervention, the more immediate need of non-vocal children may include the development of non-vocal forms of communication. In the absence of vocal speech, these children may not have alternative responses sufficient to evoke the behavior of listeners in order to access reinforcement, potentially supporting the acquisition of problem behaviors as a means to gain access. As such, methods have emerged to study the effects of teaching alternative methods of communication on the development of vocalizations in children with autism (Schlosser & Wendt, 2008; Tincani, 2004; Tincani et al., 2006). In order to help individuals with limited vocal speech acquire functional communication skills like the ones discussed above, therapists may employ alternative and augmentative communication (AAC) modalities to progress beyond prelinguistic strategies (Mirenda, 2003). The initial goal of AAC utilization involves mand training.

As previously stated, when an individual is able to ask for what they want, he or she may develop increased independence while decreasing the need for problem behavior.

AACs are divided into two categories: unaided and aided. Unaided AACs do not require technology apart from the human body, exemplified by sign language. Aided AACs require additional technology (Mirenda, 2003). Examples of aided technology include picture exchange communication systems (PECS) and speech-generating devices (SGD), also known as vocal output communication aides (VOCA). Technology is ever-changing. It is imperative for behavior analysts to remain updated on current AAC technologies (Lund et al., 2017).

The use of sign language as a functional communication aide has shown mixed results (Mirenda, 2003). Its primary benefit boasts technology that is free and accessible wherever the user's body goes. However, many drawbacks prevent this AAC from being utilized as often as its aided counterparts. Sign language requires a great deal of training and has produced unsatisfactory results for spontaneous use and generalization (Bondy & Frost, 1994; Mirenda, 2003). Additionally, sign language requires fine motor skills and pre-requisites from the user, such as eye contact and imitation (Sigafoos et al., 2004). However, arguably the biggest drawback of this form of alternative communication could be that it requires any potential communication partner to also know sign language (Bondy & Frost, 1994; Mirenda, 2003).

Bock et al. (2005) compared PECS to SGD to determine which of the two communication strategies produced repetition skills at an accelerated rate and if the skills generalized to a classroom setting. Students moved through PECS phases more quickly and completed more phases than SGD. Three of the four participants showed a preference for PECS and one showed no preference at all. Students using SGD needed more hand-to-hand guidance than when using PECS.

Tincani (2004) compared sign language to picture exchange for mand training using the presentation of preferred items with prompting and prompt fading procedures with two elementary school students with ASD and severely limited functional speech. Using an alternating treatments design, both students received sign language and PECS training counterbalanced across days, times, instructor, and order to reduce confounding variables. The final phase for each student was a best-treatment phase, utilizing which ever method worked best for that student. Tincani found that sign language produced greater independent mands for one of the two students participating in the study (from 2.1% in baseline to 34.1% during training). The other student lacked hand-motor imitation skills and favored PECS. However, most interestingly, the sign language training produced more vocal output compared to baseline for both students (46.3% compared to 22.3% for PECS for student one and 93.4% compared to 77.9% for PECS).

PECS was first developed by Bondy and Frost (2002) in response to the drawbacks of sign language. This system initially involves exchanging a picture representation for a preferred item. The user performs a basic request and receives a positive consequence, increasing the frequency of its use. More complex responding happens in phases where the user is required to discriminate between pictures, travel to the PECS book and communication partner, and eventually make complex sentences. PECS does not require any pre-requisites for use and can be immediately utilized to request preferred items and activities. Most conversation partners would be able to identify the meaning of the card. However, the picture exchange system is bulky, containing either a gigantic PECS book or numerous cards which would have to be transported wherever the user wishes to communicate. Responses would be limited to the pictures available.

Tincani and Devis (2011) conducted a quantitative synthesis and component analysis of PECS in single-participant studies. They confirmed that data supports PECS as an effective intervention for mand training for individuals with autism as well as other disabilities. However, the 16 studies included in their meta-analysis failed to demonstrate more advanced communication, such as tacts or intraverbals. Most participants from these studies met criterion for Phases I-III, whereas the more advanced communication training is exclusive to Phases IV and V. This analysis demonstrates a great variability among how successfully and readily participants employ picture exchange; for example, one participant mastered all six phases in a total of 246 trials (Charlop-Christy et al., 2002), while another participant met criterion for the first two phases with 358 trials (Tincani et al., 2006). Despite this variability, typical for studies conducted using children with ASD, Tincani and Devis (2011) found that 10 out of the 16 participants in the analysis increased vocal output with a range from mild to substantial, supporting findings by Schlosser and Wendt (2008).

Speech-Generating Devices

While all AACs are used for functional communication training, research supports the hypothesis that AACs may have the potential to increase vocal speech (e.g., Schlosser & Wendt, 2008; Tincani, 2004; Tincani & Devis, 2011; Tincani et al., 2006). AACs have shown vast improvements in children with a developmental disability diagnosis and their peers (Biggs & Snodgrass, 2020; Thiemann-Bourque et al., 2016; Thiemann-Bourque et al., 2019; Alzrayer & Banda, 2017; King et al., 2014; Lorah, 2016a, b; Lorah et al., 2013, 2018; van der Meer et al., 2011; Waddington, 2018; Xin & Leonard, 2015). This is in direct contradiction to fears cited by clinicians and parents that a child may become dependent on an alternative modality to communicate, inhibiting the acquisition of verbal speech (Schlosser & Wendt, 2008). The promising data using AAC to increase vocal output leads to new paths for research: Which modality most successfully generates vocal speech? Why do some individuals increase vocal output when trained in AAC and others do not? Can the likelihood of generating speech be increased when training clients with AAC?

Speech-generating devices (SGD), also known as voice output communication aides (VOCA), are electronic devices that convert non-vocal communication behavior (pressing a button) into synthesized verbal messages. The voice output can be understood by a wide range of communication partners, including strangers. Large and heavy stand-alone systems made original SGDs difficult to generalize to different locations; however, applications for tablets and smartphones transform widely used technology into SGD that can hold unlimited amounts of words in a light weight, easily portable device. Applications within SGDs can be instantly customized to include novel responses and pictures and the number of icons (stimuli) seen on the screen. According to Common Sense Media and Rideout (2013), 75% of families in 2013 had access to the internet in their home with 10% of children owning their own tablet. In 2013, there were over 265 SGD apps available in the Apple Store. Tablets and smartphones are highly desired items that may lessen the stigma of carrying and using an SGD. Gevarter et al. (2013) suggest that VOCA (and other aided AAC) produces quicker acquisitions perhaps because of the addition of the graphic symbol which may act as a prompt and that its user needs only learn one response class (pointing to a picture) for a variety of requests. Many SGD formats include a grid format where the learner scrolls through several icons in order to select the appropriate communication target.

There are various types of SGDs from which to choose. Over the years, advances in technology have widened the available options. For example, alphabet-driven devices involve the client using an on-screen alphabet or text system that the client uses to create words, sentences, and other forms of communication. Visual scene displays uses imagery, often personal photographs in order to capture language within the various social contexts in which clients often experience, which is claimed to support generalization and ongoing visual contextual support, though no research currently exists to validate this assertion. Picture tablets involve an application or program downloaded on a device, such as a tablet or smartphone in which pictures are organized in a grid display of individual pictures that correlate to specific items, emotions, contexts, and other communication targets.

More recently, advances in SGDs have made possible the inclusion of photographic visual scene displays (VSD) that synthesize objects, familiar people, community helpers, and common actions, to name a few, into an integrated image of these things (see Beukelman & Mirenda, 2013, for more information). Some have suggested that SGDs, particularly those that incorporate VSD, may have benefits for young learners who may benefit from visual support. To date, little research has emerged on prerequisite skills necessary to successfully use any type of SGD, with some studies finding mixed results with typically developing learners across traditional SGD formats and VSD. Robillard and colleagues found that certain cognitive factors, such as sustained attention, categorization, and fluid reasoning, were necessary prerequisite skills in order to benefit from the use of SGD. Hand-eye coordination, fine motor coordination, prior history with technology, overall cognitive deficits, and severity of disability may also predict the success of SGD for certain learners. Unfortunately, little research has been conducted in training individuals to use this type of technology. For example, Gevarter and Horan (2019) found that the traditional grid display served as a distraction to some learners using SGD. A large body of the training literature on correct SGD use has focused on a discrete-trial teaching (DTT) format (e.g., Lorah et al., 2015), with more recent research focusing on naturalistic teaching strategies in which the SGD is embedded into naturally occurring contexts with the learning receiving prompting, error correction, and reinforcement to support skill acquisition.

Although studies have demonstrated that all three major forms of AAC (manual signs, picture exchange, and SGDs) may be used to train individuals with autism and developmental delays to communicate a functional request, the question emerges of which form is superior. The results of the Achamadi study highlighted advantages of determining AAC preference. Several studies have found that mand acquisition in children with ASD was roughly equal, though the children showed a preference for PECS (Bock et al., 2005; Son et al., 2006). However, these studies compared PECS to the cumbersome stand-alone speech-generating devices (SGD). With the popularity and availability of smartphones and tablets that can be easily converted to an SGD (through the purchase of an AAC application directly from the smart device, the differential response effort may have tipped in favor of SGD.

Lorah et al. (2013) compared picture exchange (PE) and the iPad as an SGD (or VOCA) in mand training for children with ASD. Data were collected from five boys diagnosed with autism, aged between 3 and 5. All participants scored limited or absent for manding and echoic skills on the *VB-MAPP Barriers Assessment* (Sundberg, 2007). It was reported that the boys had no history with PE or SGD. The study employed an alternating treatment design in which the dependent measure was observed. The dependent variable included independent and prompted mands. For the PE, this would involve placing a picture representation into the hand of the therapist. For SGD, the icon representing the item must be pressed with enough force to elicit vocal output. The application Proloquo2Go was utilized to transform the iPad into an SGD. Pictures taken from Proloquo2Go (*see* Fig. 53.1) were then used to create the pictures for PE. Following baseline, the two training conditions were presented in random order with an equal number of trials each. During training, a preferred item was placed in view but just out of reach with the appropriate AAC arranged directly in front of the participant. A 5-second time delay followed by a physical prompt ensured skill acquisition. Upon criterion of both modalities, the therapist conducted a preference assessment.

The results of the study show SGD produced an 85% overall higher rate of prompted or unprompted manding during training and maintenance, compared to a rate of 64% produced using PE. Additionally, four out of five of the participants showed a preference for the iPad as an SGD. While one could surmise that the ease and customizability make the iPad (or other smart device) the obvious choice for an SGD, this study does have limitations that should be further

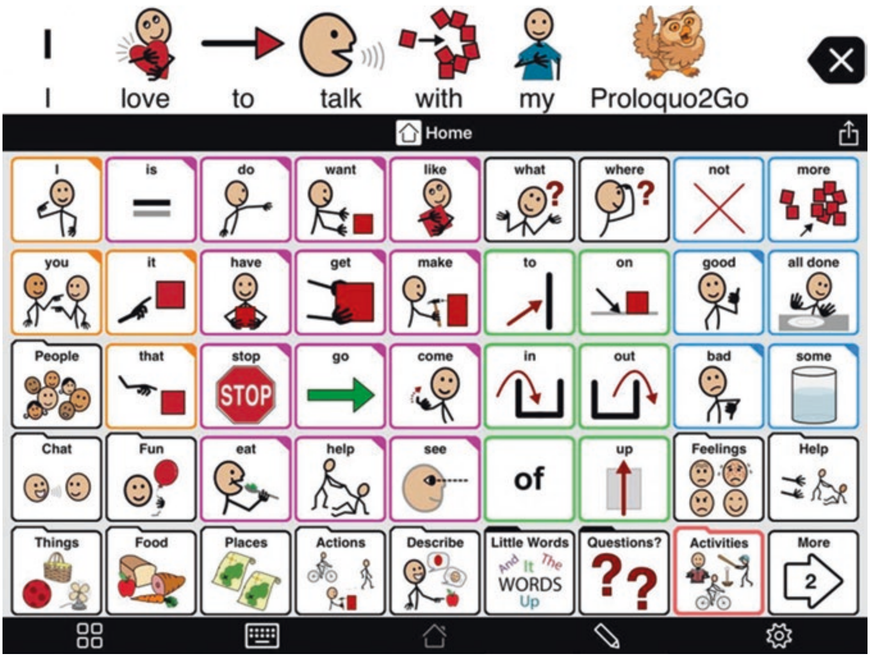

Fig. 53.1 Proloque2go sample screen

explored. First, no discrimination training was conducted for either AAC, an important factor in communicating functionally. Second, the absence of data for generalization across trainers or environments limits any conclusions drawn from the study. Finally, future research should investigate the effects of using AAC for mand training on increasing vocal speech.

A study by Tincani et al. (2006) explored the effects of PECS on manding and speech development for non-vocal children with autism. Tincani et al. (2006) particularly wondered about the effects on manding in older children using PECS and wanted to confirm reports of spontaneous speech development during Phase IV of PECS. Speech development would be a highly desirable outcome of functional communication interventions.

Tincani et al. (2006) broke the study down into two smaller studies. Participants in the first study comprised two boys with autism, ages 10 and 12, neither of whom used speech to communicate nor had prior training with AAC. The dependent variables included independent and prompted manding (either physical or gestural) and speech (words or approximations). Baseline data confirmed that neither participant used PECS to request a preferred item nor manded vocally. During PECS training within a delayed multiple baseline design, the therapists followed the protocol established by Bondy and Frost (2002). The participants moved from one level to the next after mastering 80% criterion during at least one session of that phase (see introduction for further explanation of PECS phases). Speech was neither reinforced nor prompted for the first three phases. However, in Phase IV, participants were trained to create sentences using the PECS cards. Additionally, a 3- to 5-second delay for the delivery of the reinforcer was employed for word vocalization or approximates. When the participant would successfully place the sentence in the hand of his communication partner, the partner would delay the delivery of the reinforcer. If the participant vocalized during the delay, reinforcement was immediately delivered. If not, the reinforcer would be delivered at the conclusion of the delay. A generalization condition included the child's teacher as therapist. During Study 1, both participants increased manding significantly compared to baseline. One participant progressed through Phase IV and produced vocal output. Because of the presence of vocal output during the addition of the prompt delay procedure, a second study was conducted to explore the relationship between the additional procedure and speech development.

A 9-year-old boy with autism participated in Study 2. He had a history with PECS but did not use it functionally. The therapists retrained him in Phases I–III, using identical procedures to Study 1, until he met criterion for each. Study 2 began at Phase IV using an ABAB design. The "A" condition included Phase IV training with no prompt delay, while the "B" condition included training plus prompt delay. Although the number of independent mands was not affected by the condition changes, the participant's approximations increased greatly from A to B. The first change increased from 3% to 83% and the second change saw increases from 2% to 80%. No full words were observed during Study 2.

Tincani et al. (2006) expanded the literature on AAC in a very important way. It affirms that AAC can effectively be used to teach functional communication (like manding) to non-vocal children with ASD. However, it also confirms the possibility of speech generation in some previously non-vocal children with ASD using AAC techniques. Further, it introduces the prompt delay as a possible means of increasing speech production and imitative skills when used in conjunction with AAC training.

Carbone et al. (2010) performed a study to evaluate the effectiveness of the addition of prompt delay and vocal prompting to manual sign mand training when used to increase vocalizations in children with autism and developmental delays. Previous research had suggested that sign language may increase vocal responding in children with strong imitative repertoires. Carbone and colleagues hypothesized that the addition of prompt delays and vocal prompting may increase vocal responding in children with poor imitative skills, based on previous research by Tincani et al. (2006) that combined a prompt delay procedure with PECS as the alternative communication system. Two boys with autism (ages 4 and 6) and one boy with Down syndrome (age 4) participated in the study. All three had no functional verbal speech, though two used signs to request between 10 and 15 strongly preferred items.

Carbone et al. (2010) used a multiple baseline design across participants to measure the occurrence of unprompted and prompted vocal responses including sounds, approximations of words, or full words. Unprompted vocal responses were counted if they occurred while signing, after a non-vocal prompt to sign, or with 5 seconds of the manual sign. Prompted responses were counted if they occurred after a vocal prompt. Sessions were conducted twice a day for 50 trials. Six items selected from a preference assessment conducted prior to intervention were presented one at a time to the participant at eye level. If the participant did not look at or reach for the item, the next item was presented. If the participate did indicate interest but did not mand for the item within 5 seconds, the therapist would begin a prompt sequence until the participant successfully requested the item. The therapist first gestured, then provided a physical prompt if 2 seconds passed without response. The participant was then provided 30 seconds of access to the item. During the prompt delay and vocal prompt condition, the therapist performed a 5-second prompt delay of the reinforcer when the participant correctly signed for the item. If the child produced vocal output without the sign, the therapist used the prompt sequence and then performed the 5-second delay. During the delay in either scenario, if the child produced a vocal response, the reinforcer was delivered immediately. If the child failed to produce vocal output, the instructor provided vocal modeling of the item's name. If vocal output was then produced within 2 seconds, the item was delivered. If not, the therapist repeated the sequence two more times.

All participants in Carbone et al.'s study showed increases in unprompted vocal responding during intervention as compared to baseline (as much as three times the amount). The study supports other findings that AAC may not hinder vocal output, but facilitate it. After increasing vocal output, the participant could access a form of communication that brought immediate results from his communication partner while strengthening the more desired skill. Increased vocal output in previously non-vocal participants also provides the therapist with a foundation in which to shape sound into speech. While Carbone and colleagues acknowledge that similar results may be produced without the addition of alternative communication, the use of sign language allowed for immediate reinforcement for the participant while the new skill was being mastered.

A study by Gevarter et al. (2016) examined the use of an SGD to increase independent target vocalizations for children with ASD who exhibit very limited vocal output. Gevarter and colleagues proposed to determine whether a combination of differential reinforcement and delayed reinforcement (a 5-second delay before reinforcement to provide opportunities for the preferred response and therefore access to the highly preferred item) while using an SGD could increase vocalizations, and if not, could vocalizations be increased through the addition of echoic prompts and prompt delays. This study also aimed to produce independent vocalizations that would remain even upon the removal of the device.

Gevarter et al. (2016) collected data on four boys, aged 4–7 years, diagnosed with ASD. Requirements for participants included limited vocalizations (assessed by the Vineland Adaptive Behavior Scale), limited echoic skills (assessed using the VB-MAPP), and experience using an SGD for manding. Sessions were conducted in-home using an iPad as an SGD with the AAC application GoTalkNow. Multiple stimulus without replacement (MSWO) preference assessments conducted prior to intervention determined items used as reinforcement and did not include any items with a request history. Items were labeled in the AAC application with efforts to include sounds reported emitted by the individual (e.g., “Sun,” instead of “Capri Sun” for the participant with an “S” sound in their vocalization history).

Gevarter and colleagues used a multiple baseline across participants design to evaluate their interventions. Although the number of baseline sessions was determined randomly, Greenberg et al. (2014) set the precedent for allowing up to 15 intervention sessions for everyone to reach criterion for the dependent variable, independent vocalizations (full words or approximations). During baseline, the SGD was placed within reach of the child and in view of a highly preferred item. A correct response occurring within 5 seconds, one that produced speech output on the SGD for that item, allowed access to 20 seconds of reinforcement. Vocal responses, incorrect responses, or no response was followed by physically prompting the correct response on the SGD and then providing access to the preferred item. After baseline, the intervention unfolded into three phases: Phase I, Reinforcer delay and differential reinforcement; Phase II, Addition of echoic prompt after delay; and Phase III, generalization probes.

Phase I continued the protocol of the baseline condition; however, full vocal responses for the preferred item received immediate reinforcement whether utilization of the SGD occurred or not. Responses using only the SGD were not immediately reinforced, but instead initiated a 5-second delay. If during that delay a vocal mand was performed, reinforcement would follow immediately. If no vocalization occurred, a simple request (like “clap your hands”) was given followed by access to a less preferred item. Following vocal word approximations, the SGD response would be physically prompted and then reinforcement would be delivered. So, only full vocal responses or approximations in conjunction with an SDG response provided access to the highly preferred item. Children who did not meet criterion during this phase moved on to Phase II.

Phase II procedures continued to follow the protocol for Phase I but added a vocal echoic prompt if vocalization did not occur in tandem with the SGD response. Vocal responses yielded access to the highly preferred item, but failure to respond initiated the “distractor trial” (“clap your hands”) followed by access to the less preferred item. Once the child demonstrated mastery of this phase, Phase I would be repeated. Generalization probes occurred throughout the conditions and provided opportunities to request for items vocally without the presence of the SGD.

Two of three participants reached criterion at Phase I, one required the supplemental procedures in Phase II to then reach criterion for Phase I, and the other participant never met criterion despite mastering the Phase II skills. During intervention, only one participant emitted target vocalizations (approximates) during the generalization probe. However, three participants showed an increase in post-intervention probes (all approximations). Additionally, initiations were observed in three out of the four participants on extinction. However, only one child ever emitted full words during any of the phases.

Gevarter et al. (2016) provided a valuable extension to previous research on SGDs and PECS. All participants successfully emitted target vocalizations, and, of particular interest, two of the participants did not require vocal modeling from the therapist to be successful. This could arguable be a great advantage over using the PECS system in interventions. Gevarter and colleagues also solidified the research suggesting that children with ASD will employ an alternative form of manding when their initial form is ignored; more specifically, vocal speech (a higher effort mand) increases when possibility of the SGD response (a lower effort mand) is placed on extinction. Results of this study also indicate that vocalizations may increase for children with ASD when adding a vocal instruction component (with reinforcement) to the SGD training, consistent with previous research. This could be an effective procedure for children who display poor imitation skills initially. Implications for this study include reducing fear that assisted communication procedures hinder talking, giving the child an immediate outlet to communicate while developing further skills. Further, vocal output can be maintained and improved upon even while fading the use of the device.

This study made great strides in expanding the literature; however, it was not without limitations. First, the study did not account for SGD proficiency in language acquisition. This study also failed to provide a comparison for language acquisition with only vocal instruction. Gevarter et al. (2016) suggest that further research addresses these issues while also exploring how targeting novel sounds might affect the procedures and how well the skill acquisition might generalize to requesting for other items. Finally, the variance in the study's data proved to be a limitation in that stable responding was not achieved. One explanation could be that the study utilized ineffective motivating operations in the form of weak potential reinforcers. While Gevarter et al. (2016) performed an initial MSWO to identify preferred items, research suggests that daily preference assessments produce more effective stimuli (Call et al., 2012; Deleon et al., 2001).

Bishop et al. (2019) replicated and extended the findings of Gevarter et al. (2016), showing that the Carbone prompt-delay method, demonstrated as effective with sign language, can also be implemented easily with a SGD. One major extension of the Bishop et al. study was the implementation of session-by-session preference assessments. Like Gevarter et al. (2016), Bishop and colleagues found that the inclusion of the prompt delay method with an SGD increased the vocal speech of three individuals with autism. The addition of the more frequent preference assessment also led to more novel vocalizations and less variance than seen in previous studies. This line of research clearly establishes mand training as an appropriate target for use with SGDs. More research is still needed on other verbal behavior targets, such as echoics, tacts, and intraverbals.

In summary, given the similarities in the efficacy of various forms of AAC, the ease, portability, likelihood of caregiver and educator buy-in, forms of SGDs on tablets and/or smartphones offer the most convenient and effective approach to providing avenues for AAC for children with deficits in vocal speech. As with all ABA interventions, however, practitioners should conduct careful and thorough assessments in the feasibility of any type of AAC that may be considered with a particular client. Though the field of speech and hearing sciences have developed a handful of standardized assessment for AAC, such as the Checklist of Communication Competencies (Bloomberg et al., 2009), the Functional Communication Profile (Kleiman, 2003), and the Test of Aided-Communication Symbol Performance (Bruno, 2010), none of these published assessments consider the verbal behavior perspective used in ABA to conceptualize spoken human language. In terms of ABA assessments, the field currently has a crisis of limited research on most of the assessment methods employed related to language and learning (Ackley et al., 2019). This is especially true for assessments that determine the appropriateness of an AAC for a particular client. For example, *Essentials for Living* contains a *Methods of Alternative Speaking* assessment that attempts to match client strengths with the benefits of various AAC methodologies. Unfortunately, no research to-date has evaluated the efficacy of such assessment or provided the type of psychometric data typically seen with published assessment tools.

Implications for Practice

The literature indicates that sign language, PECS, and SGD function effectively as functional communication aides. As demonstrated by Gevarter et al. (2013) and Bishop et al. (2019), effective methodologies employed in other approaches, such as sign language, can be effectively employed on SGDs. Research also suggests that SGDs produce increased verbal output for some previously non-vocal children with ASD, particularly when used with a prompt delay. Modalities selected by the clinician for AAC training may reflect the preference or ability of the client; for example, a child with limited imitative skills may not respond well to sign language and a child with poor fine motor skills may be unable to manipulate a Velcro board of picture exchange cards. SGD, in its most modern form as a smartphone app, most appropriately addresses the variability in skill sets among children with vocal speech difficulties, including the added benefit of instant customization through the device camera function; ability to store endless graphics and words while remaining lightweight and portable; and providing a means to communicate functionally without the stigma of other modalities. Additionally, caregivers may be more likely to embrace and use SGDs given the technology and ease of use over more labor-intensive approaches, such as having to learning sign language or keeping up with a PECS book.

The first decision a practitioner must make prior to designing intervention using an SGD, they should assess for needed prerequisite skills. As noted previously, there are no currently published assessment methods for AAC in general with empirical support. A task analysis of SGD use should uncover the skills clients need to effectively use SGDs. First, the practitioner should determine if the client has sufficient attending skill to the device screen. As screen arrays increase, the client will need precise fine motor skills, specifically refined proximal pointing. The client must have sufficient access skills, which may involve both gross and fine motor skills, such as obtaining the device, accessing it, swiping, pointing, and other skills. Additionally, the client must have the ability to make simple visual discriminations. Finally, due to the voice output delays indigenous to many of the SGDs, the client must tolerate delayed access to reinforcement.

If an ABA practitioner works with a client who uses an SGD, what types of language targets and other programs can incorporate the technology to support client progress? In keeping with assertions made by Skinner (1957) and the subsequent literature that has emerged with verbal behavior and the use of AAC, mand training seems like an obvious first step. Skinner believed that mands are the first topography of verbal behavior to emerge in humans, likely because the source of reinforcement for mands is directly related to an MO that is currently active in the learner's environment. As demonstrated by both Gevarter et al. (2016) and Bishop et al. (2019), the prompt-delay method demonstrated with sign-language by Carbone et al. (2010) shows great promise, not only in providing a source of functional communication for learners who do not currently possess vocal speech, but also led to the emergence of vocal mands. Mands likely represent the most appropriate and effective initial target of SGD intervention due to the relationship between an active MO with the source of reinforcement for manding directly related to the MO. For example, if the individual has not consumed liquid for several hours, they would likely demonstrate greater motivation to mand for a drink than to simply label a drink to receive some other generalized reinforcement, such as with tact targets.

The approach employed by Gevarter et al. (2016) and Bishop et al. (2019) involve methods that most practicing behavior analysts could easily integrate into ongoing treatment plans. Although the setting of training could occur in a more structured discreet-trial training (DTT) format, a more naturalistic approach where the therapist follows the client's motivation may prove more effective. Future research should compare training formats related to mand training with SGD. To begin mand training with technology, first the client must be taught to use the device to access specific reinforcement. Initially, place the device in close proximity to the client with sources of MO-related specific reinforcement visible but not necessarily available without communication. If the client correctly uses the device to request a specific reinforcer, that stimulus is immediately delivered for at least 20 seconds. If the client does not engage in a correct SGD demand, the therapist should physically guide the client to the correct SGD response. At first, physically guided responses should still produce the reinforcer, but over time, reinforcement should be only delivered for correct independent SGD mands. Given the findings of past research, intervention should involve a prompt-delay and an echoic prompt.

In this methodology, correct independent SGD responses produce a 5-second delay. During that delay, vocalizations immediately produce access to the reinforcer. The practitioner should decide on a client-by-client basis if full or partial vocalizations will access reinforcement. If a correct vocalization does not occur within the delay, the therapist then provides a full echoic model of the vocalization. For example, if the client used the SGD to mand for bubbles, the therapist would model "bubbles" following the 5-second delay. If the client still does not engage in vocal mands, the therapist would then provide a distractor trial, such as "touch your nose" and then provide contingent reinforcement with a lesser preferred stimulus. In other words, once manding is captured within the SGD response, extinction is implemented with SGD in the hopes of producing variability leading to vocal mands. The echoic prompt has shown in multiple studies to provide adequate support to the client in emitting vocal mands (Carbone et al., 2010; Gevarter et al., 2016; Bishop et al., 2019). Bishop et al. varied from Gevarter et al. in one key aspect. Bishop et al. conducted one-trial MSWO preference assessments prior to each session, whereas preference assessments used by Gevarter et al. were more temporally distant from the actual training trials. Although the more frequent assessment of stimulus preference led to less variability seen in previous research, data reported by Bishop et al. were still highly variable for some participants. Practitioners and researchers may wish to evaluate a more client-directed approach, such as seen in naturalistic environmental training, in which the environment is baited with multiple potential mand targets. The client then can shift mand targets from trial-to-trial. This approach may not only reduce response variability but may also led to faster acquisition of novel vocalizations.

In addition to manding, a tacting repertoire can be built in the absence of vocal speech with the aid of a SGD. Lorah and Parnell (2017) described an effective and efficient approach to teaching tacts with a SGD. This approach also employs delays to responding in hopes of evoking the target response, though no data to date have been reported that shows the emergence of vocal speech following tact training with a SGD. Lorah and Parnell targeted tacts during "circle time" within a classroom. The teacher would read a pop-up book with various animal tact targets. Upon reaching the target animal for a student, the teacher would pause for 5 seconds. If the student independently selected the SGD icon that corresponded to the target stimulus, the teacher would provide verbal praise. If the child failed to provide the correct SGD response, the teacher would deliver a full physical prompt to evoke the tact of the animal.

Future Directions

Technology has shown great promise in the development of communication, vocalizations, and speech for many individuals with speech difficulties. Despite emerging literature showing the efficacy of SGDs in speech and language treatment, more research is needed, not only comparing SGDs with other forms of AAC but also comparisons of various SGD formats. Research should not only include single subject design but randomized clinical trials as well to establish the legitimacy of the verbal behavior approach with technology beyond the field of ABA. Two major practice implications that require much more research involve training individuals to use SGDs as well as effective assessment methods in the appropriate use of AAC and SGD. More efficiency data is also needed for interventions beyond mand training, such as intraverbal training, matching-to-sample, receptive labeling, and discrimination training, to name a few. Although promising, the rise of technology remains relatively young and still requires empirical evaluation to not only further demonstrate the efficacy of SGDs but also refine and improve methodologies to produce better client outcomes over time.

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54 Remembering and Cognition

Rebecca J. Sargisson

Who Can Benefit from Remembering Interventions?

I am sure we have all wished, at some time in our lives, that we were better at remembering. We have all had the experience of entering a room and forgetting why we walked in there. We go to the supermarket and return without the item we needed. We lose our keys. We panic that we have missed an appointment. We forget where we parked the car. For some members of our world, however, remembering is particularly difficult.

Older persons often report problems with remembering (Verhaeghen et al., 2000), and, indeed, there is robust evidence that memory performance deteriorates with age (Verhaeghen, 2012). Older persons are also more likely to experience memory difficulties due to dementia and Alzheimer's disease (Arvanitakis et al., 2019). With virtually every country in the world facing an aging population, memory-related issues among older persons are likely to become an important focus for psychologists (Caprani et al., 2006).

Many other individuals have problems with remembering, making memory a very relevant issue for psychological practice. There is evidence to suggest that memory problems are experienced by persons with autism spectrum disorder (ASD) (Kercood et al., 2014), Down syndrome (Doerr et al., 2019), and attention deficit/hyperactivity disorder (ADHD) (Ramos et al., 2020), among others. The ability to report past events is important for the development and maintenance of relationships with others and for health and well-being (Shillingsburg et al., 2017).

When we think about remembering, we tend to think of recalling stimuli and events that occurred in the past—known as *retrospective remembering*. However, another form of remembering—*prospective remembering*—refers to remembering to perform certain behavior in the future (Peisley et al., 2020). Prospective remembering can be time-based or event-based. We are engaging in time-based prospective remembering when we remember to go to the dentist next Wednesday, for example. It is time-based because we need to remember to complete the action at a certain time. Remembering to take our antibiotic tablet when we eat dinner is event-based prospective remembering because an event serves as the cue to complete the behavior. Prospective remembering contains elements of retrospective remembering, in that the person must remember what it is that they need to do. The additional requirement is remembering to perform the behavior at the right time, or in response to the right cue.

Many groups of people have impairments in prospective remembering, including older persons (Henry et al., 2004), people with

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_54

schizophrenia (Wang et al., 2018), multiple sclerosis (Rouleau et al., 2018), dyslexia (Smith-Spark, 2018), traumatic brain injury (McCauley et al., 2009), and children with ASD (Sheppard et al., 2018) and ADHD (Talbot et al., 2018). Such impairments have implications for people's day-to-day lives. My 90-year-old grandmother needs to remember to take her medication at certain times. If she takes it at the wrong time, it could seriously affect her health. Children need to remember to do their homework and to deliver notes from their teacher to their parents.

Aside from the day-to-day issues that arise for people who have memory problems, such as remembering to perform actions in the future, and being able to connect with family and friends by talking about shared historical events, there is evidence that memory ability is important for the performance of other behaviors. For example, people with ASD who score poorly on tests of working memory also score lower on tests of mathematical ability (Kercood et al., 2014) and other cognitive tasks (Kenworthy et al., 2008). Therefore, interventions to improve remembering may also lead to improvement on other tasks.

How Do We Remember?

One puzzle for early philosophers was how humans could seemingly resurrect stimuli and events from their past. If an object is no longer here, how is it that we can respond as if it were?

The Cognitive View

Cognitive views of short-term memory evolved from early philosophical theories that when people encounter stimuli or experience events, copies of these stimuli and events are "stored" or "stamped" in our brains (Delaney & Austin, 1998; Palmer, 1991). They reasoned that as we cannot store the original stimulus or event, we must store a copy. If we rehearse the copy (or trace) of the stimulus, we can hold it in short-term memory, and if the trace is associated with other stored stimuli, it may be transferred to long-term memory. It is these stored copies of past stimuli and events, retrieved from our memory stores that are assumed to affect our current behavior (Fryling & Hayes, 2010). It is assumed that our short-term memory store has a finite capacity and cognitive psychologists have placed some focus on measuring the limits of this store. As Delaney and Austin (1998) point out, if remembering involves the storage of copies or traces, then counting the number of such traces that can be stored is a logical step. Most people have heard of the cited "fact" that humans can generally hold seven items, or chunked pieces of information, in their short-term memory store (Miller, 1956).

Over time, the nature and number of memory stores described by cognitive psychologists have changed. Since Atkinson and Shiffrin's (1968) three-stage model consisting of the sensory register, working memory, and long-term memory, other cognitive models involving memory stores have been proposed. Some models suggest that different types of information are stored in different places (e.g., the working model of memory; Baddeley & Hitch, 1974) and others that traces are generated in short- and long-term memory stores simultaneously (the Feature Model; Nairn, 1990). These cognitive models all have in common the notion that information is received in some sort of (hypothetical) memory store and must be rehearsed or in some way processed (e.g., by association with other information; Woodward et al., 1973) to be retained. When asked to remember, a person must search the long-term store for the relevant information and then recall it. The problem of remembering then becomes one of retrieval of information from the long-term store.

The Behavioral View

Behaviorists argue that viewing remembering from the perspective of memory stores and traces is unhelpful. Firstly, behaviorists insist on studying behavior, not hypothetical structures such as memory stores or copies. Hypothetical memory stores engender all the usual behavioral objections to mentalisms; scientific enquiry is directed to explaining how the memory stores work, which is not necessary to the study of the behavior of remembering, and distracts researchers from explaining the behavior itself (Baum, 1994). Secondly, even if copies of stimuli and events are stored in our brains, the cognitive perspective does not shed any light on how we search through the stores to retrieve the copies (Palmer, 1991).

White and McKenzie (1982) describe remembering as "discriminative behavior under the delayed control of prior stimuli differing in degree of discriminability" (p. 311). The delay between the stimulus presentation and the opportunity to respond (or "remember") makes the discrimination more difficult than discriminations made in the presence of the stimuli, but there is no requirement to hypothesize internal memory stores to explain the behavior. The time that has passed between the presentation of a stimulus or event and the opportunity to remember it is a dimension of the discrimination, just as the color, size, and distance of such stimuli are. In the same way that we may have difficulty identifying an object that is far away from us in space, we might have difficulty describing a stimulus that is further away in time (in the past). When we remember, just as when we see, we "do" something, and although no one else can easily observe the "doing," it does not mean that it is somehow different to overt behaviors. Behaviorists argue that public and private behaviors differ only in the number of people who can observe or report on them (Baum, 1994)—they otherwise have the same properties and are subject to the same contingencies, shaped and maintained by the same processes (Baltruschat et al., 2011a).

According to the behavioral view, we learn to perform remembering behaviors in the same way as we learn to perform other behaviors (Palmer, 1991). Adults shape the remembering behavior of children, just as they shape other behaviors (Palmer, 1991). For example, a parent may say to a child, "Tell Grandma what did you did today." The adults present will reinforce the child's response with attention, approval, interest, and so on. If the child is unable to answer, the parent might provide prompts to facilitate the response, for example, "Remember? We went to the park. What did you play on there?" Adults can provide more and more explicit prompts until the child responds, and prompts can be faded as remembering behavior emerges. Adults will also shape "correct" remembering behavior, to the extent that they are aware of the accuracy of the description of the past events. They might correct the child's remembering behavior, for example, by saying "No, you didn't play on the swings today, but you did play in the sandbox."

Natural consequences also shape and maintain remembering behavior. Forgetting a person's name will lead to embarrassment. Remembering to bring your lunchbox to school will prevent hunger, and so on.

Why Does the Perspective on Memory Matter?

In practical terms, does it really matter whether we take a cognitive or a behavioral approach to remembering? Behaviorists would argue that it does. If remembering behavior is explained using storage models, failure to remember is attributed to failure of the hypothetical structure (Chiesa, 1994). As Chiesa (1994) points out, in applied settings, how can a psychologist intervene to enhance a hypothetical structure? In other words, understanding and explaining the storage model do not help us in our efforts to improve remembering behavior.

There are other implications of the storage model. If our short-term memory capacity is limited, as assumed by the cognitive perspective, then it is presumably not possible to improve our memory beyond its limits. With a limited physical capacity for storing and retrieving information, we can presumably only improve to some maximum and further efforts to improve will be unsuccessful. Also, if items and events are stored temporarily as fading traces, remembering accuracy will necessarily decline over time since the presentation of the information to-be-remembered. The strength of the trace should be strongest at a zero delay. When introduced to a new person, for example, the likelihood that I will remember that person's name should diminish as time passes due to the fading of the trace of the name, unless I rehearse the name to hold it in my short-term memory. With the view that remembering involves fading traces, there is an assumed inevitability that our ability to recall a stimulus will decrease over time.

Some behavioral researchers have attempted to demonstrate that it is possible to train an animal to remember better after longer delays than after shorter delays after the presentation of a stimulus. Such a finding would throw doubt on the idea that remembering involves copies of stimuli that fade over time. In an attempt to dispute trace-decay theories of remembering, Sargisson and White (2001) trained pigeons in a delayed-matching-to-sample task to perform a remembering behavior after a certain delay. We reinforced the pecking of a key (the comparison stimulus) when the key color matched a sample key color presented earlier. Each group of pigeons experienced a different, single delay between the presentation of the sample and the comparison keys during training; either 0, 2, 4, or 6s. In a probe test using delays of 0, 2, 4, 6, 8, and 10s, the pigeons performed more accurately at their training delay, even when it was longer than other delays (Fig. 54.1). Remembering performance also generalized to proximal delays—pigeons were better at remembering after delays close to their training delay than they were after delays that were more different. These results aligned with findings of researchers measuring purely visual behavior—or "seeing" (Blough, 1972), and provided evidence that "remembering" is similar to other, immediate behaviors. Increasing the delay between the presentation of a stimulus and the opportunity to recall it increases the difficulty of the remembering task (seen in the lower discriminability scores for longer delays in Fig. 54.1) in the same way that increasing the physical distance between an observer and an object makes it more difficult to see the object. Neither situation requires reference to hypothetical "copies" stored in the brain.

White and Brown (2011) found further evidence that remembering can be more accurate after longer delays than after shorter delays. In a

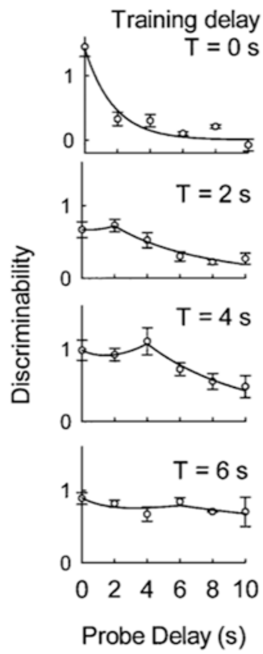

Fig. 54.1 Mean discriminability (remembering accuracy) at different delays by pigeons trained with a single delay of 0, 2, 4, or 6s. (Reproduced with permission by Wiley from Sargisson and White (2001))

delayed-matching-to-sample task, they presented a signal during the delay interval to indicate whether the reinforcer on the current trial would be small or large. Pigeons performed the remembering task more accurately when large reinforcers were signaled, but, importantly, when the cue was changed partway through the delay interval, accuracy increased after longer delays when the cue changed from a small to a large reinforcer. White and Brown's result is important because rehearsal of the correct stimulus during the delay could not explain the enhanced performance at longer delays. These results and others (Sargisson & White, 2007; White & Sargisson, 2011) demonstrate that it is possible to train animals to "do" better remembering after longer delays than after shorter delays—a finding incompatible with trace theories of remembering.

Unlike the approaches of cognitive psychology, where memory is viewed as a limited resource in which copies of information are stored, a behavioral approach to remembering assumes that remembering, as a behavior like any other, is subject to modification through its contingencies. That is, just as we can improve a person's reading or writing, we can improve their remembering, for example, by changing the contexts in which the remembering occurs, or by manipulating the consequences of remembering behavior. The behavioral approach suggests that applied behavior analysts can use any of the behavior modification tools in their repertoire to enhance remembering behavior. In fact, there may be no need for interventions tailored specifically to problems of remembering.

Behavioral Assessment

The first step a behavior therapist takes when working with a client is to understand and measure the behavior of interest. Establishing a baseline of current behavior will help a therapist to demonstrate that a particular intervention has resulted in improvement of that behavior. In terms of remembering behavior, one common way of assessing current memory ability is to use *indirect assessment* methods, such as questionnaires like the Instrumental Activities of Daily Living: Compensation Scale (IADL-C) (Schmitter-Edgecombe et al., 2014) and the Multifactorial Memory Questionnaire (Troyer & Rich, 2002). Such instruments measure what an individual perceives their remembering ability to be, their satisfaction with their memory, and which memorial strategies they use. The problem with indirect methods—especially in the self-report format—is that they do not occur at the time that the target behavior is performed, but rely on the individual's recollection of their own behavior (Miltenberger, 2016), an obvious drawback for people who have problems with remembering. In fact, Troyer and Rich (2002) found no significant correlations between self-reported memory ability and performance on objective tests of remembering with a sample of older persons *without* memory difficulties.

Another way to assess remembering ability is through *direct assessment* methods—observing and recording remembering behavior as it occurs. To assess remembering ability, for example, an observer could ask a person about events that occurred in their personal histories, or ask them to recall items from a list presented earlier (Richardson-Klavehn & Bjork, 1988). A behavior analyst could also devise a more unobtrusive recording method to measure remembering behavior, for example, by observing the person interacting with friends and family, or after being asked to perform a task by a third person. Behavior analysts generally prefer direct assessment methods (Miltenberger, 2016). However, although direct, and to some extent indirect, assessment methods will provide a baseline of a person's remembering ability, only the verbal responses of the individual are overtly visible, and as such, they may not reveal which strategies the person is using to remember, and which interventions might be especially effective to improve remembering outcomes.

Talking Aloud

One challenge, then, when seeking to intervene to improve the remembering performance of our clients is that some parts of the remembering behavior are performed covertly, making it difficult to ascertain the nature of the remembering problem, or to identify strategies that might be efficacious in improving the client's remembering behavior. One way to overcome the challenge is to make the covert overt. Delaney and Austin (1998) recommend "talking aloud" to determine the specific challenges a person is experiencing with their memory. Talking aloud involves verbalizing the thinking process, without reflection or interpretation, as a person engages in remembering behavior. By verbalizing the thought process, covert behavior becomes overt behavior giving a practitioner some insight into the strategies that a person is already using, and which interventions might be most helpful.

Using the talking-aloud approach, Williams and Hollan (1981) investigated the process taken by individuals as they attempted to recall first and last names of students in their year group at high school. Multiple sessions over many hours produced an impressive number of names recalled by their subjects—up to 214 for one subject. The verbalizations of the subjects revealed a process whereby participants sought discriminative stimuli that would lead to the recall of the names, for example, by recalling specific classrooms, events, and friends who might be linked to peers. The participants sometimes tested each letter of the alphabet for names that they recognized.

The talking-aloud approach, then, might be a useful tool as part of an assessment of a person's remembering behavior. It may highlight strategies that the person is already using, and suggest other strategies that could be taught to improve the person's remembering performance.

Cognitive Approaches to Improving Remembering

Many cognitive strategies for improving short-term memory ability stress the importance of practice. Unless we rehearse information, or transfer it to a long-term memory store, it is assumed that information will be forgotten, either because information held in short-term stores fades, or because we lack the mental resources to hold the information and perform other mental processes simultaneously, or because it will be overwritten by new incoming information (Oberauer et al., 2016).

Cognitive techniques to increase memory capacity have centered on rehearsal and practice (Bahar-Fuchs et al., 2013)—with the idea that repeatedly using our memory will strengthen our ability to remember, much like exercise improves muscle tone (Melby-Lervåg & Hulme, 2013). *Articulatory rehearsal*, the type of rehearsal that people most commonly use (Oberauer, 2019), describes the simple repetition of stimuli (usually by silent verbalization) until the information is needed. An example is repeating a phone number to yourself until you can enter it or otherwise record it. From a behavior analytic perspective, each verbalization of the stimuli serves as the discriminative stimulus for the next verbalization and the behavior of rehearsal is reinforced by successful completion of the task requiring the stimuli (correctly dialing the phone number, for example) (Delaney & Austin, 1998). Such behavior closely resembles behavior *chaining*, where each behavior in a sequence acts as the discriminative stimulus for the next behavior (Miltenberger, 2016).

Based on the assumption that practice will improve ability, computer programs have been designed specifically to improve short-term remembering ability. These programs include memory exercises to "challenge" working memory. Such programs are typically referred to as *working memory training* or *cognitive training*. The programs guide users through memory tasks of increasing difficulty in different domains (Bahar-Fuchs et al., 2013) to "strengthen" and increase brain activity. Improvements gained in one type of task are expected to generalize to other types of tasks (Melby-Lervåg & Hulme, 2013). In terms of generalization, a distinction is made between near-transfer and far-transfer. Near-transfer is the generalization of a skill or ability to tasks similar to, or in the same domain as, the training task. For example, a cognitive training program in verbal memory might improve remembering skills not only for the specific verbal memory task presented in training, but in other, similar, verbal memory tasks. Far-transfer is achieved when improvement in the verbal memory task leads to improvements not only in verbal memory, but other kinds of memory, or even in more general domains, such as reading or writing (Sala et al., 2019b).

One such cognitive training program, Cogmed (https://www.cogmed.com/), claims that, because their visuospatial and verbal memory training strengthens neural networks—in a different way to behavioral strategies—the process of network strengthening will enhance performance in non-trained tasks. They state that their tasks "challenge the working memory capacity" at its limits. The website for another memory-training program, Jungle Memory (https://www.junglememory.com/), again refers to their program as a way to "strengthen" memory, and claims that by training children to "use" their working memory, improvements can also be seen in reading and writing skills.

Despite the claims, however, such memory training programs have shown rather unconvincing outcomes. Several meta-analyses, presenting the combined effect of many individual studies, have been published. Melby-Lervåg and Hulme's (2013) meta-analysis of 23 studies of memory training programs reported immediate benefits in visuospatial and verbal memory, but the improvement was only maintained long-term for verbal tasks. There was no evidence that improvements in one domain generalized to other domains. A meta-analysis of 11 randomized-control trials where cognitive training was used in an attempt to improve the remembering ability of persons with dementia showed no improvements relative to control groups (Bahar-Fuchs et al., 2013). A review of 10 studies investigating cognitive training (most delivered using a computer program) with persons with mild cognitive impairment found mixed results (Gates et al., 2011). Although a few studies in Gates et al.'s (2011) analysis reported improvement in memory performance after cognitive training, some reported negative effects, whereby controls performed better than those in the treatment group, and there was little evidence of generalization to other domains.

For children with ASD, there is also little evidence to support the use of working memory training. De Vries et al. (2015) concluded, after a large, randomized control trial, that there were only marginal effects on working memory and that computerized memory training, of the type used in their study, is not a feasible treatment for children with ASD.

A second-order meta-analysis (a meta-analysis of meta-analyses) showed that cognitive training generalized successfully to near-transfer tasks (that is, memory training improved performance on other memory tasks), with the improvement being greater for children than for adults (Sala et al., 2019b). However, far-transfer (improvement in other tasks, such as language tasks) did not occur for any population, a finding also reported in other meta-analyses (e.g., for Cogmed specifically, Aksayli et al., 2019; for older adults, Sala et al., 2019a; for typically developing children, Sala & Gobet, 2020). Some scholars have cautioned psychologists to take care when recommending computerized cognitive training programs, given the lack of evidence to support claims that they result in real-world improvements (Hague et al., 2019).

Interventions Classified by the Three-Term Contingency

Many factors affect our ability to remember, and in the language of behaviorism, I will categorize them according to Skinner's three-term contingency into antecedent, behavior, and consequence factors. From a behavioral perspective, these factors are all located in the environment, and are therefore available for manipulation to improve remembering performance. However, Baltruschat et al. (2012) note that there has been little published research on working memory from behavior analysts. They state that research on memory from a behavior analytic perspective is important because, firstly, behavior analysis needs to demonstrate that it can address the full scope of psychological phenomena, and secondly, remembering behaviors are legitimate and interesting behaviors that are critical to the successful performance of many other behaviors.

The two main approaches to assisting people with memory problems are either *restorative* or *compensatory* (Wade & Troy, 2001). A restorative approach seeks to improve innate remembering ability, while a compensatory approach seeks to teach a person strategies to cope with their remembering difficulties, without assuming that memory ability itself can be improved. In behavioral terms, there is no real difference between these strategies—both involve teaching techniques to enable the person to perform memory-related tasks. If a therapist teaches a client how to create mnemonic devices to help them remember the names of people they meet, and the person is later able to successfully remember the names of a person they meet, is this strategy restorative or compensatory? How would an observer know? Thus, I will make no distinction between the two types of approaches.

Antecedent Factors

All currently occurring events and stimuli are things that we will potentially want to remember in the future. Sometimes we know at the time events occur that we will need to remember them later. For example, when we park our car at the airport, we know that we will need to remember where it is when we return from our trip. How can we manipulate the antecedent conditions to optimize later remembering behavior?

Behavioral antecedents are the stimuli or events that are present prior to an operant response (Miltenberger, 2016). Antecedent stimuli gain control over behavior when behavior is reinforced in the presence of those stimuli. Stimuli thus become discriminative, and certain behavior is more likely to occur in the presence of such discriminative stimuli. Such behavior is said, then, to be under stimulus control by a discriminative stimulus. Most behavior under stimulus control is performed in the presence of the discriminative stimulus, and not in its absence. We are more likely to drive through a green traffic light than a red one—the light is present at the time we drive through the intersection. When we remember, however, we are performing behavior in relation to a discriminative stimulus that may no longer be present. It is easier to describe your mother's face (here, your mother's face is a discriminative stimulus, and your description of it is behavior under stimulus control) when she is present than when she is absent. When she is absent, and your behavior is therefore under delayed stimulus control, if you are unable to recall your mother's face immediately, you may need to recall other discriminative stimuli related to your mother to assist your remembering behavior. For example, you may recall her in locations, and performing tasks, that are particularly associated with her.

If the behavior to be performed in the future (remembering) is associated strongly with the stimulus to be recalled, or is associated with other stimuli that can serve as discriminative stimuli at the time remembering is required, then we will be more likely to produce accurate remembering. Conversely, forgetting is a failure of stimulus control—there are insufficient stimuli available, or the association with the stimuli is too weak, to cue accurate remembering.

Many studies have demonstrated that the strength of the initial discriminative stimulus is important to remembering. In animal memory research, for example, presenting the sample stimulus for a longer period, or requiring the animal to respond to it a greater number of times, improves the animal's remembering accuracy of that stimulus across various delays (White, 1985). With humans, we might think of stimulus strength as a problem of attention. If we were not paying attention at the time that the stimulus or event occurred, it is unlikely we will be able to recall that stimulus after a delay. Cognitive psychologists might argue that increasing the strength of the initial stimulus serves to increase the strength of the trace, and a stronger trace will be available longer than a weaker trace. Behaviorists, however, would argue that stimulus strength is about providing opportunities for the current stimulus to be associated with other stimuli that, when they appear in the environment later, can serve as discriminative stimuli to evoke remembering behavior (Fryling & Hayes, 2010).

Researchers have reported that people do not always notice, or attend to, unexpected or surprising stimuli in their environment (Simons, 2000)—a phenomenon referred to as *attentional blindness*. A well-known experiment, for example, demonstrated that when people were asked to count the number of passes made during a short segment of a basketball game, most failed to notice, and were unable to recall, a person walk across the court wearing a gorilla suit (Simons & Chabris, 1999). There is some evidence that using mindfulness techniques can reduce attentional blindness (Schofield et al., 2015). Schofield et al. (2015) reported that participants in a brief mindfulness condition detected distractor stimuli at a significantly higher rate than participants in the control conditions. Lueke and Lueke (2019), who found that participants in a brief mindfulness condition performed better on tasks requiring them to remember lists of words than did controls, propose that the improvement in remembering ability is due to "encoding" of the stimuli; in other words, something the participant is doing prior to the opportunity to recall the words. Being mindful when parking your car at the airport, for example, would imply that you pay particular attention to the car's surroundings, noticing landmarks that might be useful for remembering at a later time where the car is parked. These promising recent findings suggest that a client engaging in mindfulness therapies might also experience improvements in their memory.

If we are currently experiencing an event that we believe others will ask us about later, or that we know we will need to remember later, we tend to pay attention to other features of the environment. When parking the car, we may look for a sign, trees, or other distinctive stimuli near to where the car is parked. When at an important family event, we may take photos, talk to others who are present, text friends, or post about it on social media. These additional associations with the original stimulus or event will aid later remembering (Fryling & Hayes, 2010). While some of these associations are created without much thought, some we deliberately create at the time that the stimulus to-be-remembered occurs to aid later remembering, so-called *acquisition strategies* (Delaney & Austin, 1998). For example, when being introduced to a new person, we might try to connect their name to some aspect of their appearance, so that when we see them again, we are more likely to remember the associated name—*B*elinda has *B*londe hair, for example. Note that the association does not need to be thought of as residing in any kind of memory store: The stimuli are associated in the environment.

During the process of classical conditioning, pairing an unconditioned stimulus with another stimulus creates an association between the two stimuli. If I say "sit" as my puppy sits, I will create an association between the spoken word "sit" and the behavior of sitting. The presentation of the, now-conditioned, stimulus ("sit") elicits the behavior (sitting) initially elicited by the unconditioned stimulus (whatever prompted the puppy to sit in the first place). In the same way, a stimulus associated at one point in time with a to-be-remembered stimulus can elicit behavior at a later time. Thus, just as a bell can become a conditioned stimulus eliciting salivation, or the word "sit" with sitting, the sight of Belinda's blonde hair acts as a discriminative stimulus prompting the response "Belinda." One way to enhance remembering, then, is to strengthen the associations between antecedent stimuli (Fryling & Hayes, 2010).

Mnemonic devices, as an acquisition strategy, involve deliberately constructed stimuli that are easier to recall than the stimuli that are likely to be needed in the future, and that serve as discriminative stimuli for these difficult-to-remember stimuli. For example, I learned in school the mnemonic "my very earnest mother just showed us nine planets" to aid the recall of the names, and order, of the planets that orbit the sun. (Of course, a new mnemonic will be needed now that we have lost Pluto as a planet!) Such mnemonics are quite effortful to learn, but there is evidence that humans can learn to develop their own mnemonic devices. Ericsson et al. (1980), for example, reported an analysis of a single person who became an expert at the digit-span memory task. This task involves presenting a sequence of digits (or words in the word-span task), at a rate of one digit per second and asking the subject to repeat the digits in the same order. If the list of digits is recalled correctly, one digit is added to the list. Ericsson et al.'s subject was initially able to recall seven digits—within the range of the average person's recall ability. However, after 2 years of training, the subject had increased the number of digits he could recall to 80. The subject was asked to describe his thought processes during each trial (the "thinking aloud" approach), providing insight into the learning process. Initially, the subject reported using only rehearsal strategies, but when rehearsal proved insufficient, he developed different mnemonic strategies, for example, by creating hierarchical groups of numbers, each group serving as discriminative stimuli for subsequent groups.

Belleza (1981) described many different types of mnemonic devices, which could be a helpful resource for practitioners seeking to teach clients how to use these devices, but they noted that evidence suggests it is better to encourage the client to develop their own mnemonic devices.

Training target groups in the use of mnemonic devices has been shown to improve their ability to remember information, not only in the short-term, but also more permanently. Mastropieri and Scruggs (1989) showed large and consistent effect sizes in a review of research where children with mild developmental delay were taught to use mnemonics to enhance their recall of academic content. An updated synthesis of 34 experiments concluded that the use of mnemonics for improving the recall of academic content is "extremely powerful" (Scruggs & Mastropieri, 2000, p. 170). A nice feature of mnemonic devices is that they can be an effective strategy for whole-class instruction, as the use of mnemonic devices has been shown to improve memory for academic content both for developmentally normal and developmentally delayed students in a classroom (Mastropieri et al., 2000). According to another meta-analysis, mnemonic devices also improve the memory performance of older adults (Verhaeghen et al., 1992), particularly when the training is delivered in a group setting.

Forgetting can occur when antecedent conditions or discriminative stimuli are either absent at the time of remembering, or when they become involved in new associations (Fryling & Hayes, 2010). For example, we may forget to take our medication when we are on vacation because the usual discriminative stimuli to prompt the behavior are absent. We might be unable to find the car in the carpark because different cars are now parked beside our car. A specific location may remind you of a person or event until it becomes associated with a new person or event. In such situations, to facilitate remembering, it may be wise to create associations with stimuli that are more independent of context, or to ensure that discriminative stimuli do not become involved in new associations. For example, when parking the car, it is not wise to use nearby cars as discriminative stimuli (Fig. 54.2), but rather immobile cues such as signs and trees that will still be there when you return.

In some cases, a therapist does not want to improve a client's memory, but rather to help a client forget something, for example, a painful experience (Fryling & Hayes, 2010). Exposure to the discriminative stimulus in the absence of the stimulus that caused pain, or pairing the discriminative stimulus with pleasant stimuli, can help weaken the association (such processes are known in behavior analysis as, for example, exposure therapy or systematic desensitization and counter-conditioning).

Antecedent or acquisition strategies, then, can help to improve remembering behavior by intervening prior to the need to remember, for example, by strengthening stimuli and events to-be-remembered, and by creating associations between to-be-remembered stimuli and other stimuli that can act as discriminative stimuli at the time of recall. How might we intervene to improve remembering in the absence of such antecedent strategies?

Behavior

Have you ever walked into a room and forgotten what you wanted in there? It is likely that you retraced your steps in the hope that it would help you remember. Stimuli in the place you return to will act as cues (discriminative stimuli) for the initial thought. You did not think, at the time you decided to move into the other room, to pay attention to stimuli in the first room, and yet, these stimuli have been associated in time and can therefore act as cues, even without the deliberate use of antecedent strategies. When asked to recall past events, then, contacting associated stimuli may aid accurate remembering (Shillingsburg et al., 2019).

As mentioned in the previous section, because stimuli-to-be-remembered are often associated with other stimuli and events, one way to achieve remembering is to contact the discriminative stimuli associated with the original to-be-remembered stimulus or event (Palmer, 1991). Such recall strategies work best in combination with acquisition strategies, whereby we attempt to create associations prior to the need to remember (Palmer, 1991). Some recall strategies are techniques that humans learn to engage in; that

Fig. 54.2 When taking note of your parking place, it is not very helpful to notice only the adjacent cars (left photo) as they may not be there when you return. A better approach is to take note of immobile stimuli, such as the 1b sign on the post (right photo)

is, the behavior is shaped over time by its consequences. For example, when trying to remember the name of an acquaintance, we commonly test out each letter of the alphabet in turn. Such a strategy often works because the sound of the letter is associated with the sound of the beginning of the person's name and acts as a discriminative stimulus to its recall. When using this strategy results in correct recall of the name, the use of the strategy is reinforced. Similarly, when asked what you had for dinner one night last week, you might first recall what other activities you were engaged in that day—recalling that you worked late, for example, you might recall that you did not have time to cook, so picked up a pizza that night. Again, if the strategy is successful, you will be more likely to use the same strategy in the future. Associative recall also occurs in the absence of a specific need or request for recall. For example, smelling a certain cologne on a passer-by may trigger the recollection of a man you knew who used the same cologne. During a visit to your hometown, you will spontaneously recall events from your childhood.

Forgetting can occur both when we do not encounter the necessary discriminative stimuli in the present time to elicit remembering behavior and when discriminative stimuli become associated with too many to-be-remembered stimuli (Fryling & Hayes, 2010). If every man wears the cologne, then smelling the cologne would not remind you of anyone in particular. If you do not pass by the store on the way home, you may forget to buy milk.

To help another person remember a stimulus or event, we might use *prompting*. For example, when a person is experiencing difficulty remembering, a practitioner may ask probing questions to help the person contact the discriminative stimuli associated with the stimuli or event-to-be-remembered. If a person cannot remember when they last saw their doctor, for example, we might ask whether it before or after Christmas, in the spring or summer, or before or after they engaged in some other memorable activity. Deliberate prompting is similar to the prompting delivered by our verbal community when we all learn to remember (as discussed above). Shillingsburg et al. (2017) argue that naturally occurring prompts may not be sufficient for children with ASD, however, the deliberate use of prompts with young children with ASD can improve their ability to recall past events (Shillingsburg et al., 2019), thus prompting may be a useful strategy for some clients.

Prompting can be arranged in the absence of a person to provide the prompts: that is, through the use of external aids that serve to prompt remembering behavior. Such prompts are also referred to as *reminders*. We learn to support our own remembering behavior by using diaries and calendars, and making shopping lists, for example, and, similarly, we can teach others to use external aids. These external aids serve as discriminative stimuli to prompt remembering behavior. Memory wallets are one example of an external memory aid to assist with retrospective remembering. Memory wallets contain personally relevant pictures and textual information depicting facts, people, or events that a person is having difficulty remembering (Bourgeois & Mason, 1996). Bourgeois and Mason (1996) investigated the efficacy of memory wallets with four people with dementia. Care workers created a book of photos and statements to use as cues to prompt conversation. They found some improvement in the clients' conversations—clients made fewer remembering errors, repeated themselves less, were more intelligible, and increased the number of factual statements they made. Half the family members reported that the clients were easier to talk to and care workers reported that their clients smiled a lot when they looked at the memory wallets.

Mobile phones can also deliver reminders to people with memory impairments. Unlike memory wallets, which are used to promote retrospective remembering, or reminiscing, mobile phones and other, similar types of reminders are more helpful for prospective remembering tasks. Wade and Troy (2001) found promising results for the use of a mobile phone app that reminds people to perform certain tasks. Other mobile phone apps, such as Google calendar, could be a useful tool for people with prospective memory problems (McDonald et al., 2011). In fact, a meta-analysis of prospective memory aids found a large overall effect size supporting the efficacy of portable prompting devices (Jamieson et al., 2014).

Consequences

If remembering is a behavior like any other, it should be possible to improve remembering performance by manipulating its consequences. Studies with non-human animals have shown that remembering performance is more accurate when reinforcer magnitude or probability is increased for correct remembering behavior (Brown & White, 2009) and reinforcing the accurate retrospective remembering of children with ASD improved their performance in a counting-span (Baltruschat et al., 2011a) and in a complex-span task (Baltruschat et al., 2011b). In another study, Baltruschat et al. (2012) found that not only did performance on working memory tasks (backwards span recall) by children with ASD improve but accurate performance also generalized to novel stimuli when correct recall was reinforced.

Prospective remembering outcomes are regularly rewarded and punished in society. For example, fines are imposed for forgetting to return library books, forgetting to attend an appointment, or paying bills late. Conversely, remembering a friend's birthday will be reinforced by your friend's happy response. Prospective remembering, then, should also be amenable to improvement through the use of reinforcement. Peisley et al. (2020) reinforced the correct responses of children with ASD as they played a computerized memory game called the Virtual Week (Rendell & Craik, 2000). Remembering accuracy increased for all children and was maintained for most children after reinforcement ceased. Children with traumatic brain injury (McCauley et al., 2009) and orthopedic injuries (McCauley et al., 2011) performed significantly better on a prospective remembering task when they were promised larger reinforcers for correct remembering ($1 per point) compared to children who were promised smaller reinforcers (1c per point). Thus, reinforcing correct remembering may be effective for some populations, and tangible reinforcers may lead to better outcomes for those who do not respond well to social reinforcement (e.g., children with ASD; Shillingsburg et al., 2017).

Another way to manipulate consequences is to make use of the *differential outcomes effect*, where different outcomes are arranged for different types of correct remembering responses. The differential outcomes effect is well-established in non-human animal research (White & Sargisson, 2015). In a delayed-matching-to-sample task, for example, animals see a sample stimulus (often a red or a green light) and, after a delay, choosing the stimulus that matches the sample is reinforced.

In a differential-outcomes delayed-matching-to-sample task, correct red responses might result in a larger reinforcer than correct green responses. White and Sargisson (2015) showed that arranging differential outcomes at single delays increased pigeons' remembering accuracy at those delays. The differential outcomes effect has also been demonstrated in remembering tasks with typically developing children (Estévez et al., 2003), older adults (López-Crespo et al., 2009), and persons with Alzheimer's disease (Plaza et al., 2012), among other populations. A recent meta-analysis found significant medium-to-large effects on overall accuracy, test accuracy, and transfer accuracy (generalization to novel stimuli) across 60 differential-outcomes-effect experiments with humans, with larger effects in clinical populations (McCormack et al., 2019). A practitioner could make use of these findings by reinforcing correct remembering behavior of one type with a different reinforcer to remembering behavior of another type to potentially maximize the effect of reinforcement on remembering outcomes.

Summary

While remembering has often been viewed from the cognitive perspective of fading traces and retrieval of copies from memory stores, behaviorists have argued that remembering is a behavior no different to any other behavior. Viewing remembering as a behavior enables a practitioner to apply behavioral principles to improve remembering behavior, and, indeed, in this review, I have shown that behavioral methods are successful for this purpose. Remembering is an important target behavior for practitioners given the global aging population, and the fact that remembering ability is linked to many other important behaviors.

One difficulty for practitioners in addressing the memory problems of their clients is that remembering is a covert process. The therapist or practitioner sees only the final remembering response, not the process that the person undertook to reach that response. One way to make the covert process of remembering overt is to ask the client to "think aloud" as they perform remembering tasks. Thinking aloud may allow the practitioner to identify strategies that the person is successfully using, and suggest others that could be taught. Once a baseline measurement of remembering behavior is established, the practitioner can apply any of the evidence-based behavioral techniques for behavior change. I have discussed a few here, involving antecedent, behavioral, and consequence interventions. However, a sophisticated behavior analyst should be able to adapt other behavioral interventions to assist their clients in coping with memory problems.

As published behavioral research on methods for improving the remembering behavior of target populations is sparse, I would encourage practitioners to track their progress as they introduce interventions, using robust single-subject research designs, and publish their findings to assist future behavior analysts in this fascinating area of behavior.

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55 Picture-Based Communication

Rocío Rosales and Jack F. Blake

Introduction

One of the defining characteristics of autism spectrum disorder (ASD) is difficulty with social interactions and communication (American Psychological Association, 2013). These characteristics are manifested in many ways but may include challenges in understanding or responding to social cues (i.e., eye contact and facial expressions), back-and-forth conversation, and communicating basic wants and needs. These challenges in functional communication can result in the development of undesirable behaviors such as tantrums, aggression, and self-injury. Teaching communication of basic wants and needs is often referred to as "mand training" in line with B.F. Skinner's (1957) *Verbal Behavior* and is recommended as an early target in behavioral intervention programs (Sundberg & Michael, 2001).

In their seminal study on functional communication training (FCT), Carr and Durand (1985) clearly showed the relationship between self-harmful behavior and deficits in communication. Their research showed that teaching socially appropriate communicative acts resulted in the reduction of unwanted behaviors. The study included an assessment to find specific situations when unwanted behaviors of four students with developmental disabilities occurred. Following this assessment, participants were taught an alternative form of communication to request specific reinforcers related to the occurrence of the unwanted behavior. For example, if a participant emitted unwanted behavior during work situations, they were taught to vocally request teacher assistance (e.g., "I need some help"). The functional communicative response successfully decreased occurrence of each student's undesirable behavior.

Reviews of the research on FCT have continuously shown the efficacy of this teaching procedure for reduction of unwanted behaviors (Durand & Moskowitz, 2015; Heath et al., 2015). When individuals with ASD cannot communicate their basic wants and needs through vocal verbal behavior, a variety of augmentative and alternative communication systems (AACs) can be used to set up a functional communicative repertoire. AAC modalities include sign language, vocal output, or speech-generating devices (e.g., iPads and tablets), and picture-based systems. Importantly, FCT includes all modes of communication (Tiger et al., 2008) although the evidence to date shows slightly favorable outcomes for verbal and aided AACs (e.g., picture-based

Chapter to be included in *Applied Behavior Analysis: A Comprehensive Handbook.* Department of Psychology, 850 Broadway Street, Lowell, MA 01854-3059.

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_55

systems and speech-generating devices) compared to unaided AACs (e.g., sign language; Heath et al., 2015).

Several variables should be considered in selecting a communication modality including the response effort required of the learner, learning histories correlated with presence of a specific communication modality, the likelihood that communicative acts will be reinforced in the learner's natural environment (Heath et al., 2015), as well as pre-requisite skills and learner preference (Valentino et al., 2019). To date there is little experimental research to guide modality selection by practitioners. Although more research is needed in this area, there is a large body of evidence to support the widespread use of picture-based systems for learners with ASD. This chapter will highlight the evidence base for this form of augmentative communication.

Picture Exchange Communication System

The Picture Exchange Communication System (PECS; Bondy & Frost, 2011) is a well-recognized picture-based communication system with robust empirical support. PECS was developed to teach learners to initiate communication and thereby promote independent communicative acts (Bondy & Frost, 1994). PECS is comprised of six phases that are taught in sequence. The goal of Phase 1 is to teach "how to communicate" by initiating an independent single picture exchange with an adult trainer who is deemed the listener or "communicative partner" (Frost & Bondy, 2002). The goal of Phase 2 is to teach "distance and persistence" and expands the use of single picture card exchanges to require the learner to travel first to the communication binder, and then to the communicative partner across various settings. Phase 3 teaches discrimination between picture icons primarily through error correction procedures. It is divided into two phases—Phase 3A teaches the learner to discriminate between a preferred and a non-preferred item, while Phase 3B teaches discrimination between two preferred items. Importantly, it is not until Phase 3 that multiple picture icons are presented to the learner on their communication book. Phase 4 teaches the beginnings of simple sentence construction; Phase 5 teaches the learner to respond to the question "What do you want?" and Phase 6 teaches commenting with various expansions such as use of attributes (Bondy & Frost, 2011; Frost & Bondy, 2002). PECS benefits from a robust line of research showing its efficacy in teaching an alternative form of communication for learners with ASD (Ganz et al., 2012).

Learner Outcomes

PECS was designed to be accessible to users who struggle with reliable pointing, imitation, and other behavioral basics of functional communication. The primary benefit for learners who successfully use PECS is development of these core functional communication skills. Ancillary benefits that have been noted in the literature to date include a reduction in unwanted behaviors, increase in *initiating* communication, development of simple sentence construction, spontaneous communication, generalization of responses, and increases in mean length of utterance (Bondy, 2001; Ganz et al., 2012). According to Bondy (2001) most children who start using PECS before age six and use the system for more than a year will develop speech (vocal verbal behavior) as their sole communicative modality with 80–120 icons; while other individuals need much larger icon representations before vocalizations begin to emerge.

An early comprehensive study by Charlop-Christy et al. (2002) taught three minimally verbal boys with ASD (aged 3–12 years old) all six phases of PECS. Participants showed proficient performance in all phases and several other functional communicative skills emerged including spontaneous speech (during Phase 4), imitation in play and academic settings, social-communicative behaviors (i.e., joint attention), as well as reductions in unwanted behavior (i.e., tantrums, grabbing, disruptions, etc.). The development of spontaneous speech is a particularly important outcome of this study. Other researchers have reported similar outcomes in vocal verbal behavior for learners who achieve proficiency in Phase 4 of PECS (Bondy & Frost, 1994: Ganz & Simpson, 2004; Tincani et al., 2006).

Tincani et al. (2006) examined the effects of PECS on the manding and speech development of two school-aged children with ASD. In this study, experimenters varied the training by delivering verbal feedback when the child emitted a vocalization in one condition, and no verbal feedback for child-produced vocalizations in a second condition. The verbal feedback condition resulted in differentiated outcomes for speech production (only following proficiency in PECS Phase 4). The increase in vocalizations following delivery of verbal feedback suggests this was a function of the explicit reinforcement provided by the experimenters in this study. These findings suggest that prompting and reinforcement procedures that target speech may be necessary to produce such increases, and without such procedures the increases in speech production may be less likely.

In a larger outcome study, Carr and Felce (2007) evaluated the impact on learner outcomes for 41 children with ASD (ages 3–7 years old) who received 15 hours of PECS instruction (Phases 1–3) compared to a group of children who did not receive PECS instruction. Results showed a significant increase in the persistence, spontaneity, and generalization of communicative initiations for the children who received PECS training. The generalizability of PECS outcomes (across objects, activities, environmental settings, and people) was a particularly noteworthy outcome of this study since reports of generalization are not widely reported in the literature (Ganz et al., 2012).

Carré et al. (2009) evaluated the generalizability of PECS Phases 1–3 from a training setting to classrooms and homes for three 5- and 6-year-old children with ASD. The participants received one-on-one PECS training modified to enhance generalization outcomes. These efforts to enhance generalizability included briefing sessions with teachers and teacher aides during regular intervals to ensure that all communicative partners understood how to respond promptly and consistently to picture symbol exchanges, as well as the importance of making communication materials accessible to children throughout the school day. Child participants of this study showed consistent use of PECS in the classroom, but minimal communicative acts in the home. There was also considerable variation in spontaneous PECS requests across both settings. Results of this study showed the need for intervention that incorporates features of a new communicative environment (e.g., typical communication partners and contexts) to systematically program for generalization.

Some recent studies have reported generalization outcomes including learners successfully using PECS to communicate access to items not directly trained (Marckel et al., 2006), in novel settings (Greenberg et al., 2012), and with novel communication partners (Tincani, 2004, Tincani et al., 2006). Greenberg et al. (2012) evaluated the effectiveness of a train and probe generalization assessment technique following each of the first four phases of PECS implementation. Specifically, generalization of use of PECS was measured across various settings (i.e., a center playroom area, a convenience store found in the nearby community, and the living room and other central in-home areas of each participant). The train and probe procedure was effective for three of the four participants included in the study. The researchers note procedural details of the generalization probes may have contributed to these positive outcomes. First, access to the highly preferred items was limited for the duration of the study. Second, the preferred items were visibly shown to the participants on a timed-interval schedule to evoke a response. Future research should evaluate these contextual variables that may contribute to positive generalization outcomes.

Peer Involvement Another important learner outcome of PECS is interaction with peers. Functional communication training directed at peers is a vital component of behavioral language interventions. This type of training gives learners an opportunity for social interactions that may lead to developing friendships. Training directly with peers is also important to address unwanted behaviors where peers are involved. For example, if another child is playing with a preferred item, the target child should be taught a socially acceptable response to request access to said item. In addition, pairing peers with access to preferred items may increase the reinforcing value of these social interactions and in turn condition peer interactions as reinforcers (Kodak et al., 2012).

Paden et al. (2012) evaluated the effects of a treatment package to increase peer-directed mands for preferred items using PECS among two boys with ASD. Once participants learned to use PECS with adults, requests directed towards adults were no longer reinforced, but participants were prompted to direct the same request to a peer who was prompted by the adult trainer, as necessary, using a least to most prompting hierarchy. Results showed an increase in frequency of peer-directed mands for leisure items, which also resulted in brief social interactions with peers (e.g., playing together with a toy). These results were replicated and extended by Kodak et al. (2012) who showed generalization of peer-directed mands to novel peers and to a novel setting. Doherty et al. (2018) further extended these results by evaluating the effects of a systematic prompt fading procedure on rates of independent peer-directed mands in six boys (ages 3–5 years old). The measures included some participants initiating communication and others responding appropriately to communicative bids by a trained peer. Generalization and maintenance probes showed overall positive lasting effects of this training.

Although these collective results are promising, more research is needed on the generalization and maintenance of peer-directed mands. As noted above, this line of research is important given the social validity and direct potential benefits of increased social interactions for both the learner and the peers learning to communicate with children with ASD. Future research on this topic should replicate and extend the procedures outlined in these studies. For example, demonstrations for peer-directed mands that expand into later phases of PECS (e.g., beyond Phase 4) are needed, as well as evaluation of the components necessary to support these skills in the absence of adult mediation.

PECS Adaptations A unique feature of PECS is its flexibility and adaptability for a variety of learners (Frost & Bondy, 2002). The developers of PECS outline many ways this communication system can be modified to meet the needs of learners with a variety of disabilities, but demonstrations of these adaptations have not been widely published. Malandraki and Okalidou (2007) report a successful adaptation of the PECS protocol for a 10-year-old with ASD and bilateral sensorineural profound hearing loss (i.e., deafness). Over the course of a 4-month intensive training program, the learner was taught to use PECS up to Phase 4, followed by a less intensive 4-month maintenance program and 6-month follow-up assessment. Modifications to the PECS protocol accounted for the participant's hearing loss and potential writing abilities. For example, he showed spontaneous writing once and finger-spelling of 31 words during an informal assessment, thus PECS picture cards were replaced with written cards. The participant emitted his first *spontaneous* vocalizations during the generalization of Phases 4 and 5; and follow-up probes showed the participant maintained spontaneous requesting and responding to requests in both written English and Greek sign language. Collateral responses included increases in eye contact, sitting with other children in a common-room, and interacting with other children during play.

Another demonstration of adaptation of the PECS protocol was reported by Lund and Troha (2008). These researchers used tactile symbols (i.e., three dimensional objects) to teach Phases 1-3A of PECS to three blind adolescents with ASD (12–17 years old). Referents included computers, rain sticks, and crash pillows represented with a combination of craft supplies (e.g., plastic, fabric, masking tape) and household items (e.g., grains of rice, marbles) and placed on 3 × 3 in. squares of cardboard. These items were then attached to a 4 × 8 in. Plexiglas board with Velcro to create the modified PECS communication board. Other modifications included limiting the instruction team to two individuals and the total daily number of trials for Phases 1 and 2 to account for time constraints and the unique obstacles presented by the participants' disability. One participant successfully completed all three phases of the modified PECS instructional program in under one month, while the other two showed notable improvement from baseline. All participants' rates of progress resembled those of sighted children using PECS. This demonstration suggests that tactile symbols can be incorporated into a PECS protocol to teach manding to children with ASD who are also blind.

Finally, Bracken and Rohrer (2014) assessed the effectiveness of an adapted form of PECS to increase independent requesting in deafblind adults with intellectual disabilities. PECS cards were created to accommodate the individual needs of each participant. This included use of enlarged photographs and swelled images created on raised line drawing paper. Participants were successfully taught to use PECS up to Phase 3 and generalized responding to different settings and with multiple communicative partners. Further research is needed to better understand the suitable AAC modalities and protocols for individuals with ASD and visual impairments or other forms of multiple disabilities.

Caregiver Implementation of PECS

In addition to learner outcomes, it is important to evaluate measures of treatment integrity for implementation of PECS. As a demonstration for the need to train caregivers on correct implementation of this popular augmentative communication system, Jurgens et al. (2012) asked 12 families to upload a series of videos on YouTube to show their in-home use of PECS for their child with ASD. Treatment integrity scores showed elevated levels of errors in several categories. For example, 61% of all observed exchanges included use of a vocal or gestural prompt by the communicative partner, an open hand prompt error, lack of timely reinforcement, and/or incorrect implementation of the 4-step error correction procedure during Phase 3 of PECS. These results highlight a need for specific training in the implementation of PECS. Fortunately, several studies have evaluated various training approaches for the implementation of PECS by parents (Alsayedhassan et al., 2016) as well as practitioners and education professionals who work directly with children and adults with ASD (McCoy & McNaughton, 2019).

Rosales et al. (2009) evaluated the use of a behavioral skills training (BST) package to teach implementation of the first three phases of PECS to two undergraduates and one graduate student with no prior training in the implementation of PECS. The training package consisted of written and verbal instructions, modeling by an expert trainer, practice with a confederate learner, and verbal feedback provided by the trainer until participants met a predetermined mastery criterion for each phase of training. Training sessions were conducted with a confederate and generalization probes were conducted with an adult with developmental disabilities that had no prior experience using PECS. All participants acquired predetermined performance levels on the implementation according to a treatment integrity checklist developed for the study. The overall effectiveness and efficiency of this three-hour training package provides trainers with a practical model for teaching individuals who have limited experience working with people who have ASD and other developmental disabilities. Results of this study were replicated by Homlitas et al. (2014) with three teachers who worked directly with young children with ASD.

Ganz et al. (2013) evaluated the impact of "instructional coaching" on implementation of PECS Phases 1–4 with three practitioners who worked with 3–4-year-old children with ASD and language delays. The coaching included a group workshop training (i.e., verbal explanation and review, practice, goal-setting, and guided implementation), as well as instruction to supply increased opportunities for clients to emit requests using PECS. Therapists showed an increase in providing PECS opportunities by ensuring the communication book was within 5 ft. of the child and enticing them with gestures or superimposition. Clients showed a corresponding increase in usage of PECS, but results did not generalize to a novel context. These results indicate a workshop alone may be insufficient in supporting the generalization of target behaviors in practitioners and their clients with consistent treatment integrity. Further research is needed to decide how direct training models can be modified for successful implementation and long-term maintenance.

Hill et al. (2014) taught PECS data collection and implementation (Phases 1–4) to three preservice teachers and staff with education and experience in special education but no prior direct experience with PECS. Researchers examined treatment fidelity in an extended school year (ESY) setting and student progress over the 4-week experiment. Training included modeling procedures across six 3-hour sessions with practice and feedback components, while implementation consisted of two teachers, one serving as the physical prompter and another as the communication partner, per student. Teachers showed successful communication using graphs of student progress with parents at the conclusion of the summer program. Follow-up observations in the three students' schools the following school year showed successful generalization of functional communication skills, though students progressed at uneven rates. These results show that teachers with no prior experience in PECS data collection or implementation can be taught both in a classroom setting with high fidelity through a practice- and feedback-based instruction program, and that their students can in turn make progress in their independent requesting in a short timeframe. Future research should incorporate more learner outcomes (i.e., measure of emerging vocalization and words, reductions of any unwanted behaviors, and spontaneous initiations).

Parent implementation of PECS is also vital to the ongoing maintenance of functional communication. Park et al. (2011) examined the effects of a mother-implemented PECS protocol for Phases 1–3B on the independent picture exchange of three children with ASD (2–3 years old). Each mother received 40- to 60-min training sessions that included written instructions, a video model of each phase to be trained, an opportunity to practice the role of communication partner, and feedback by the experimenter. All parent participants met or exceeded the criterion for correct implementation of PECS Phases 1–3B. Child participants increased their use of independent picture exchanges, generalized their use of PECS to different communication partners, and maintained the skills acquired for at least 1-month post-training. Notably, all mothers also reported high levels of satisfaction with the goals, procedures, and outcomes of the study. Researchers hypothesized that the children's rapid acquisition of functional communicative behaviors via PECS may be attributed to their training in naturalistic settings with familiar communication partners.

Recently, Alsayedhassan et al. (2020) investigated the effectiveness of a BST package (i.e., written and verbal instructions, modeling, role play, and feedback) to teach two parents to implement PECS with their 3- and 8-year-old children with ASD (one child per family). The researchers delivered formal PECS training to the parents in both university and in-home settings using a bug-in-ear device to deliver immediate verbal feedback; they then measured the parents' percentage of correct PECS implementation in Phases 1–3. Researchers also measured the percentage of correct exchanges by the children. Results of the study showed parents learned implementation quickly and the children mastered the respective levels of PECS in few sessions. Importantly, probes for generalization and maintenance also showed promising results for independent manding via PECS by the child participants.

The use of BST to train implementation of PECS is effective but can be time consuming in terms of the expert trainer supplying direct teaching to all participants. The demand for well-trained service providers who work directly with individuals with ASD calls for the development of efficient training methods as alternatives to face-to-face training. To address the limitation of the need for an expert trainer for all trainees, follow-up studies have evaluated the use of pyramidal training (Martocchio & Rosales, 2016), voice-over video modules (Martocchio & Rosales, 2017), and computer-based training (Rosales et al., 2018). The use of these asynchronous training methods helps to address the challenge associated with training methods that require the presence of an expert trainer and may also help increase accessibility to systematic training on the implementation of PECS and other behavioral intervention procedures (Gerencser et al., 2020). A review of asynchronous training methods revealed only one study (McCulloch & Noonan, 2013) that focused on "mand training" employed this form of training. Future research should focus on replications and extensions of the work that has been conducted using asynchronous training for various other behavioral intervention procedures as it can be adapted to teach implementation of PECS or other functional communication systems in general.

Comparison of PECS to Other AACs

Studies that have directly compared the use of PECS to other forms of AACs have reported mixed results. For example, Boesch et al. (2013) found no significant difference between PECS (Phase 1) and a speech-generating device (SGD; standard 5-button Logan ProxTalker) in terms of independent requests for edible items by the three elementary-aged participants with severe ASD. PECS was considered a more accessible choice given its portability and low cost, while the SGD offered enhanced durability with features including voice and dialect adaptability. In a similar study, Hill and Flores (2014) compared the independent use and effectiveness of PECS with Proloquo2Go AAC via the Apple iPad in three pre-school and two 9-year-old students with ASD and developmental disabilities. Results for this study were mixed whereby one participant acquired more independent initiations and independent requests using PECS, while another showed increased requesting behavior when the iPad was used. A potential confound with the use of a speech-generating device is that the auditory stimulus generated by the device may serve as a reinforcer for selecting an icon on a device. Two participants showed greater independent requests using the iPad and the final participant showed no significant differences in behavior, though she did begin saying words aloud during the PECS condition. These results suggest that low-tech intervention can be as effective as high-tech intervention during the first stages of communication development, though more research is needed to evaluate whether this transition from low-tech to high-tech is effective, and if so, when it should be implemented. Further investigation on graphic symbol iconicity, generalization across settings, and transitioning from PECS, the Logan ProxTalker, and other low and mid-technology to high technology such as the Apple iPad are also needed.

Caregiver and Learner Preference Some studies have systematically evaluated *preference* for picture-based systems such as PECS in comparison to other AACs. For example, Lorah (2016) recruited four teachers and paraprofessionals with no prior AAC training to conduct training trials using both a picture-based system (PE) and an iPad Mini with the AAC application (Proloqu2Go). Participants were exposed to a multi-component training package that included verbal prompting, time delay prompting, graduated guidance, and differential reinforcement. Measurements of teacher fidelity of implementation and acquisition of independent manding suggested no significant difference in treatment methods, but preference evaluations for students and teachers alike showed a general preference for the iPad-based SGD. While the positive reception of Proloqu2Go among elementary-aged students may simply be due to it being a well-liked consumer device overall, preference among teachers is especially important given their position as the stakeholders of this technology. In summary, the literature to date shows an overall preference for speech generating devices by caregivers, but the nature of these devices with appealing voice-output features and applications that serve functions other than communication need to be considered as potential confounds (Couper et al., 2014). A critical next step in this research is to focus on best practices for individualizing selection of AAC modality by incorporating learner preference.

Van der Meer et al. (2012) compared acquisition, maintenance, and preference for three AAC modalities (i.e., a speech-generating device, a picture-exchange, and manual signs) by four children with developmental disabilities. Participants were taught to mand for preferred snacks and toys using one of three modalities. Preference for use of a modality was evaluated and showed that three of the four participants selected the SGD most often, while one participant selected the picture exchange. LaRue et al. (2016) also evaluated learner preference for AAC modality (card touch, manual sign, or vocal approximation) and found that all three participants acquired labels most rapidly using their preferred modalities. Although the results showed a clear preference for a single modality and this preference corresponded with how quickly learners acquired use of the AAC modality (i.e., participants selected the modality they had acquired in the fewest trials), this study did not incorporate use of PECS, but rather taught a card touch. Finally, Valentino et al. (2019) examined the use of a brief prerequisite assessment to predict the effectiveness and rate of acquisition of mand training for three modalities (sign, picture exchange, and vocalizations) in 13 young children with ASD. In this study, PECS was the most effective and efficient modality for acquiring a rudimentary functional communication repertoire. Collectively, the results of these studies show that preference for communication modality may be idiosyncratic and thus should be evaluated during the preliminary stages of intervention.

Limitations of Research

As noted throughout earlier sections of this chapter, there is ample empirical support that shows the benefits of PECS for learners with ASD and limited vocal verbal repertoires. However, this research has largely focused on teaching the first three phases of PECS with few exceptions (e.g., Charlop-Christy et al., 2002). The paucity of research on implementation and outcomes for the latter three phases of PECS may be due in part to learners transitioning to electronic devices that have gained popularity and accessibility over the last decade. It is also likely that when some vocalizations start to appear, implementers of PECS shift focus to shaping vocal verbal behavior and pause the use of the aided AAC system, although this is not recommended or supported by research. Interruption of the use of PECS may lead to disadvantages in the development of increased length of utterances and complex verbal repertoires (Bondy, 2001, 2019).

In comparison to the evidence base of PECS with children with ASD, there is little research on adult learner outcomes. Hughes-Lika and Chiesa (2020) reviewed the literature of PECS implementation for adult learners and found only five empirical studies with a total of 18 participants (ages 19–52 years old). Importantly, the review showed only one participant with ASD in these studies, while the other participants had a wide range of disabilities including intellectual disability (ID), Down syndrome, and deaf blindness. Results of this review showed that PECS has the potential to teach functional communication skills to adults with difficulties in communication due to various disabilities, though further research is needed to explore such potential beyond Phase 3. Future research should not be restricted to ASD/ID in children and adolescents and instead evaluate the collateral effects and other unique aspects of PECS implementation in adults with various disabilities.

It is important to note that this paucity of research for adult learners is not unique to functional communication training or picture-based systems, but it is an area that needs to be further explored. The use of speech generating devices and the use of technology in general may be preferred for this age group, but there is limited research to show its efficacy. In addition, although voice-output devices may be *preferred* for adult learners, the transition to exclusive use of an electronic device should be done in a systematic manner. The next section of this chapter will outline recommendations for an optimal transition to electronic devices.

Use of Electronic Devices

There are many potential advantages of adopting the use of electronic devices as a form of functional communication for children and adults with ASD. Among these benefits is the decrease of social stigma that can be attached to carrying a picture board since much of the current population relies and carries at least one electronic device on their person. There are also potential disadvantages to teaching functional communication solely with the use of a voice-output device. The advantage of starting with a traditional tangible icon-based system is the step-by-step sequence for development of critical communication skills. Potential disadvantages to this system are that individual learners may acquire the functional use of hundreds of icons for their communication needs, which in turns demands a careful transition to electronic devices and other AACs without unethical skill degradation and loss of skills (Bondy, 2001).

When implementing PECS for individuals with a variety of communication problems, it is important to consider the practical and ethical risks present in distinct phases of intervention. While some learners who use PECS may develop vocal verbal repertoires, other learners may need several hundred picture icons for a complete functional communication system. Such repertoires may demand a transition to an electronic AAC. However, if the AAC leads to poor implementation, this puts at risk the communicative and social skills developed in earlier stages of training. Ethical and accessible intervention, however, holds many benefits (Bondy, 2012).

King et al. (2014) examined the acquisition of requesting skills in three 3–5-year-old children with ASD using the iPad application Proloquo2Go. Importantly, participants in this study were not taught using the PECS training protocol. Rather, after preferred items were identified via a formal preference assessment, training sessions started with a Proloquo2Go/iPad-modified PECS protocol. The AAC was effective in the development of requesting skills. All participants achieved proficiency in three of the five phases adapted from the original PECS protocol, and two of the three participants mastered the fourth phase as well. The emergence of vocal requesting in one participant and the increased frequency of vocal requesting in the other two participants also suggests Proloquo2Go can assist in the emergence of vocal verbal repertoires. These results suggest that PECS and other low-tech interventions can be adapted to high-tech applications to achieve target behaviors, as well as function as a speech-generating device.

Alzrayer (2020) also evaluated the effects of PECS Phase 4 protocol on the acquisition of spontaneous augmented requests with four children with ASD. During a natural play condition, the modified PECS protocol was used to teach participants to request access to preferred items by emitting a multisymbol message (e.g., I WANT + name of a preferred item) with an iPad as well as vocalizations. The results of this study suggest a modified PECS protocol can be successfully used to transition from a low to a high-tech communication modality. Similarly, Wendt et al. (2019) described an AAC that consists of PECS infused with the electronic SGD SPEAKall! This represents an accessible intersection between low- and high-tech intervention for the reliable development of requesting skills and of vocal verbal behavior.

Given the outcomes of these studies, the relevant question might be not whether electronic *should* be adopted, but at what point might the learner benefit from a transition to an electronic device. Bondy (2012) suggests this transition may be ideal during Phase 4 training, since this is usually also when vocal verbal behavior begins to emerge as a result of PECS. Alternatively, users may benefit not from a transition to electronic device as a sole form of functional communication, but a combination of the two modes of communication.

Alternative Picture-Based Communication Systems

Although PECS is a well-recognized communication system with robust empirical support, there are variations of picture-based systems that may also prove beneficial depending on unique learner characteristics. For example, although adaptations to the PECS protocol have been noted in prior research, learners with limited mobility in upper extremities may need to rely on eye gaze communication systems supplemented by pictures. In this case, eye gaze requires that the learner attend to a single picture or to shift eye gaze from one item ("yes") to another ("no") on a communication board or chart. Sigafoos and Couzens (1995) evaluated the effectiveness of eye gaze communication with photographs for a 6-year-old boy with multiple disabilities. The participant quickly showed spontaneous requests through eye gaze communication evaluated by the TARC Assessment Inventory (Sailor & Mix, 1975). Specifically, the participant learned to use eye gaze to select a missing item from a chart that was needed to complete a preferred activity. In the first phase of intervention, the participant was presented with a cassette tape and tape player with missing headphones. These items were supplied for 60 s only after the child requested the headphones by orienting to this item on the eye gaze chart. This procedure was repeated by omitting the cassette tape and requiring the child to request this item using the same procedure. Results of this study suggest that eye gaze can be targeted for instruction to accommodate learners with physical disabilities. There is limited research on this topic and some noted limitations to use of eye gaze for communication (e.g., cost, need for constant recalibration of the equipment, and restriction to a limited number of eye movements; Pai & Bhardwaj, 2019). Despite these limitations eye gaze technology is crucial for individuals with limited motor capabilities. A recently developed smart phone-based system known as Eye-based Alternative Communication Exchange (E-ACE; Pai & Bhardwaj, 2019) offers a promising alternative.

Other picture-based communication systems referenced in the published literature include SymbolChat (Keskinen et al., 2012) and Dynavox PCS (Nakamura et al., 1998). One of the main concerns and limitations of picture-based systems is that these do not require the learner to initiate communication with a listener (communicative partner) and this may limit *spontaneous* and *independent* communication. For this reason, an important variable to consider in deciding the efficacy of picture-based systems and other AACs is how well the system will transition to naturalistic settings. Nam and Hwang (2016) reviewed studies that evaluated the efficacy of mand acquisition using picture exchange-based and signed communication systems. Results of this review showed that children with ASD acquired picture-based systems more easily and rapidly than signed responses. Limitations of the picture-based systems noted above include required use of equipment, limited distance between listener and speaker/pictures resulting in lack of spontaneous communication or initiation, as well as difficulties with representation of abstract words.

Cultural Considerations and Adaptations

An area of recent interest for both the autism community and for applied behavior analysis practitioners is how best to adapt and accommodate ABA approaches for learners from culturally and linguistically diverse backgrounds (Lim et al., 2018; Wang et al., 2019). These adaptations necessarily apply to the use of AACs, including PECS. Yu (2018) evaluated the implications for bilingualism in the development and implementation of AAC interventions in children with ASD and reaffirmed earlier research that showed bilingual children with ASD perform on par with their monolingual peers on various language assessments that evaluated both listener and speaker behaviors, as well as social responsiveness, vocabulary size, age of first words and first phrases. Importantly, learning multiple languages is an asset beyond functional communication, including the development and maintenance of essential bonds with immediate and extended family members.

The flexibility of PECS allows for incorporation of multiple languages and the communication system has been implemented across the globe since its development (Al-dawaideh & Al-Amayreh, 2013; Hu & Lee, 2019; Odluyurt et al., 2016; Sulzer-Azaroff et al., 2009). Fahim and Nedwick (2013) examined how unique cultural and developmental circumstances of young dual language learners with ASD influence language acquisition skills and effective intervention plans. The authors distinguish between universal characteristics of ASD (e.g., poor joint attention and responding skills) from modes of communication that may be influenced by culture (e.g., gestures and facial expressions). Functional communication training can incorporate culturally relevant routines and bilingual AACs into young children's treatment plans. For example, intervention specialists may work with a child's family to incorporate words and phrases used in daily routines (e.g., greetings, bath time, mealtimes). Fahim and Nedwick (2013) discussed a case example of a family who incorporated Arabic songs, signs paired with both English and Arabic words, and verbal countdowns delivered in both English and Arabic by different family members into the intervention of a 3-year-old dual language learner with ASD. Although this paper does not specifically mention the use of PECS, integration of visual supports in two languages can be provided by including written labels in the home as well as the dominant language (e.g., English) to help promote generalization of the communication skills the child experiences across different environments (e.g., home and school).

Despite the flexibility of picture communication systems, there are features that require special attention and consideration. For example, Nakamura et al. (1998) discussed the difficulties of picture-based systems for Japanese speakers because these systems tend to be based on English sentence formation. These researchers evaluated the use of a computer-based version of the Dynavox Picture Communication Symbols (PCS) and discussed use of Bliss symbols as an alternative to the typical symbol-based sentence construction commonly used by English speakers. Chompoobutr et al. (2013) also described the importance of evaluating the choice of graphic icon symbols as these may have different meanings depending on the learner's cultural background. These authors evaluated the various semantic beliefs of graphic symbols used in the Thai picture-based communication system and in other AACs that use the Minspeak™ iconic encoding and language representative. Application among 65 Thai-speaking participants of varying educational backgrounds between the ages of 10 and 50 was assessed. Researchers emphasized the cultural factors that decide the efficacy of graphic symbols in AAC. For instance, apples are not traditionally consumed in Thailand; therefore, using an image of an APPLE to stand for a food concept can create unnecessary confusion to the learner.

Similarly, Dukhovny and Kelly (2015) outline basic guidelines for effectively designing and implementing AACs to multilingual and multicultural users with limited functional speech (e.g., age-appropriate picture symbols, gender- and language-appropriate voice options, and multilinguistic keyboards). The researchers evaluated the use of a simple phase-based application iWant™ for a Ukrainian-speaking 76-year-old man and another using the touchscreen communication aid Accent 100 for a 4-year-old Spanish-speaking boy. The success of these interventions suggests accessible and inclusive AACs include culturally relevant picture/symbol supports, a capacity for digitized speech, and multilingual synthesized voice options, keyboards, and grammatical support. However, the lack of Ukrainian grammatical support and Spanish-speaking intervention limited each participants' treatment options and long-term progress, respectively. For instance, the child's ability to generalize his English AAC skills to Spanish was limited, making his device less useful in a home setting than in an English-speaking classroom. The 4-year-old boy received AAC intervention services from exclusively English-speaking specialists. Bilingual support may aid in the successful use of the Accent 1000 device in both languages and settings. Instead, he often resorted to gestures and vocalizations to communicate with Spanish-speaking family at home. Suggestions for developing effective AAC with picture-based systems include the use of age-appropriate visuals and devices and gender-appropriate voice selection, especially for users like the elderly Ukrainian man in this case study, whose age and maturity are not often reflected in the design of AACs.

Overall, there is a need for more experimental studies to evaluate the variables that have been studied in descriptive and observational studies to date. In addition, there is a need for research on the development and implementation of AACs with age-appropriate visuals and devices as well as gender-appropriate voice selection, especially for adults with ASD and other developmental disabilities. This research will help to address optimal training strategies to implement functional communication with learners who come from diverse backgrounds. Findings from the literature to date suggest that ethical AAC practice demands informed practitioners who are capable of understanding, respecting, and collaborating with the wants and needs of their clients' families in developing more linguistically fluid and culturally relevant interventions.

Summary

This chapter reviewed picture-based communication systems with particular attention to PECS as an evidence-based AAC. This specific mode of functional communication has been shown to be an effective method for learners with ASD, although the research to date supports its use with children more so than adult learners. When compared to other modes of communication, PECS has not always been reported to be preferred by both caregivers and learners alike. Instead, the research to date shows speech-generating devices may be preferred by both groups. However, idiosyncratic results are reported in the literature and best practice suggests that an initial assessment should be conducted during the intake process to help find the ideal mode of communication for each learner (Valentino et al., 2019). Although there is a large body of support for PECS for learners with ASD, limitations of the existing research include a lack of systematic applications for all six phases of PECS, demonstrations of PECS with adult learners, and evaluation of the protocol with bilingual learners with ASD. Despite these limitations, picture-based communication systems should continue to be considered when learners with ASD do not have an established form of functional communication.

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Teaching Foreign Language

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Global communication and mobility have characterized the twenty-first century, creating social and occupational advantages for those who can communicate effectively in more than one language. In the United States, demand for such workers more than doubled between 2010 and 2015 (New American Economy, 2017). In addition to enhanced employability, learning a foreign language positively affects cognitive functioning and increases cross-cultural awareness (for a review, see Fox et al., 2019). Around the world, vast numbers of students in elementary grades and beyond receive compulsory or optional education in languages other than those spoken in their home environments. Other people learn new languages outside of formal educational systems. In recent years, a flourishing market has appeared for interactive software applications that facilitate self-study of languages; for example, Duolingo®, Rosetta Stone®, and Babble® for adults, and Dino Lingo®, Rosetta Stone Homeschool®, and Gus on the Go! for children.

Behavior analysis has a long history of considering how behaviorally based teaching procedures may be applied to foreign-language instruction (Rocha e Silva & Ferster, 1966). Nevertheless, the behavior-analytic literature on this topic is small, and sustained, systematic programs of research have yet to emerge. In this chapter, we will consider the potential value of a behavior-analytic approach to foreign-language instruction, provide a behavioral analysis of foreign-language learning, and review existing behavior analysis research on this topic.

Learning a New Language: Concepts and Terms

We will begin by introducing terms to describe the language(s) in which a person can communicate or seeks to learn, followed by a brief overview of the different components of a new language that must be mastered for effective communication.

A *native language* (L1) is a language acquired to proficiency through natural environment exposure from birth or early childhood. A *second language* (L2) is acquired subsequent to L1, typically after the earliest years of childhood, but within an environment in which the language is widely spoken. L2 is not necessarily the second language a person learns; it can also be third, fourth, etc. (Gass & Selinker, 2001). L2 may be learned as a result of moving to a new country or region, or as a result of contact with a community of speakers in one's native region. In some cases, L2 becomes a person's predominant language and proficiency of use may approximate native speakers (Forsberg

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_56

& Fant, 2010), whereas in other cases, the L2 learner gains only limited command of the L2. Persons who speak two or more languages fluently, such as two L1s or an L1 and an L2, are referred to as bi- or multilingual. Age of acquisition and amount of exposure to L2 are influential factors in L2 learning outcomes (Peñaloza et al., 2019).

Learning a *foreign language* (FL), in contrast to L2, refers to learning a nonnative language outside of the natural linguistic community (Gass & Selinker, 2001). An FL, therefore, is learned primarily through classroom instruction or self-study, as opposed to immersion in a natural language environment. A language initially learned as an FL can later become an L2, and an L2 may be partially learned through formal instruction similar to an FL (e.g., in classes for immigrants). In contrast to L2 exposure, researchers have not consistently found advantages to starting formal FL instruction in early childhood (Baumert et al., 2020). Finally, the term *heritage language* is used to describe a language to which a person has a cultural or familial connection, but did not learn to proficiency in childhood (Valdes, 2005). For example, a heritage language may be the L1 of one or more immigrant parents or grandparents, or it may be an endangered ancestral language of an indigenous population.

In this chapter, we will focus on the potential application of behavior analysis to teaching a nonnative language, whether it is taught as an FL, an L2, or a heritage language. We will generally use the term FL to describe the target language of instruction, except in the context of studies that specify L2 or heritage language instruction as a goal.

Learning a new language is a complex task. In part, the problem lies in the large amount of information to be learned. Command of the 3000 most frequent words in a language is considered essential to everyday use (Nation & Waring, 1997), and at least 5000 words are needed to read for pleasure (Hirsh & Nation, 1992). Thus, *vocabulary* acquisition is an important and time-consuming aspect of FL learning. Vocabulary alone, however, is not sufficient for effective communication. FL learners often struggle with the *grammar* of the new language, which may differ from the student's L1 in both syntax (e.g., word order, sentence structure) and morphology (e.g., word inflection). For example, an L1 speaker of English learning Icelandic as an FL might struggle with the notion that nouns can take different forms (i.e., cases) depending on accompanying prepositions or verbs. The student also needs to master the *phonology* or sound system of the new language, which involves learning to both discriminate and articulate sounds that in some cases may not exist in the learner's L1. Other aspects of vocal speech, such as *prosody* (i.e., the pattern of stress and intonation), are perhaps less essential, but enhance the intelligibility of speech (e.g., Field, 2012). Because children immersed in an L2 environment are more likely than adults to master grammar, phonology, and prosody to the point of approximating native speakers, it has been hypothesized that critical (Lenneberg, 1967) or sensitive (Oyama, 1976) periods exist for these aspects of FL learning. However, data exist that contradict the notion of a biologically determined critical period (e.g., Hakuta et al., 2003), suggesting other factors (e.g., motivational) may play a role in the difference between the typical achievements of children and adults.

FL learners also need to master the writing system of the FL, which may be either similar to or very different from that of L1. For languages that use *alphabetic* or *syllabic* writing systems (i.e., systems in which each symbol roughly corresponds to a single vowel or consonant, or to a syllable, respectively), mastery of the writing system is closely tied to the phonology of the new language. For *logographic* systems, learning to read and write may be thought of as more closely related to vocabulary learning. Finally, relevant skills may include distinguishing between formal and informal speech, learning common idioms and expressions, and learning to choose words or expressions based on one's audience (e.g., children vs. older adults, or friends vs. colleagues).

What Can Applied Behavior Analysis Contribute?

A large literature exists on FL teaching and learning, with contributions from disciplines such as applied linguistics and psycholinguistics, educational science, and cognitive psychology. Topics of research include evaluations of teaching strategies and digital technologies (see, e.g., Golonka et al., 2014), strategies for addressing barriers to learning, such as anxiety (e.g., Dolean, 2016) and lack of motivation (e.g., Taskiran, 2019), age and gender differences in outcomes of language instruction (Baumert et al., 2020), and many others. Theoretical perspectives in the literature vary, but rarely include purely behavioral perspectives. According to Castagnaro (2006), the possibility of a behavioral approach to FL or L2 instruction has often been dismissed based on two faulty perceptions: First, a fictitious association between B. F. Skinner and the audiolingual method, a formerly popular method of FL instruction that has now fallen from grace, and second, "a demonstrably erroneous notion that operant psychology is too simplistic to effectively take up language issues" (p. 519). Castagnaro (2006) noted that contemporary behavior analysis is successfully engaged in the application of its theoretical system to teaching language skills to children with language delays, and suggested it was time to seriously consider its application to FL instruction.

Behavior analysis is well equipped to contribute to the literature on FL teaching and learning for several reasons. Behavior analysis offers a conceptual system that relies on well-studied learning processes and integrates language learning and human communication with all other learning and behavior. A long tradition exists for considering how this system may be applied to understanding human language as behavior (Hayes et al., 2001; Horne & Lowe, 1996; Sidman, 1994; Skinner, 1957), and to the design of language interventions (e.g., Hart & Risley, 1975; Sundberg & Partington, 1998). The twenty-first century has seen a surge of interest in areas of research of high relevance to FL teaching and learning; that is, verbal behavior (Petursdottir & Devine, 2017) and derived stimulus relations (O'Connor et al., 2017). Thus, a community of researchers and practitioners exists that may be well positioned to tackle topics in FL acquisition.

Some characteristics of applied behavior analysis may be particularly helpful in addressing the individual variability that characterizes outcomes of FL and L2 instruction (e.g., Ehrman et al., 2003). The emphasis placed on the role of reinforcement variables in behavior analysis may be helpful in addressing motivation as a barrier to student success. More generally, the emphasis on identifying functional relations at the level of the individual may be of value for identifying appropriate instructional modifications for struggling students.

Finally, behavior analysis has a long history of application to various problems in educational settings. Pioneering work on technologies that permit automated feedback on active student responding originated in behavior analysis (Skinner, 1958), and indeed, was applied to FL learning (Rocha e Silva & Ferster, 1966). Recent developments include the integration of programmed instruction with stimulus equivalence principles (Brodsky & Fienup, 2018); an area of research that may be highly applicable to educational software development in FL instruction. Existing, commercially available FL software applications bear an interesting similarity to the program described by Rocha e Silva and Ferster (1966), though we are not aware of a direct influence. These applications additionally incorporate many empirically based strategies (e.g., Settles & Meeder, 2016). However, we have not found evidence suggesting substantial influence from research on stimulus control, verbal behavior, stimulus equivalence, or derived stimulus relations. Application of these areas of research to FL instruction could potentially serve to inform effective software design in addition to classroom instruction.

Behavioral Analysis of FL Learning

From the perspective of Skinner's (1957) analysis of verbal behavior, target behaviors in FL instruction can be analyzed in terms of elementary verbal relations (Table 56.1) and autoclitic processes. Other behavior-analytic concepts of relevance to FL acquisition include functional equivalence (e.g., Dougher & Markham, 1994), stimulus equivalence (Sidman & Tailby, 1982), and parity (Palmer, 1998). Space does not permit a detailed analysis, but in this section, we will roughly outline how FL learning may be conceptualized from a behavioral perspective.

Vocabulary

Behaviorally speaking, an FL learner has acquired an FL vocabulary word or phrase when its emission (regardless of pronunciation) is controlled by the same variables that control native speakers' emission of the word or phrase. In Skinner's (1957) verbal operant taxonomy (Table 56.1), the learner emits the appropriate response as a *tact* controlled by a class of nonverbal stimuli, an *intraverbal* response controlled by a variety of verbal stimuli, and as a *mand* under relevant conditions of deprivation or aversive stimulation. The response does not need to be vocal; verbal operants can also involve written responses, hand signs (as in sign languages), or even pointing to written words or symbols.

According to Skinner (1957), tacts, intraverbals, and mands are functionally independent operants governed by different contingencies of reinforcement, and their presence in the learner's repertoire may be a product of separate reinforcement histories, as opposed to a single "word-learning" history. In FL learning, however, relations that already exist in the student's L1 repertoire may render it unnecessary to reinforce each novel FL response topography in the presence of multiple antecedents. An English-speaking learner of German, for example, can take advantage of the fact that "Hund" is controlled by much the

Table 56.1 Skinner's (1957) verbal relations applied to a subset of target behaviors in FL instruction

Verbal operant	Controlling antecedent	Example[a]
Tact	Nonverbal stimulus	Say "agua" as a result of seeing a glass of water
Intraverbal	Verbal stimulus	L1-FL: Say "agua" as a result of hearing "water" FL-L1: Say "water" as a result of hearing "agua"
Mand	Motivating operation	Say "agua" as a result of being water deprived
Echoic (duplic[b])	Spoken word that has the same sound pattern as the product of the spoken response	Say "agua" as a result of hearing "agua"
Copying text (duplic[b])	Written word that has the same visual pattern as the product of the written response	Write AGUA as a result of seeing AGUA
Textual behavior (codic[b])	Written word that bears point-to-point correspondence, but not physical similarity, to the spoken response	Say "agua" as a result of seeing AGUA
Taking dictation (codic[b])	Spoken word that bears point-to-point correspondence, but not physical similarity, to the written response	Write AGUA as a result of hearing "agua"
Relational autoclitic	Relationships between variables currently influencing the speaker's verbal behavior	Saying "agua fría" (as opposed to "fría agua") as a result of the relationship between the stimuli contributing tact control to the utterance

[a]Examples assume an L1 speaker of English learning a Spanish (FL) word. AGUA represents the printed word and "agua" represents the spoken word
[b]From Michael (1982)

same class of stimuli that control "dog" in L1. Learning to say "Hund" in the presence of a single exemplar of a dog (e.g., a picture of a Labrador Retriever) likely suffices to acquire "Hund" as a tact under the control of the entire class of stimuli (e.g., sights of dogs, sounds of dogs, smells of dogs) that control the tact "dog," exemplifying transfer of function within a class of functionally equivalent stimuli. Alternatively, learning to say "Hund" in response to L1 "dog" or even to say "dog" in response to "Hund" may suffice to establish appropriate tact control over "Hund" (e.g., Dounavi, 2014), as well as corresponding listener behavior, such as scanning the environment for a dog upon hearing "Hund" (e.g., May et al., 2016). In this case, establishment of a single intraverbal relation between an FL and an L1 vocabulary word produces tact and listener relations involving classes of nonverbal stimuli in the absence of any directly experienced relation between the FL word and the nonverbal stimuli. Exactly how to explain such effects is a matter of theoretical debate that will not be reviewed here. Operationally, however, they might be said to exemplify expansion of existing equivalence classes that include the various nonverbal stimuli and the L1 word (Joyce et al., 1993). Relations that emerge in this manner without being taught directly are usually referred to as emergent or derived relations.

Skinner (1957) suggested an adult's verbal (L1) repertoire contains vast numbers of intraverbal relations in which each verbal response form is controlled by many different verbal stimuli, and each verbal stimulus controls multiple intraverbal responses. Once equivalence relations are established between a multitude of FL and L1 words, intraverbal relations in L1 can likely transfer to the foreign language. For example, once "Hund" and "Katze" are related to "dog" and "cat," the learner might emit "Katze" as an intraverbal response to "Hund" or vice versa under conditions similar to those that evoke corresponding L1 intraverbal relations.

Of course, there are many instances in which an exact correspondence does not exist between controlling variables in L1 and an FL. An English-speaking learner of Icelandic, for example, will find the class of stimuli related to "kanna" to include both stimuli that control L1 "mug" and stimuli that control L1 "pitcher." Such non-correspondences may be even more prevalent in the case of abstract words that have no tangible referents. In these cases, the FL learner may rely on rules, or interactions with native speakers may gradually produce the appropriate stimulus classes via contingency learning. These processes may be slow and imperfect, however—the first author lived in an English-speaking (L2) country for many years before grasping the full range of vessels that control native speakers' emission of "cup."

Grammar and Syntax

Skinner (1957) provided an analysis of grammar and syntax that relied in large part on the concept of *autoclitic behavior*; verbal behavior that serves to adjust the effects of a speaker's other verbal behavior on the listener based on the strength or other properties of variables currently affecting the speaker. As an example, the "I think" in "I think I heard thunder" is a descriptive autoclitic that conveys weakness of control by the auditory stimulus that evokes "thunder." The verbal community reinforces inclusion of autoclitics in verbal utterances because they permit the listener to react more effectively to a speaker's verbal behavior. Applied to grammar and syntax, Skinner (1957) pointed out that these important characteristics of language may be thought of, in part, as serving autoclitic functions. The order in which verbal responses are emitted (i.e., syntax) is a relational autoclitic controlled by relationships between variables currently affecting the speaker's verbal behavior (Table 56.1), serving to fine-tune the effects of the verbal utterance on the listener. Similar functions are served by many instances of morphological inflections.[1] Skinner (1957) emphasized that whereas autoclitic control is the source of grammatical conventions, it need not be present in every grammatical utterance. With experience, responses like "the milk is in the refrigerator" may become functional units under tact or intraverbal control without an autoclitic component. Additionally, Skinner (1957) emphasized that although autoclitic functions are acquired through social reinforcement, it is not the case that every grammatical utterance must be a product of direct reinforcement. Instead, through reinforcement of multiple exemplars, we acquire autoclitic, grammatical *frames* of speech into which novel responses can be inserted as they come to strength (e.g., as tacts).

Numerous efforts have also been made to analyze grammatical behavior in terms of stimulus equivalence, functional equivalence, and contextual control over equivalence classes (e.g., Chase et al., 2008; Green et al., 1991; Mackay, 2013). For example, syntax acquisition has been interpreted in terms of transfer of ordinal functions (i.e., the order in which stimuli are placed) through equivalence classes that roughly correspond to grammatical categories like "subject," "verb," and "object" (e.g., Green et al., 1991).

In addition to the reactions of listeners as a source of reinforcement for verbal behavior, another source of reinforcement that has been proposed to explain the acquisition of some aspects of grammar and syntax (as well as other aspects of speech, such as pronunciation and prosody) is automatic reinforcement by *parity* (Palmer, 1998). Parity is detected when the products of one's own speech sound similar to that of other speakers, and serves as a reinforcing event. Learning to speak grammatically, from this perspective, is similar to learning to pick out a tune on the piano: Attempts that *sound right* are repeated and those that do not drop out. Reinforcement by parity has been used to explain findings such as the effects of modeling on children's grammatical utterances (e.g., Østvik et al., 2012). In the context of FL instruction, parity might be involved in the superior FL achievement observed among students who watch subtitled FL television and films in daily life, compared to those who watch material that is dubbed in L1 (Almeida & Costa, 2014).

Whereas behavior-analytic accounts of grammar emphasize the role of direct-acting reinforcement contingencies in L1 grammar acquisition, FL learning in formal settings likely relies heavily on rules that describe relations between grammatical constructions in the student's L1 and the FL under study. For example, L1 English speakers in a Spanish FL class may be exposed to the rule that in Spanish, the noun comes before the adjective, before they directly contact any social or automatic reinforcement contingencies involving Spanish word order.

Phonology, Reading, and Writing

Unlike the process by which L1 is learned, students learning FL in formal instructional settings are often exposed to reading and writing from the beginning of instruction. When learning languages that use alphabetic or syllabic writing systems, learning FL reading and writing is closely tied to learning the phonology of the FL and can be said to involve acquisition of *duplic* and *codic* (Michael, 1982) verbal relations (Table 56.1). In duplic relations, the product of a verbal response is a copy of the stimulus that evoked it. Duplic behavior includes the *echoic* (Skinner, 1957); in which the speaker vocally reproduces a prior stimulus. Although most FL students likely possess generalized echoic repertoires in L1, the phonology of an FL will in most cases include sounds that do not exist in L1 and the student may not be able to echo accurately without instruction. Another type of duplic repertoire is copying text. When an FL uses the same alphabetical writing system as L1, the FL student is likely to already have a relevant text-copying repertoire that can then be used for prompting additional written responses. However, learning a

[1] In some instances, according to Skinner (1957), morphological inflections may be under tact rather than autoclitic control, as when the presence or absence of the English plural -*s* ending is controlled by the number of objects perceived.

new writing system, such as when an English L1 speaker is studying Arabic, may necessitate practicing copying text. In codic behavior, the form of a verbal response is also under strict control by an antecedent stimulus, but instead of duplicating the stimulus, the response converts the stimulus to a different form. An example is *textual behavior* (Skinner, 1957), in which written text exerts precise control over the vocalizations of a person reading out loud. In FL classrooms, it is common to teach FL phonology in the context of textual behavior and letter-sound correspondences. Learning to spell FL words involves another codic repertoire of *taking dictation* (Skinner, 1957) in which the speaker converts spoken words to writing. Establishment of codic relations, of course, is only a first step toward reading an FL. Reading with comprehension (i.e., responding to text as a listener) also necessitates vocabulary and grammar.

Stimulus equivalence also may be thought of as contributing to acquisition of FL reading and writing. From this perspective, a written FL word ultimately enters an equivalence class together with the spoken FL word, the spoken L1 word, the written L1 word and, if applicable, the nonverbal referent. In a basic stimulus equivalence paradigm, each equivalence class member must be linked to at least one other class member through direct experience. However, once the FL student has acquired codic repertoires with respect to spoken and written words, it should be the case that only one FL stimulus (i.e., either spoken or written words) needs to be explicitly linked to an existing class member in order for both stimuli to join the class.

In the case of logographic writing systems, such as Chinese, learning FL reading and writing is similar to vocabulary learning. Ultimately the student must be able to tact each logogram in both L1 and the FL, and respond as a listener to L1 and FL spoken words by writing logograms. This process can also be analyzed in terms of equivalence class expansion, in which the logogram enters an existing equivalence class that includes L1 spoken and written words and may or may not already include the spoken FL word.

Behavior-Analytic Research on FL Teaching and Learning

As we have outlined, well-studied concepts that include elementary verbal relations, stimulus equivalence, and derived stimulus relations are available to support a behavioral analysis of FL acquisition. Other relevant concepts, such as autoclitic processes applied to grammar, are less well studied (Petursdottir, 2018). Nonetheless, substantial work has historically been done in applied behavior analysis on teaching L1 grammatical functions to children with neurodevelopmental disorders (e.g., Garcia et al., 1973; Guess et al., 1968). We will now turn our attention to the small portion of the behavior analysis literature that has explicitly addressed FL teaching and learning.

To our knowledge, Rocha e Silva and Ferster (1966) were the first to address FL acquisition from a behavior-analytic perspective. They evaluated an automated program for teaching grammatical functions of the German (FL) language to college students who spoke English as L1, drawing substantially on Skinner's (1957) verbal behavior analysis to articulate potential sources of strength for correct responses in each trial. Instruction was conducted in matching-to-sample (MTS) format and presented on a specialized teaching machine. In each trial, the student was presented with a sample consisting of a picture, German text, a spoken instruction in German, or a combination thereof. The student then selected a response from among several textual or pictorial comparison stimuli. Prompts were used when new content was introduced, and later withdrawn. The program began with basic vocabulary instruction and quickly moved to sentence construction, addressing grammar and syntax as new vocabulary continued to be introduced. Pronunciation was not taught directly, as it was assumed that automatic reinforcement by parity would be the primary influence on pronunciation development (p. 95). Progress through the program was, indeed, accompanied by increasingly accurate pronunciation, and after 14–18 h of instruction, the students were able to have simple conversations and write paragraphs of original text.

Roche e Silva and Ferster's (1966) study remains unparalleled as an evaluation of a comprehensive, behaviorally based program addressing essentially all components of FL learning. Subsequent research has focused more on isolated details of the learning process, such as the conditions under which FL tact and intraverbal relations emerge without instruction, and instructional variables in specific FL learning tasks. We will review this research in the sections that follow,[2] beginning with and devoting the most space to emergent relations in FL vocabulary learning, which has been the topic of a majority of all recent studies.

Emergent Relations in FL Vocabulary Learning

Studies on emergent relations in FL vocabulary learning have utilized both verbal behavior and stimulus equivalence frameworks to analyze teaching outcomes. We will begin by considering studies in which instruction has targeted specific FL relations, followed by assessment of the emergence of untaught relations and sometimes interventions to promote that outcome. Next, we will review studies that have examined how the type of directly taught relation influences emergent relations. Finally, we will consider potential benefits of capitalizing on emergent relations in FL vocabulary instruction.

Demonstrating and Promoting Emergent FL Relations

In the first study to examine derived relations in FL vocabulary instruction (Joyce et al., 1993), two English-speaking (L1) adolescents with memory impairment following traumatic head injury received computerized Spanish (FL) vocabulary instruction arranged according to stimulus equivalence principles. For each of 20 target nouns, five stimuli were included in assessment: A picture of the noun referent, the spoken and written L1 word, and the spoken and written FL word. Pre-assessment suggested the participants' L1 repertoires included relations between all nonverbal referents and the corresponding L1 spoken and written words. One participant was also proficient at matching written FL to spoken FL words. However, neither participant could match spoken or written FL words to spoken or written L1 words or to referent pictures. Instruction consisted of MTS conditional discrimination training. For one participant, FL written words served as sample stimuli and referent pictures (four per trial) as comparisons. For the other, pictures served as samples and FL written words as comparisons. Post-assessment revealed 90% or better accuracy for all relations among the five stimuli. This included performance in trials in which the spoken FL word was presented as an antecedent stimulus or requested as a vocal response from the participant, in spite of the spoken FL word not being included in training at all. Today, the approach exemplified in this study is often referred to as equivalence-based instruction (EBI).

In a similar vein, Petursdottir et al. (2008) taught Spanish (FL) nouns to five-year-old children who were native speakers of Icelandic (L1). Written words were not included in instruction; instead, each L2 target word was represented by relations between the referent picture, the spoken L1 word, and the spoken FL word. Although the aim of the study was to investigate emergent intraverbal responding in children, and not to address FL learning per se, we describe it here as a simple example of a study in which some of the trained relations involved vocal responding instead of MTS. Specifically, two of the four participants received FL tact instruction in which they were taught to vocalize each FL word when presented with the referent picture, whereas the other two received MTS listener instruction in which they were taught to select pictures given spoken FL words. All participants demonstrated

[2] To identify studies for review, we conducted a literature search using PsycINFO, Google Scholar, and websites of behavior analysis jurnals, using the keywords "foreign language," and "second language" combined with "behavior analysis" (except on journal webpages). We included all studies that directly addressed a topic related to FL teaching using behavior-analytic concepts and terms.

emergence of two types of intraverbal relations; L1-FL intraverbals (vocalizing the FL word in response to the L1 word) and FL-L1 intraverbals (vocalizing the L1 word in response to the FL word). However, the participants who received tact instruction responded with greater overall accuracy than the participants who received listener instruction.

Several other studies have employed similar methodologies to demonstrate derived relations in FL vocabulary learning, and extended this research to children for whom FL learning was a culturally important goal. May et al. (2016, 2019) taught Welsh (L2 or heritage language) nouns to children residing in Wales who spoke English as L1. In the first study (May et al., 2016), three preschool-age children were taught L1–L2 vocal intraverbal relations, and subsequently demonstrated emergence of L2 tacts and listener relations. In the second study (May et al., 2019), five- and six-year-old children received group-based L2 tact instruction. Three of six participants demonstrated robust increases in both L1–L2 and L2–L1 intraverbal responding, whereas results for the other three participants varied across stimulus sets. In a study by Haegele et al. (2011), participants were Native American pre-kindergarteners who spoke English as L1, but received classroom instruction in an endangered heritage language (Ojibwe for some students and Dakota for others). Computerized MTS instruction was used to teach the students to select both two-digit numbers and written number words in the heritage language when presented with spoken L1 words as samples. Emergent relations were then demonstrated between the numbers and the heritage language number words. Participants who received EBI substantially outperformed control participants from the same classrooms who, meanwhile, received classroom instruction in the heritage language as usual. No relations involving spoken words or vocal responses were tested, however.

Not all studies have shown such consistently positive results. Rosales et al. (2011) taught English (L2) nouns to four preschool-age children who resided in the United States but spoke Spanish as L1. Participants initially received L2 listener instruction in MTS format, following which they showed minimal emergence of L2 tacts, with variable improvement after additional, remedial listener instruction. Next, the researchers implemented multiple-exemplar instruction (MEI) to examine if directly teaching both L2 listener relations and tacts for several new L2 words would promote emergence of L2 tacts for the originally taught words. Although additional improvement was observed, it was not consistent across participants or stimulus sets. Petursdottir et al. (2014) similarly found FL listener instruction did not produce FL tacts and intraverbal relations to criterion for English-speaking (L1) children of preschool and kindergarten age who were taught Japanese (FL) nouns. In Experiment 1, collateral response training (CRT) was implemented as an intervention. CRT involved teaching participants to respond to spoken FL words by not only selecting the corresponding referent pictures, but also echoing the FL word and saying the corresponding L1 word as they pointed to each picture. CRT was followed by criterion-level performance in FL-L1 intraverbal probe trials, but not in FL tact or L1-FL intraverbal trials. Subsequently, direct instruction on all relations with some or all of the target words produced criterion-level performance. In Experiment 2 with three new participants, partial CRT implemented from the beginning of instruction did not increase emergence of tacts and intraverbals relative to listener instruction without CRT. In summary, therefore, both studies found limited effects of listener instruction on the emergence of vocal FL responding in young children, and intervention did not produce consistent improvement.

Teaching procedures in the aforementioned studies involved differential reinforcement of correct responses, combined with prompting and prompt-fading or least-to-most prompting. Other studies have demonstrated emergent FL relations as a result of instruction in which there was no active response requirement or contingency. First, Ramirez et al. (2009) demonstrated emergent Spanish (FL) tacts and listener relations in a child who had simply observed his sibling receive

FL listener instruction. Second, two studies have examined the effects of stimulus pairing procedures in which the teacher models FL tacts without requiring a response from the student. Rosales et al. (2012) used stimulus pairing to teach English nouns to Spanish-speaking (L1) preschoolers who, as in Rosales et al. (2011), were learning English as L2. The number of times each tact was modeled was yoked to the number of MTS trials implemented in the previous study (Rosales et al., 2011). Stimulus pairing increased correct responding in L2 tact and listener probes, and two of three participants reached mastery with some sets of words. Subsequent MEI produced criterion-level performance in most cases. Interestingly, the participants in this study performed better in L2 tact probes after stimulus pairing than did participants in Rosales et al. (2011) after listener instruction. Cao and Greer (2018) also used a modeling procedure to teach Chinese (FL) nouns to preschoolers who spoke English as L1. Tacts were modeled while the participants matched identical referent pictures to one another; however, although a contingency was placed on correct identity matching, there was no requirement to respond to the FL word in any way. Two hours after each session, participants were tested for emergent tacts and listener relations. The participants initially did not perform to criterion or performed to criterion only in FL listener but not in FL tact trials. The researchers then implemented an intervention that consisted of teaching the participants to echo FL syllables. After the echoic repertoire was mastered, performance improved substantially when new L2 words were modeled. Thus, the results suggested an effective FL echoic repertoire might be a prerequisite for novel FL tacts to emerge from modeling alone.

In summary, this literature suggests that for both young children of typical development, and for adolescents with neurological impairment, derived FL vocabulary relations tend to emerge after related relations are taught, with the possible exception that listener instruction has produced inconsistent effects on vocal responding (Petursdottir et al., 2008, 2014; Rosales et al., 2011). They also suggest that, at least with certain prerequisites or learning histories in place, even young children may demonstrate emergent FL vocabulary relations simply as a result of exposure to a model (Cao & Greer, 2018; Rosales et al., 2012). Nevertheless, other research suggests that differential reinforcement is an influential factor in FL vocabulary acquisition in natural contexts (Whitehurst & Valdes-Menchaca, 1988). Additional research may be warranted on the role of response contingencies in FL vocabulary learning for various age groups.

Comparison Studies on Emergent FL Relations

Following up on previous findings (Petursdottir et al., 2008), Cortez et al. (2020) formally compared the effects of FL tact and FL listener instruction on the emergence of L1-FL and FL-L1 intraverbals in children. Participants were of elementary school age, spoke Portuguese as L1, and were taught English (FL) nouns within the study. Each participant simultaneously received listener instruction with one set of stimuli and tact instruction with another. Trials to mastery were variable across participants and conditions. However, the results were consistent in that once mastery was achieved, all participants responded with substantially higher accuracy in intraverbal probes for items on which they had received tact instruction than for items on which they had received listener instruction. In a study with two five-year-old children, Petursdottir and Haflidadóttir (2009) similarly compared emergence of untaught FL relations following instruction that targeted FL tact, FL listener, L1-FL intraverbals, and FL-L1 intraverbals. Listener instruction did not produce criterion-level performance on any untaught relations for either participant, whereas outcomes of FL tact and FL intraverbal instruction were variable. The results of these studies are consistent with a broader literature demonstrating that listener instruction is less likely to produce speaker relations than speaker instruction to produce listener relations for children with neurodevelopmental disorders (see Contreras et al., 2020) and for children and adults of typical development (Connell & McReynolds, 1981).

A number of similarly themed studies have been conducted with adult learners. In a series of experiments with college students, Polson et al. (1997) and Polson and Parsons (2000) compared the effects of teaching L1-FL and FL-L1 intraverbals. The participants spoke English as L1 and were taught French (FL) vocabulary words using a computerized flashcard program. In Polson et al. (1997), the L1-FL intraverbal condition required participants to type the FL word when presented with the corresponding L1 word on the screen, whereas the FL-L1 condition required typing the L1 word when presented with the FL word. Across three experiments, each participant was taught half of the target words in each condition. Following mastery in both conditions, the L1-FL words were switched to the FL-L1 condition and vice versa. This reversal occasioned greater disruption of performance for words originally taught in the FL-L1 condition, suggesting L1-FL instruction produced a greater effect on the reverse FL-L1 relations than FL-L1 instruction on L1-FL relations. Polson and Parsons (2000) replicated this finding, in addition to comparing two different types of FL-L1 intraverbal instruction: topography-based and selection-based. The topography-based condition was identical to the previously described FL-L1 condition, whereas the selection-based condition involved MTS instruction in which an FL word appeared as a sample in each trial and four L1 words as comparisons. After the participants mastered one set of words in each condition, test trials presented words either in the same condition in which it has been taught, or in the opposite condition. All participants scored poorly in initial topography-based L1-FL test trials but with perfect accuracy in selection-based L1-FL trials, regardless of how the word had been taught. Thus, emergence of novel intraverbals depended on the mode of testing more than on the mode of teaching.

In another series of studies with adults, Dounavi (2011, 2014), and Daly and Dounavi (2020) compared emergence of vocal FL tacts and intraverbal relations following vocal tact instruction, L1-FL intraverbal instruction, and FL-L1 intraverbal instruction. Participants either spoke Spanish as L1 and were taught English (FL) nouns within the study (Dounavi, 2011, 2013) or spoke English as L1 and were taught French (FL) nouns (Daly & Dounavi, 2020). The results agreed with the previously described studies in that FL tact instruction and L1-FL instruction were more likely to produce derived relations than was FL-L1 instruction. Finally, W.-L. Wu et al. (2019) conducted a similar study with college students that additionally included an FL mand instruction condition, and tests for untaught FL mands. FL mand and FL tact instruction produced more untaught responding than did either form of intraverbal instruction, and for three of the four participants, mand instruction took the fewest trials to complete.

Overall, these studies suggest the extent to which derived verbal relations are observed in FL vocabulary instruction may depend on which relations are targeted for teaching, as well as on the format of testing. Overall, when vocabulary instruction is approached by selecting specific relations to teach and leaving others to emerge, the greatest degree of emergent topography-based responding may be seen when the taught relations involve participants responding by saying or typing the FL word, as opposed to the FL word simply being presented as a stimulus. Some studies suggest that specifically, tact or mand instruction may be more efficient than intraverbal instruction. Intraverbal instruction, however, may be easier to program for a wider variety of vocabulary targets, such as abstract nouns, prepositions, and conjunctions.

What Are the Benefits of Capitalizing on Derived Vocabulary Relations?

The emphasis on emergent relations in research on FL vocabulary acquisition is in line with an emphasis in modern behavior analysis on harnessing the power of derived stimulus relations to achieve efficiency in teaching (Critchfield, 2018). EBI and similar applications, which have flourished in recent years (Brodsky & Fienup, 2018), capitalize on the notion that teaching effort is saved when teaching a small number of relations generates a larger number of relations "for free." Interestingly, it is not clear from the existing literature if teaching fewer relations necessarily saves effort compared to teaching more relations. Comparisons of EBI with complete instruction (i.e., direct teaching of all possible relations) have favored EBI as the more efficient form of instruction (e.g., Zinn et al., 2015). However, laboratory research comparing stimulus equivalence procedures with complete instruction control conditions suggests efficiency may be influenced by training structure and type of mastery assessment more than by the number of relations taught (Oliveira et al., 2021; Petursdottir & Oliveira, 2020).

In light of these and other findings, it may be reasonable to ask how teaching, for example, FL tacts or L1-FL intraverbals, compares to instruction in which many types of FL relations are taught directly. In part, this information is of interest because the latter approach tends to characterize commercially available FL software applications. To date, only one study (Matter et al., 2020) has compared an EBI approach to FL vocabulary instruction with a complete instruction control condition. Preschool-age children who spoke English as L1 were taught sets of Spanish (FL) nouns through vocal FL tact instruction alone, and other sets through mixed instruction that included FL tact trials, FL listener trials, L1-FL intraverbal trials, and FL-L1 intraverbal trials. FL tact instruction reliably took fewer trials to complete for three of the four participants, whereas mixed instruction took fewer trials for the fourth. When post-tested on all relations, the participants performed just as well with words on which they had only received FL tact instruction as with those on which they received mixed instruction. Thus, capitalizing on derived relations may, indeed, increase the efficiency of FL vocabulary instruction. Additional research with adult learners might be of relevance to instructional software development, and should be extended to more complex networks of relations.

Other Research on FL Teaching and Learning

Besides derived vocabulary relations, several other topics in FL teaching and learning have been addressed in behavior analysis research. The remaining literature is small and scattered, but provides interesting examples of how different topics related to FL teaching and learning may be tackled empirically from a behavior-analytic perspective.

Procedures in Vocabulary Instruction

A number of studies have investigated the blocking effect in FL vocabulary learning with students of various ages. As an example, Solman and Chung (1996, Experiment 1) taught Chinese (FL) and French (FL) words to English-speaking (L1) children under two conditions: In a compound stimulus condition, trials were presented on flashcards that contained both the target FL word and the L1 word. In a spacing condition, the FL word was presented first, followed by the corresponding L1 word. Acquisition was enhanced in the spacing relative to the blocking condition. Other studies in this line of research (e.g., Adepoju & Elliott, 1997; Solman & Adepoju, 1995; Elliott & Adepoju, 1997) similarly suggest that simultaneous presentation of FL and L1 stimuli should be avoided during instruction.

In a study with high school students who spoke English as L1 and were enrolled in a Spanish class, Lloyd (1996) examined Spanish (FL) vocabulary acquisition under conditions of individual and group study with individual and group contingencies. Group study with group contingencies produced the best outcomes. In a more recent field study, Davidson and O'Connor (2019) evaluated the effects of morphological instruction as an intervention in vocabulary learning for elementary school students learning English as L2. Morphological instruction consisted of teaching the students to analyze words into morphemes in order to determine their meaning. The intervention increased all students' vocabulary scores, and generalization was observed to untaught words that shared morphemes with the taught words.

In a different vein, Duan and Cuvo (1996) taught adults who spoke English as L1 to tact written Chinese (FL) characters in English (spoken Chinese words were not taught). In a prototype condition, participants were taught the meaning of the prototype portion of each character along with the L1 translation of the word depicted by the character. For example, the authors explained that the character for "eat" contains a prototype component that has the meaning "mouth." In a rote condition, by contrast, participants learned only the L1 translation but not the prototype. Five of six participants learned faster in the prototype condition.

A number of studies additionally exist in which FL words were taught as examples of previously unknown instructional targets, but the researchers' primary interest was in some aspect of the instructional procedure rather than in FL learning per se. We will not provide a comprehensive review here, but to name examples, in Cengher et al. (2014), the amount of attention children received prior to FL teaching sessions affected the number of correct FL tacts they emitted, and in Haq et al. (2015), spaced learning opportunities produced faster acquisition of FL tacts for children than did massed learning opportunities.

Teaching Grammar and Syntax

Madrid and Torres (1986) taught Spanish negation to preschool-age children who came from homes in which both English and Spanish were spoken, but were not proficient in Spanish (L2). Two instructional conditions were compared with a control condition in a between-subjects design. In the simultaneous condition, trials alternated between L1 and L2 negation, whereas only the L2 trials were presented in the independent L2 condition. Results were in part dependent on the participants' L1 proficiency. Participants who were proficient in L1 acquired L2 negation while maintaining 100% correct responding in L1 trials, regardless of instructional condition. For participants who were not proficient in L1, both conditions increased correct responding in L2 trials, but no participant achieved mastery within the allotted instructional sessions. Additionally, participants who were nonproficient in L1 and received L2 without L1 trials showed a decrease in correct L1 negation responses in test trials as correct L2 negation responses increased.

Sigurðardóttir et al. (2012) used a stimulus equivalence paradigm to teach aspects of Icelandic (FL) grammar to adult and teenage participants who spoke different languages as L1. Participants were first taught a small vocabulary of feminine and masculine nouns. After learning to match both pictures and FL printed words to FL spoken words, conditional relations emerged as expected between the printed words and the pictures. The participants also passed tests in which plural forms of the spoken and written FL nouns were substituted for the original word forms, and pictures containing multiple items substituted for pictures of single items. Later they passed tests for matching singular nouns to pictures of single items, and plural nouns to pictures of multiple items. Contextual control was then established over matching based on gender or plurality. One contextual stimulus predicted reinforcement for matching singular to singular and plural to plural word forms, and another contextual stimulus predicted reinforcement for matching feminine to feminine and masculine to masculine nouns. All participants acquired contextually controlled matching by gender and plurality, with variable generalization to a card-sorting measure.

Teaching Phonology

Shimamune and Smith (1995) used discrimination training procedures to teach relations between written forms and pronunciation of English (FL) words containing consonants that can be difficult for Japanese L1 speakers to discriminate. One participant was first taught, via modeling and feedback, to pronounce FL words containing the target consonants when presented with printed words (i.e., textual behavior). Correct pronunciation increased to high levels, accompanied by a smaller increase in correct selections of printed words when presented with spoken words. The latter repertoire was then successfully taught. The other participant was taught to select printed words when presented with spoken words, and acquisition was accompanied by—indeed, preceded by—increases in correctly pronounced textual responses, even though pronunciation was not taught directly.

H. Wu and Miller (2007, 2012) developed a tutoring package to teach L1 speakers of English to pronounce Mandarin Chinese (FL); a tonal language in which pitch variations can alter meaning. Tutoring consisted of teaching participants to effectively respond to pinyin prompts (i.e., Chinese written in Roman alphabet with tonal symbols), using procedures that included modeling of lip and tongue placement, hand gestures to indicate changes in tone, feedback on pronunciation, and error correction in the form of repeated practice. In a similar vein, Cihon et al. (2013) used a visual phonics system to successfully teach correct pronunciation of printed Italian (FL) words to English-speaking (L1) college students preparing for a study-abroad experience.

Transfer from Classroom to Natural Environment

Washio and Houmanfar (2007) conducted a laboratory study with college students that modeled transition from an FL classroom environment into the natural environment. Stimulus features that tend to be present in instructional contexts (e.g., carefully articulated speech, simple sentence structures, unambiguous word choices) are often less salient in a natural language environment. Thus, to model the transition, the authors gradually decreased the salience of contextual stimuli that controlled the participants' matching of English (L1) and Japanese (FL) words that can have different meanings depending on context. As salience decreased, so did correct matching.

L1 Dominance over L2

In another laboratory study, Houmanfar et al. (2005) modeled L1 dominance over L2. No FL words were taught in this study; instead, nonsense syllables were used as stimuli. The procedure involved establishing contextually controlled equivalence classes in which pairs of classes shared a common member (the referent), modeling L1 and L2 vocabulary. L1 was overtrained relative to L2. L1 dominance was then demonstrated by showing that after exposure to equivalence class disruption, L1 resurged under extinction to a greater degree than did L2.

Future Directions

In summary, applied behavior analysis offers well-studied concepts and methods of relevance to FL teaching and learning, and the field has a long history of considering application in this area. The existing empirical literature is small and somewhat scattered, but provides (a) insights into the applicability of derived stimulus relations and EBI to FL vocabulary instruction, and (b) examples of successful application to various other topics.

Many topics related to FL teaching and learning would be of interest to explore further from a behavioral perspective. Additional research is needed on EBI applications in common language-learning contexts, such as FL classrooms and computer-based FL instruction. Such research additionally should be extended to scenarios that go beyond simple vocabulary learning in complexity, and address grammatical sentence construction and pronunciation, similar to existing commercially available applications. Existing behavior-analytic research on instructional variables in programmed instruction (e.g., Kritch & Bostow, 1998) could also be extended to FL instruction, along with further examination of optimal trial structures and contingencies. Further, understudied conceptual tools, such as autoclitic behavior and automatic reinforcement by parity, could be applied to grammar instruction, and interactions between rule-governed and contingency-shaped behavior might be examined in the context of FL grammar, pronunciation, and vocabulary learning.

In a different vein, the literature on anxiety and lack of motivation as barriers to FL learning might benefit from input from applied behavior analysis. In particular, attention might be given to identifying and resolving these and other acquisition barriers (e.g., faulty stimulus control) for struggling learners whose lack of progress may impede job mobility and earning potential (e.g., immigrant workers). Additional consideration might also be given to the applicability of behavior analysis to other problems of particular social significance, such as language revitalization efforts for endangered languages (Haegele et al., 2011).

Several recent developments in applied behavior analysis may predict a future increase in research and application to FL instruction. First, as previously mentioned, research interest in verbal behavior and derived stimulus relations is on the rise. Second, provision of services to bilingual children is receiving increasing attention in the field (e.g., Kornack et al., 2019), and engendering much-needed examination of how language of instruction—including when teaching language skills—affects acquisition and challenging behavior (e.g., León & Rosales, 2018; Neely et al., 2020). Third, increased emphasis on diversity and cultural competence in the training and practice of behavior analysts (e.g., Fong et al., 2016) may translate into increased interest in cultures, languages, and multilingualism. Because FL teaching and learning are already studied from multiple perspectives, behavior analysts breaking into these areas may need to familiarize themselves with new concepts and literatures. Such efforts, however, could ultimately be rewarded by meaningful contributions to FL and L2 teaching and learning.

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57 Teaching Verbal Behavior

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A phenomenon may be investigated by varied scientific approaches which differ in the level of analysis chosen and/or in experimental procedures followed. These methods should be considered as parallel and assessed in a non-hierarchical way, that is, they are not mutually exclusive and that none of them can include others. The study of complex human behavior labeled as language also seems to follow this reasoning: there are different structural language classifications; it is possible to examine its shape by observing the smallest unit of sound (phoneme), the minimum linguistic unit with meaning (morpheme), the set of words and their relationships (lexis and syntax) and so on.

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By considering, as the main reference text, *"Verbal Behavior"* by Skinner (1957), this chapter will outline the most important elements that represent the behavior analysis of linguistic interactions and the composite relationship between the speaker and the listener. The purpose, however, is not only to describe the systematic ordering of verbal events provided by the author but also to fully understand the revealing character of his work, also offering an examination of the experimental and applied work derived from it. It's the same Skinner who, before going into the presentation of his remarks, lists the traditional formulations that have analyzed the function of language and its learning: biological theories, according to which the language seems to be completely disconnected from environmental variables, such as reinforcement or stimulus control; cognitive theories, for which there is an internal mental activity determined and structurally connected to the perceptive system that accepts, classifies, and preserves verbal information. The new formulation proposed by the behavioral approach analyzes language through its function, avoiding hypothetical constructs that require further explications. Language is a learned behavior under the functional control of environmental contingencies. Verbal behavior is thus defined as any behavior reinforced through the mediation of another per-

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_57

son. This is undoubtedly a definition of verbal behavior of a "descriptive" type (Palmer, 2008): it does not aim to establish an immutable truth, but to discover other aspects of verbal behavior able to enrich its analysis. Therefore, the antecedent variables that stimulate and maintain it are the same that intervene on nonverbal behaviors. At the basis of the study of verbal behavior, there are not words, but *verbal operants*. The noun "operant" is essential: single responses occur only once and exclusively, that is, each is never equal to another, being able to change in form, intensity, energy, and so on. It is, consequently, of primary importance to refer to a principle that allows to associate responses that share some functional properties: the relationship that links responses to antecedent and consequent events. Thus, the operant is a class of responses that is marked by the effects they have on the environment. The consequences are, in turn, those environmental events that allow the identification and selection of a certain class of responses. From this point of view, as already mentioned, in the study of verbal behavior, the unit of analysis is not verbal response (understood as phoneme, word or phrase), but exactly the *functional relation* between the terms of contingency. After all, we can summarize by stating that verbal operants are a classification used to describe different antecedent and consequent conditions in which verbal behavior is emitted. Let's consider the following example of verbal behavior: a little girl does not play with her favorite doll that has been at grandmother's house for five days. She comes to grandma's house, sees the doll, and says: "Doll!," Grandma gives her the doll. The unit of analysis of this communicative episode is not only the word "doll," but a set of different elements: a motivation for the doll, the doll, and the grandma (they are nonverbal stimuli that indicate value and availability of the doll); the request of the doll (the word produced by the little girl) and the delivery of the doll (reinforcing consequence). It is clear that verbal behavior is well-structured. The verbal stimulus can be, alternatively, a response for the speaker and an antecedent for the listener.

The Echoic

Skinner's classification of verbal operants includes the identification of both formal and functional relationships. Formal relationships are determined by correspondence, within a verbal episode, among the constituent parts of the antecedent stimuli and those of the response. It must be taken into account that such a correspondence can vary along a continuum ranging from full form identity to possible degree changes. When the antecedent stimulus corresponds in all its parts (at the beginning, at the center and at the end) with the response, there is a *point-to-point correspondence*: "subdivisions or parts of the stimulus control subdivisions or parts of the response" (Michael, 1982). Moreover, when the stimulus and the response are in the same sensory mode (i.e., both visual and both auditory) and have a similar topography, they then present a *formal similarity*.

Because of many possible combinations with regard to relationships among different verbal behaviors and especially in order to provide a more specific categorization about the properties of verbal operants, Michael (1982) proposed the formulation of two new terms to describe the different relations among those verbal operants that present a point-to-point correspondence between antecedent stimulus and response: they are *duplic* and *codic*. The *duplic* is a verbal operant controlled by a verbal discriminative stimulus with point-to-point correspondence and formal similarity to the response. The *echoic* (vocal imitation), *mimetic,* and *copying a text* are part of the duplic relation. In the echoic relationship, the stimulus is auditory and the response makes an auditory product which is identical from a formal point of view. The echoic behavior is maintained by generalized reinforcement. A child says: "Apple" (or an approximation of it) after he has heard someone pronounce it. The "apple" stimulus said by an adult is the same in all its components to the "apple" response emitted by the child. Another important feature to define a response as echoic is the *temporal relation* between the stimulus and the response. The "later reproduction of speech," which bears a formal correspondence but is under a different stimulus control than the auditory stimulus, is not echoic (Skinner, 1957; Tsiouri & Greer, 2007).

Echoic is a verbal operant that is functionally present during daily conversation and serves an important *social function*, both in early development and in adult life (Ishikawa et al., 2019). Echoic is also called *vocal* or *verbal imitation* (Vladescu et al., 2018; Tarbox et al., 2009) and it plays a fundamental linguistic and academic developmental role, as well as being a very important tool in the attempt to teach verbal behavior (Tarbox et al., 2009; Cooper et al., 2019). Echoic is defined as a behavioral *cusp* (Cooper et al., 2019): if a person cannot echo, the probability of those responses to occur in other verbal operants is quite low (Sundberg & Michael, 2001). The echoic operant is very important for language acquisition, but forms of echoic relationships are also common in the linguistic repertoire of adults (e.g., one can repeat a religious formula pronounced by the priest during a Eucharistic celebration). Beyond that, as Skinner always suggests, echoic relations are also implicated in learning new words in an unknown language or when looking for rhymes or alliterations to write a poem.

Importance of Echoic in Language Acquisition

Echoic is an important target in every educational project, above all because achieving a well-established echoic repertoire can be the "building block" (Carr & Miguel, 2013) to facilitate the acquisition of other operant repertoires by using vocal modeling as a prompting procedure for mand, tact, and intraverbals (Williams & Greer, 1993; Vladescu et al., 2018; Tarbox et al., 2009; DeSouza et al., 2017; Rosales-Ruiz & Baer, 1997; Kodak et al., 2009; Sundberg & Michael, 2001). Getting a "generalized echoic" or a "generalized vocal imitation" (i.e., any vocal behavior in the native language frame that can hypothetically be imitated, Tarbox et al., 2009) can help clinicians to use echoic as a prompt to shape and teach vocal responses with a low-effort teaching procedure. Multiple exemplar training (MET, Young et al., 1994) is a teaching procedure used to systematically program for stimulus and response generalization (LaFrance & Tarbox, 2020) and it has been indicated as "an effective behavior-analytic procedure for teaching echoic repertoires" (i.e., generalized vocal imitation, Kymissis & Poulson, 1990); it has been well studied and "thoroughly disseminated in teaching systems for individuals with language impairment" (Carr & Miguel, 2013). MET allows the clinician to "train sufficient exemplars" (Stokes & Baer, 1977) to make the intervention efficient by determining a lesser number of targets to teach before generalization of untrained words occurs. Exemplars can be presented in a serial multiple exemplar training (S-MET, Eikeseth & Nesset, 2003; Aravamudhan & Awasthi, 2020a) where probes on untrained examples are conducted to test for generalization every time the mastery criterion is reached on the current trained target, or in a concurrent multiple exemplar training (C-MET, Wunderlich et al., 2014; Schnell et al., 2018, Schroeder & Baer, 1972), where more words are addressed at the same time. For example, to achieve the generalized articulation of the blend "sp" into words, the S-MET training is conducted on the word "spugna" (sponge in English), then a second word "spazio" (space in English) is tested, and if the word is correctly articulated, the training is stopped; otherwise, the word is taught and a third word, "spia" (spy in English), is tested; conversely, in the C-MET "spugna," "spazio," and "spia" are introduced at the same time. While MET is a training that presents a single operant at time (i.e., single exemplar instruction, SEI), multiple exemplar instruction (MEI, Greer & Ross, 2007; Guerra & Verdu, 2020; LaFrance & Tarbox, 2020) is a teaching structure where more operants follow each other within the same session, so that echoic instructions are presented mixed with other operants. Effects on echoic have been showed not only to increment accuracy and induce novel responses but also to establish joint control (LaFrance & Tarbox, 2020).

A second aspect is the role that echoic plays in daily conversations: "In a conversation a slightly atypical response is often picked up and passed from speaker to speaker. The two halves of a dialogue will generally have more words in common than two monologues on the same subject" (Skinner, 1957). Ishikawa et al. (2019) investigated the potential communicative function of four autism spectrum disorder (ASD) students' echoic. They taught, in person and through video modeling, a behavior they called "child's echoic conversational response" (also called intraverbal-echoic by Bondy et al., 2004), described as "an individual repeats a peer's topic word with appropriate prosody within 3 seconds." The target response was defined as "echoic" if it included at least the specific topic-related word (e.g., the speaker says "today is really cold," the word topic is "cold," so a correct conversational response may be "very cold"). This skill seems to be effective as a responsive ability during conversation, especially in individuals with high autism severity scores, with little interest in conversation with others: "Responding by echoic behavior permits speakers to react to it in other ways, especially in complicated conversations or directions to be followed […] asking for clarification or for expansion of what the speaker said, and acquiring echoic behavior should give the speaker another opportunity to initiate or react to the previous conversation" (p.2).

Third, echoic is important in establishing "parity" as reinforcing: "Achieving parity is a conceptually awkward sort of reinforcer. It is not a stimulus. It is a particular kind of response, a recognition that one has conformed. It is difficult to measure […]. But although difficult to measure, the reinforcement is real enough." (Palmer, 1996, p.290). When speakers have a good listener repertoire and know "what behavior should look like or sound like," they can detect whether they conform or deviate from typical verbal practices, given that conforming is reinforcing and deviating is punishing (Palmer, 1996). This ability can lead to a self-correction response, where people self-shape the responses that achieve parity with the auditory model.

Applications in the Assessment of Echoic

The echoic assessment goal is to collect information regarding the quality and the strength of the echoic repertoire (Sundberg & Michael, 2001) from small partial units (e.g., a single phoneme) to large units (e.g., a sentence), including non-speech properties such as intonation (Esch et al., 2010a). The assessment aims at establishing and sequencing a language intervention program according to typical language development (Cooper et al., 2019; Dyer et al., 2006; LaFrance & Miguel, 2014). In language development, "earlier" means "simpler" to discriminate and to produce in terms of motor control. An echoic program must be consistent with the current phonetic repertoire and phonological profile. An age-appropriate sound sequence has been proven to be more efficient in teaching vocal imitation to children with language delay and autism (Lim, 2016). Problems can be detected in the stimulus control (i.e., vocalizations are present but are not under the model stimulus control) or in evoking responses that share point-to-point correspondence and formal similarity with the model (Guerra et al., 2019), such as the sounds matching (i.e., the antecedent sounds and the response sounds are the same), the order of the sounds (i.e., the response sounds are in the same order as the antecedent ones), as well as other dimensions which could be overlooked, like co-articulation (i.e., sounds are co-articulated together and not separated), and lexical stress (i.e., the accent is in the correct position within the word). A starting point for those students who do not have echoic control is a *Vocalization Baseline* during *free operant vocal play* 30-sec interval (Esch et al., 2005) where the child is free to play and the clinician phonetically transcribes the quality and the amount of each sound that occurs during that interval (Carbone, 2005). For those students having some echoic skills, some—though few —structured tools (Esch et al., 2010a, b; Carr & Miguel, 2013), are available:

Early Echoic Skill Assessment (EESA, Esch, 2008) is a subtest for the VB-MAPP assessment (Sundberg, 2008) that evaluates speech production on a developmental base in terms of sounds (e.g., vowels, consonants), syllable combinations (e.g., diphthongs, 2-and 3-syllable words, short spoken phrases), and intonation (e.g., prosody of spoken phrases features, such as pitch, loudness and vowel duration).

Behavioral Language Assessment Form (BLAF, Sundberg & Partington, 1998) is a questionnaire asking to indicate, in a Likert-scale based range from 1 to 5, the number that best describes the learner's typical level of performance, among others, of vocal play and vocal imitation.

Kaufman Speech Praxis Test (KSPT, Kaufman, 1998) is "a norm-referenced diagnostic test assisting in the identification and treatment of childhood apraxia of speech," which registers and analyzes echoic responses to identify which sounds or sound combinations are particularly difficult for a child, pointing to a systematic course of treatment.

Motor and Vocal Imitation Assessment (MVIA, Aguirre & Gutierrez, 2019) tests echoic behavior (i.e., vocal play, canonical babbling, non-reduplicated speech, first words) in a hierarchical motor imitative context along with object imitation, body imitation, and facial imitation.

The Overall Speech Intelligibility Rating Scale (Koegel et al., 1998) aims to evaluate the child's production intelligibility and, therefore, how much the vocal productions are comprehensible and consequently can be reinforced by the community.

Echoic Trainings: Inducing and Expanding Echoic Repertoire

No single procedure presented in the literature has been demonstrated to be effective for all individuals. Cividini-Motta et al. (2017), after comparing three procedures (i.e., Vocal Imitation Training, Stimulus-Stimulus Pairing and Mand-Model), showed that the most effective procedure varied among the children involved in their experiment. Therefore, the authors suggested the importance of assessing what procedure is the most appropriate for each subject, also considering the subject's characteristics: "If the first strategy you select is not effective, attempt to use another strategy with the child until you determine what works best." Overall, according to Vladescu et al. (2018), it is important to attempt "to use one of the basic teaching strategies (i.e., Vocal Imitation Training, Stimulus-Stimulus Pairing, Mand-Model) before trying a more complex strategy that incorporates some of the basic strategies (i.e., Chaining, Rapid Motor Imitation Training)." Most of the authors presented interventions based on treatment packages where more than one procedure is concurrently implemented (Eikeseth & Nesset, 2003; Aravamudhan & Awasthi, 2020a). When a package is implemented, it is important to determine if all the components are essential to the intervention (i.e., detailed component analysis), and, if not, how to optimize the package by selecting only those really functional. Individual procedures and their clinical applications are described in detail below.

With students showing no echoic control (Cividini-Motta et al., 2017) and whose vocalization rate is too low to initiate echoic training (Shillingsburg et al., 2015), interventions are based on a strong *manipulation of antecedents*, such as Stimulus-Stimulus Pairing (SSP) and Operant Discrimination Training (ODT), or only on the *manipulation of consequences*, as with Direct Reinforcement and Differential Reinforcement of All Vocalizations, and Shaping.

Stimulus-Stimulus Pairing is a procedure used to "jumpstart vocal behavior" (LaFrance & Miguel, 2014) based on classical conditioning, a neutral stimulus (e.g., the sound "mmmm") produced at a low rate (Miguel et al., 2001) or a novel sound not produced at all (Sundberg et al., 1996), or both of a low rate and a novel sound (Yoon & Bennett, 2000) are repeatedly presented along, or just before, a reinforcer, both positive (e.g., a hug) and negative (e.g., changing the diaper). The neutral stimulus, the specific sound, being established as conditioned reinforcer (Shillingsburg et al., 2015; Sundberg et al., 1996) automatically becomes reinforcing (e.g., the child says "mmmm" also when alone even though nobody gives the child a hug). The effectiveness of the SSP procedure is still debated because results from studies are discrepant (Carr & Miguel, 2013; Shillingsburg et al., 2015), and authors have cautioned care in the clinical application of the SSP procedure. *Operant Discrimination Training* has been presented as an alternative to SSP in establishing sounds as conditioned reinforcers. The ODT procedure presented by Lepper et al. (2013) consisted of a discrimination training between target sounds and non-target sounds. The training teaches students to respond with a discriminative response (e.g., raising one's arm) only to target sounds, which become S^D for the reinforcement, and not to respond to non-target sounds, which become S^Δ. Results in this study suggest that ODT was effective in increasing the participants' target vocalizations, even though effects were similar to those of the SSP procedure. The SSP and ODT procedures through which new stimuli are established as conditional reinforcements, are of current interest for their possible clinical applications but need more research (Holth et al., 2009; Da Silva & Williams, 2020). Finally, the *Direct Reinforcing* of all vocalizations intervention aims to increase the frequency of vocalizations of appropriate speech sounds (Carbone, 2005) by the adult echoing speech-like sounds emitted by the child during play activities (e.g., jumping and singing) while delivering a reinforcement. The adult's vocal imitation, specifically the mother's, has been demonstrated to have a reinforcing effect on the infant's vocalizations (Pelaez et al., 2011a, b; Neimy et al., 2020), as it functions as a contingent social reinforcement. When associated with Differential Reinforcement, these interventions function as shaping procedures that select, by consequences, successive approximations to the final response topography (Lovaas et al., 1966; Marshall & Hegrenes, 1970). Progressive shaping can be slow in its effects (Skinner, 1957) if compared with modeling, especially for a child with a language impairment (LaFrance & Miguel, 2014).

With students who emit vocalizations but do not have echoic repertoire, procedures are essentially based on a manipulation of both the antecedents and the consequences, such as Vocal Imitation Training (VIT), Rapid Motor Imitation Antecedent (RMIA), Vocal Variability (VV) training based on a Lag reinforcement schedule. *Vocal Imitation Training* is the "basic intervention" to teach echoic control (Baer et al., 1967; Lovaas et al., 1966), consisting in the teacher's presentation of a vocal target, waiting for a defined amount of time for the echo by the child (e.g., 5 sec), and reinforcing the correct echoic. When VIT is not effective, other procedures can be implemented based on some behavioral principles, as is the case with extinction for the Lag schedule and behavioral momentum (Mace et al., 1988, 1990; Nevin et al., 1983) for the RMIA procedure. In the *Vocal Variability* Lag reinforcement schedule procedure, each trial began with the experimenter presenting a vocal model and reinforcing every child's vocal response only if different from the former one (i.e., in Lag1) or from a certain number of previous responses (e.g., Lag2, Lag3). This procedure aims at increasing vocal variability and, consequently, the phonemic repertoire, but does not reinforce parity with the model (Koehler-Platten et al., 2013; Esch et al., 2009). *Rapid Motor Imitation Antecedent* (Williams & Greer, 1993; Greer & Keohane, 2006; Ross & Greer, 2003; Tsiouri et al., 2012, Hansen et al., 2019) consists of a rapid and random sequence of three gross motor and three small motor actions (i.e., high-probability responses), with the sixth item always being a small motor action around the mouth (e.g., touch mouth, open mouth or show teeth), followed by the whole word or a pre-established approximation to the word to be echoed (i.e., low-probability response that is already in the child's repertoire, but at a low rate).

There are some other interventions that manipulate both antecedents and consequences and share the characteristic of teaching echoic simultaneously with other operants, as is the case of the Mand-Model (MM), the Echoic-to-Tact procedure, and the Natural Language Paradigm (NLP). The *Mand-Model* (Rogers-Warren & Warren, 1980) is based on EO manipulation to increase both the willingness of the child to participate in training sessions and the echoic behavior itself (Sundberg & Michael, 2001). During the MM training, the vocal target is the reinforcer name (e.g., the adult form of the word, a part of the word, an approximation), which it is echoically prompted to the child who attempts to gain access to it (Cividini-Motta et al., 2017; Drash et al., 1999). Stimulus control is shifted from the EO to the vocal verbal antecedent (Cooper et al., 2019). Similar effective results on vocal production have been achieved using a Mand-Model based on the picture exchange communication system (PECS) (Tincani et al., 2006; Tincani, 2004), on Manual Signs (Carbone et al., 2010), or on Speech-Generating devices (Gevarter et al., 2016; Gevarter & Horan, 2019) concurrent with prompt delay, vocal prompts of closer approximations, differential, and delayed reinforcement. When combined, these procedures have the advantage of safeguarding the communication function of the mand, while a vocal training based on echoic prompts is being carried out. Also, the echoic can be taught concurrently with the tact *(Echoic-to-Tact procedure)* by presenting the vocal model simultaneously with the related object and by reinforcing any vocal approximation response with a generalized social reinforcement and the functional use of the object to play (Löhr & Gil, 2015). Along the same lines, *Natural Language Paradigm* (Koegel et al., 1987; LeBlanc et al., 2006; Gillett & LeBlanc, 2007) is a parent-mediated intervention and consists in modeling the language naturally during play time sessions with preferred toys (Vladescu et al., 2018), thus directly teaching the echoic relation as well as the mand at the same time (LaFrance & Miguel, 2014).

With students that emit sounds under the control of a vocal model, but need to increase point-to-point correspondence, interventions are essentially structured on Modeling and Prompting. Procedures relying on modeling are Phonological Breakdown and Chaining of adult words. With Modeling, differently from Shaping, the clinician manipulates the vocal model (Lafrance & Miguel, 2014) by prompting a simpler form of the target word or by suggesting how to assemble echoic units, thus making the learning process faster (Skinner, 1957). In *Phonological Breakdown* interventions (Kaufman, 1998) what is known about children's natural phonological processes (Dyer, 2009) is integrated to select "word shells" that follow the developmental way (Ingram & David, 1989) through which infants and children learn to speak by moving from a simpler to a more complex form of sounds (e.g., for the target "mama" mm-ah>mah>mah-ah>mom-ah>mahmah> mama, example from Kaufman's Cards) and structures (e.g., for the target "potato" to>tato>potato) (Fee & Ingram, 1982) in order to achieve parity with the adult form of the words. Kaufman's method reduces the occurrence of errors (i.e., errorless instruction) and the response effort (i.e., stimulus demand fading) (Sweeney-Kerwin et al., 2006). In *Chaining*, a multi-syllable word is broken into smaller units such as phonemes, syllables, or group of syllables that are taught as chains (Tarbox et al., 2009; Sloane et al., 1968; Mallory et al., 2019). Tarbox et al. (2009) presented a chaining-like procedure consisting in modeling the first part of the word (e.g., "mun" for the word Monday), reinforcing the correct echo, promptly modeling the second part (e.g., "day"), reinforcing the correct echo, then rapidly modeling the entire word (e.g., "Monday") and reinforcing the correct emission. One possible limitation to these studies is the method used to break words into components. As the authors stated, "no formal rule was used for how to divide one-or three-syllable echoics into two components. Instead, clinicians judged which option sounded the simplest and least awkward" (p.903). Two problems may arise from the divisions the authors made: the first is that a single phoneme like "b," being a plosive phoneme, cannot be pronounced without adding a vowel-like sound (e.g., something like "bo," Gerenser, 2009), thereby altering the word sequence, which becomes something like "bo-all"; a second problem is that word prosody may be altered if the two parts into which the word is broken do not respect the lexical stress—e.g., for the word "Victoria," the correct position of the word stress is on the vowel "o" (i.e., Victória) and this word can be better divided into Vic-toria than Victo-ria. A proposal to investigate in the future could be a *Chaining method based on prosody* in which the word could be divided into two parts that preserve the main stress of the word. Stress is fundamentally based on vowel duration. To respect this rhythmic feature, the two words “patàta” in Italian and “potáto” in English have a stress on the second-to-last vowel; these two words could be preferably broken into “pa-tata” and “po-tato,” instead of “pata-ta” and “pota-to”; in contrast the two words “tàvolo”—table in English—and “yèsterday” have a stress on the third-to-last vowel and could be preferably divided into “tavo-lo” and “yester-day” instead of “ta-volo” and “yes-terday.” As suggested by Desouza et al. (2017, p. 242), “future research should compare the effects of backward versus forward chaining procedures in the acquisition of echoic responses involving one- to three-syllable words,” so it could also be interesting to experiment whether backward chaining may facilitate second-to-last stressed word acquisition (e.g., model “tato”> echoic “tato”> model “po-tato”> echoic “po-tato”> adult form “potato”> echoic “potato”), while forward chaining may result to be more effective for teaching third-to-last stressed words (e.g., model “yester”> echoic “yester”> model “yester-day”> echoic “yester-day”> adult form “yesterday”> echoic “yesterday”).

Procedures based on prompting use within-prompts, extra-stimulus prompts, and response prompts. Vocal imitation itself cannot be physically prompted (Hansen et al., 2019), which means that nobody can physically guide another person to echo. In general, the child who is attempting to imitate vocal sounds is helped by the ability to see the speaker’s mouth (i.e., a strong visual cue), while the speaker is speaking (i.e., the corresponding auditory information), as suggested by Imafuku et al. (2019), but no physical prompts can be helpful if students are not compliant with the request and do not attempt to produce an echoic by themselves. *Within-stimulus prompts* increase stimulus salience, thereby making that stimulus more discriminable. Within-stimulus prompts can include exaggerating some features of a difficult sound (Dyer, 2009; Aravamudhan & Awasthi, 2020b), by altering a distinctive trait (e.g., saying a more plosive “p” in the word “pasta,” a stronger “b” sound in the word “bolle”—bubbles in English), or a supersegmental dimension to increase the sound duration (e.g., saying a longer vowel “i” in the word “bici”—bike in English—“biiici”), as well as exaggerating the intonation or melodic patterns (Gerenser, 2009). Some methods use *Phonetic Hand Cues* (PHC), which are a codified system of hand prompts (i.e., gestures), studied to improve articulator precision when presented as an antecedent or simultaneous prompt (Strand & Debertine, 2000; Skinder et al., 1999). Hand cues are modeled by the clinician, paired with the production of a sound, and, in some cases, also executed by the subject (Kasper et al., 2018). Hand cues can be an example of *extra-stimulus prompts*. *Response prompts* involve the physical manipulation of the child’s articulators which are lips, mouth, and tongue (e.g., lip protrusion to say the sound “j” in the word “jeep”), toward the correct trajectory and movement (e.g., guiding the child’s jaw up and down when saying “mamma”—mama or mom in English-), and using some tools to help the articulators position.

With students who gain point-to-point correspondence, it is finally necessary to obtain fluency. Some authors (Aravamudhan & Awasthi, 2020b; Fabrizio & Moors, 2003) proposed intervention packages that involved *Precision Teaching* (i.e., an instructional approach that measures how the frequency of behavior changes in time by displaying data on a Standard Celeration Chart, Cooper et al., 2019) and *Frequency Building* (i.e., a stage of learning which aims to accelerate the performance rate of correct responding) to speed up the articulation rate and also obtain a fluency outcome.

The Mimetic

Many scholars agree that the first characteristic of the human being is his propensity to imitate the behavior of others (Girard & Doran, 2008). The action of imitating someone else’s gestures is a fundamental act for personal growth and for the evolution of the species, because it offers clear advantages in acquisition, especially in terms of time and energy. By imitating, one also learns the meaning of the context and results of the actions put in place by those who are observing.

Skinner talks about mimetic relation to imitate the non-vocal verbal behavior of another speaker through motor imitation. The antecedent stimulus is gestural (motor) and the response produces a gestural product (to imitate the movement shown): stimulus and response are identical, so the physical movement that constitutes the model to be imitated represents the control variable of imitative behavior. Imitation, however, is a complex act and is almost never governed (if not in the imitation of the simplest actions) by mechanisms of direct comparison between what is perceived and the motor scheme that is put in place. There are many mechanisms that support imitative actions: some of them refer to previous knowledge and/or abilities; others lead who imitates to analyze what does the model. The imitative repertoire also allows the acquisition of new behaviors, especially where communication and social skills are lacking.

Applications in the Assessment of Mimetic

The ability to imitate nonverbal behavior is an essential requirement in the acquisition of communication skills for which a part of mimetic assessment may include an assessment of motor imitation skill (Dequinzio et al., 2007). The main purpose of the evaluation should be to determine whether the child is able to copy the motor movements of others when required.

The first two levels of the VB-MAPP (Sundberg, 2008) allow the assessment of the motor imitation starting from the imitation of big motility with and without prompt, up to the imitation of fine motor movements and actions with more steps. The assessment results may provide important information to help determine whether augmentative communication is needed and what form may be most appropriate for a given child.

The *Motor and Vocal Imitation Assessment* protocol (MVIA) can also provide further information in the mimetic evaluation process, although not specific, as it is an assessment tool that includes tasks of imitating objects, imitation of body movements, in addition to imitation of facial expressions and vocal imitation (Aguirre & Gutierrez, 2019).

ABLLS-R (Partington, 2010) also offers 27 evaluation items of motor imitation skills. Many of the new abilities have been inserted to emphasize the importance of "paying attention to other people's behaviors" and thus assess the reproduction ability of these actions as a model.

Applications in the Teaching of Mimetic

Researches support the association between imitation and social communicative behavior (Ingersoll & Schreibman, 2006). Monitoring behaviors such as paying attention and imitating the behavior of the model form the basis of observational learning (Taylor et al., 2012). The ability to duplicate the actions of others plays a fundamental role in the acquisition of language, social behavior, and generative learning skills (Cooper et al., 2019). Motor imitation is essential to the acquisition of new verbal behaviors and teaching by imitation is one of the most important forms of teaching techniques (Michael, 2004). In addition, a conspicuous generalized imitative repertoire is a behavioral cusp, because it allows a child to easily learn new behaviors without direct teaching or reinforcing history (Rosales-Ruiz & Baer, 1996).

Motor imitation is a valuable tool for teaching sign language to people who are deaf or hearing but unable to speak. A strong imitative repertoire allows a student to immediately use sign language to learn quickly to communicate with others to get what he wants (Sundberg, 2008). Thompson et al. (2007) have shown that sign teaching can build the development of speech language by denying the belief that sign training is obstructive to early vocalizations. These results are also consistent with the results shown by Goodwyn et al. (2000). Two studies by Thompson and colleagues are very interesting: in the first (Thompson et al., 2004), the authors have implemented a sign training that includes delayed physical prompts and differential reinforcement and it was effective in producing independent signs in three children in less than four hours of intervention. In the second (Thompson et al., 2007), they inserted the model as a further prompt within the sign training to capitalize on the emerging imitative skills of participants and the results showed that the training has been effective both for the development of independent signs under new conditions both for the replacement of problem behaviors.

The Mand

In *Verbal Behavior* (1957), Skinner provided also an analysis of how motivational variables play a significant role in a human's acquisition of language and in later verbal functions. Particularly, in the second chapter, he identifies the independent variables in the review of verbal behavior, suggesting that motivation and emotions, as well as aversive situations, have a particular and distinct position with respect to other environmental variables. For example, in teaching a mand, "By reinforcing with candy we strengthen the response *Candy!* but the response will be emitted only when the child is, as we say, hungry for candy" ("Skinner, 1957 p. 31). Consequently, Skinner introduces the concept of mand: a verbal operant in which the response is reinforced by a specific consequence and is under the control of relevant conditions of deprivation or aversive stimulation. The influence of an antecedent stimulus on the response is not enough to evoke it in the absence of a learning history. Water deprivation (which is a motivational variable) will make the water (or other drinks) an effective reinforcement and will evoke some behaviors, such as the mand for water, if these behaviors in the past have produced water. Therefore, what defines a mand is the existence of a functional relationship among motivational operations, response, and a learning history. The specific form of reinforcement for the mand is directly connected with relevant motivating operation (MO), for this we can assert that a mand specifies its reinforcement and it is the only verbal operant that benefits the one who emits it.

There are also some mands which can't be explained briefly by asserting that responses of the same form have been reinforced in the past in similar circumstances: "The dice player exclaims *Come seven!,* for example, even though he has not asked for and got sevens anywhere" (Skinner, 1957 p. 47). According to Skinner these are accidental or superstitious mands: by referring to the previous quote, the dice player can state that there is no connection between his response and the behavior of the dice, but because of occasional consequences, the response retains its strength and he will continue to enunciate it.

Skinner's literary analysis among the pages of poets and writers is also very interesting: they seem to create magical mands that is born by analogy with those already used, but completely new. When a poet exclaims: "Milton, thou shouldst be living in this hour!" (Skinner, 1957 p. 48), this response (a vocative) in past history, has never brought anyone back to life, but with this mand, the speaker openly describes to the reader the appropriate reinforcement for his state of deprivation in that precise circumstance. This exemplifies a general principle: literature is the product of a special verbal practice, since it allows the issue of behaviors that would otherwise remain latent in the repertoire of many speakers.

Applications in the Assessment of Mand

The scientific literature has shown that this skill has a fundamental importance in the early stages of development: it makes the child a speaker, allowing him to control the environment. Mand can be evaluated through various assessment tools, such as the VB-MAPP (Sundberg, 2008), ABLLS-R (Partington, 2010), PEAK (Dixon, 2008), and the Essential for Living (McGreevy et al., 2012) (refer to the reading of Chap. 22, for more).

If the student has a weak vocal repertoire, however, it is important to choose an alternative communication system. *Essential for Living* (McGreevy et al., 2012) provides a system of comparison between skills and deficits in the student's repertoire (motor, visual, auditory skills); it also has specifics characteristics of each communication system and skills needed to use it (e.g., motor imitation in sign language) and some advantages that any alternative communication system retains of speech language (e.g., sign language retains the advantage of being a real language, but has the disadvantage of not having a wide audience). From the consideration of these three levels, it is possible to significantly increase the possibility that the alternative system of communication chosen will be the best for each student. Among the most widely used systems in clinical practice, we can mention the exchange of images (selection-based) and sign language (topography-based). Starting from the student's necessary requirements, Sundberg (1993) pointed out some advantages of topography-based systems over those based on selection. The latter necessarily require a skill of conditional discrimination on the part of the student, they are not portable everywhere and often fail to represent abstract concepts and do not have the characteristics to allow the development of the conversation.

Applications in the Teaching of Mand

One of the first applications to mand teaching is related to the reduction in problem behavior. Many students with autism with a weak repertoire of functional mand may show inappropriate behaviors (such as aggressions, self-injury), as such behaviors frequently lead to the obtaining of favorite objects or events (Hagopian et al., 2001). A specific methodology used for this purpose is *Functional Communication Training* (FCT): this intervention consists of teaching an appropriate communicative response (functional communicative response) with the reinforcements that maintain inappropriate behaviors (Tiger et al., 2008). For example, the child who in the past got the teacher's attention screaming is taught to require attention by calling the teacher's name: he will then be given opportunities to practice the skills and whenever the child calls the teacher by name, she will turn providing attention; on the contrary whenever the child screams the teacher will not provide attention.

The strategies of intervention for the mand teaching must necessarily take into account the critical importance of the motivating operation (MO), because the mand training can be carried out only when the student is motivated for something. Sundberg and Michael (2001) further highlight this concept, emphasizing the need to establish what are termed "pure" mand or responses evoked exclusively by motivating operations and maintained by specific reinforcements, so that the response is under the control of the correct stimulus. In the mand teaching, it is therefore essential that the caregiver is prepared to have control of the motivating operations. This is not always easy, as MO is not fixed, but may vary at different times depending on the levels of deprivation and satiation, but also on the basis of competition with other MO or with the required instructions (Alling & Poling, 1995). To overcome this difficulty, it is useful to use an evaluation of the MO, by observing the free operant behavior in order to *capture* the natural changes in the value of the MO. A further strategy is to manipulate the environment in a way as to alter the value of a consequence and at the same time to *create* an MO for that specific consequence such as an adult presenting to the student a jar of sealed Play-Doh and conditioning as a reinforcing event the opening of the jar. Sundberg and Partington (1998) point out that only after the MO has been contrived, the practitioner can start teaching using prompting strategies to evoke the target response and deliver the corresponding reinforcement after the child has emitted the mand.

In mand training, it is particularly important to teach in the natural environment. In addition to the motivating operations in place, the practitioner can use a nonverbal S^D (e.g., the presence of the desired item), or a verbal S^D, for example to ask: "What do you want?" The prompting strategies may vary depending on the communication system used by the student, for example, echoic prompts for vocal students. It is important, however, to fade the prompt as soon as possible in order to avoid a dependency, while reinforcing differentially the independent responses and providing opportunities for generalization (Cooper et al., 2007).

Indirect Approaches an important part of the literature has provided to more details related to teaching strategies aimed at establishing emerging mands. Among principal currents, there are Stimulus Equivalence and Relational Frame Theory.

Stimulus equivalence: several authors have pointed out the importance of the expansion of verbal repertoires through the formation of derived stimulus relations. Rehfeldt and Root (2005) for example, investigated the presence of derived mand as a result of conditional discrimination training on students with severe disabilities. The AB relation (spoken word-corresponding image) and AC relation (spoken word- written word) were taught to students who requested using the PECS system (Frost & Bondy, 1994). At the end of the training, participants derived the ability to request by selecting the written word corresponding to the desired object. In addition, the ability to match image-word (BC) and word-image (CB) has also emerged in all students and one participant has shown emerging tact skills of images and reading skills of words.

Relational frame theory: The RFT, in its proposal for an analysis of verbal behavior, raises some questions as to how to define mands to obtain new stimuli. Referring to the definition of Skinner (1957), Barnes-Holmes et al. (2000), state that the presence of the valuable stimulus is not necessary for the response to be shown, but it is necessary that in the past the stimulus has consistently followed previous instances of mand. However, this described above does not happen in the case of a mand for a new stimulus, in a condition that excludes generalizations of stimulus, inductions of response, and conditioning processes. A concrete example is provided by the authors themselves, comparing the case of a child who, following direct teaching, learns to say "car" within a toy shop, when he is motivated to get a toy car, with the case of a child who is taught to say "game" in the presence of a multitude of toys, thus building a category, and at the same time learning to require at least one (e.g., after learning that the car is a game, when the adult asks him: "What game do you want?," the child uses the mand "car"). In the second case, unlike the first, the child will not need a direct mand training to make the request for each specific game, as the "toy function" brings together all the stimulus that are part of a coordination frame. Such merging would thus allow generalizing the skill to new stimuli and would be what allows defining the mand as derived. In this context, the authors of the RFT emphasize how the emission of "pure" mand, whose importance has been highlighted, as previously explained, by Sundberg and Michael (2001), is in reality rather rare.

The Tact

In all verbal behavior under stimulus control, there are three important elements to take into account: a stimulus, a response, and reinforcement: it is the well-known three-term contingency. Let's now analyze, in more detail, the verbal response controlled by an antecedent nonverbal stimulus, the *tact*. Consider the following examples: a child pronounces the word "ball" in presence of that object and his mum says: "Yes, it's a ball. Good for you!"; a student gives a name to the relation between two objects of different sizes identifying it with the expression "bigger" and the teacher says: "That's great, right." Although the verbal form of responses takes on in these examples, different aspects, all are united by the presence of nonverbal stimuli as antecedents and by a generalized reinforcement as a consequent event. The word tact, from a terminological point of view, has many elements of contact with what in the common language is defined *to label* or *to name*, provided that the response is emitted in the presence of the object named. In fact, we can pronounce the word "apple" in the presence of the fruit as in its absence, but only in the first case we can speak of tact. For Skinner the tact is a "behavior that *"makes contact with"* the physical world" (Skinner, 1957, p.81). The characteristic that marks this operant is precisely in the presence of a nonverbal variable that acts as discriminative stimulus for the emission of a verbal response. It should be noted that the tact differs from the mand not only because the response is under control of an antecedent nonverbal stimulus, but also because the consequence is not specific, that is, it has no correspondence with the object of the tact itself. While the topography of a mand and a tact may be similar, Skinner confirms that the function of each operant is different and independent. A large number of stimuli may become part of this verbal relationship as antecedents: objects, people, animals, actions. Some tacts are general and have antecedents belonging to very large classes of stimuli (men, animals, plants); other tacts have antecedents belonging to more restricted classes (such as a person's own name). Moreover, the discriminative stimulus which controls the issue of a tact may be represented by physical characteristics of an object (the shape, the color) and by the relation among objects: the word "red" may be pronounced in the presence of a red light, a ruby or a wine; similarly, the placement of two objects on top of each other controls the verbal response "under/over." A response in a tact may be also controlled by less perceptive and culturally elaborate stimulus characteristics, such as when we recognize a writer by his literary style, or we recognize a guitarist by his executive expression. The tact may even be controlled by variables that only the speaker feels such when you have feelings of pain or happiness. A person learns to describe what she perceives and in the presence of a certain sensation (discriminative stimulus) can pronounce the phrase: "I have a stomach ache." The verbal community teaches and maintains the correspondence among environmental events and the expression that describe them: even in the absence of direct access to what a person feels, the correspondence between private events and language is modeled on the basis of other publicly observable events. Skinner refers to the metaphors as extended tacts: metaphors describing internal states commonly refer to properties and events of which everyone may have experienced or are of common observation: "An example of metaphorical extension is provided by the child who, upon drinking soda water for the first time, reported that it tasted like my foot's asleep." ("Skinner, 1957 p.92). It is therefore evident that what Skinner calls tact is a fundamental operant for the acquisition of those processes defined by the author himself as abstraction or learning concepts.

Applications in the Assessment of Tact

The assessment of a child's tact repertoire is primarily for discrete trials. The purpose of the assessment is the analysis of the degree of stimulus control exerted by the nonverbal stimulus on the tacting behavior. As the stimuli become more complex (settings with more stimuli, property of objects, spatial relations between objects), it is possible to observe a stimulus control weakness on the student's response. The purpose of the evaluation is to identify the basic level from which tact teaching can begin. The tact assessment can be conducted through various tools including VB-MAPP (Sundberg, 2008) and ABLLS-R (Partington, 2010).

The VB-MAPP proposes 15 subtest tact milestones organized in three levels of increasing complexity, starting from the tact of a reinforcing object, to possess a repertoire of 1000 tacts including nouns, verbs, and adjectives in the last level.

The "denomination" section of the ABLLS-R (Partington, 2010) proposes 47 objectives starting from the tact of reinforcing objects to arrive at more complex skills such as spontaneously tacting social interaction behaviors (e.g., a child says "Marco is fighting" while watching Marco and Antonio discussing each other) and events (e.g., a child during the party says "this is Marco's birthday"). Among the evaluation objectives are included the tact of emotions and private events of themselves and other individuals.

Applications in the Teaching of Tact

The ability to label objects, actions, property of objects, relationships, and private events is essential to living in society satisfactorily (Hall & Sundberg, 1987). One of the easiest strategies to implement in the teaching of tact is to exploit the repertoire of other verbal operants such as the use of a strong echoic repertoire. The teacher presents the nonverbal stimulus (a car) together with the echoic prompt ("car") and provides differential reinforcement when the student repeats "car"; then, she will proceed with the prompt fading until the stimulus control transfer is completed. Another method of teaching (Barbera & Kubina, 2005) consists in the use of the transfer of stimulus control from matching to sample (to show an example of the item and to ask the student to match, choosing the same item from a group of many items) to the echoic (the student labels vocally after the teacher shows the nonverbal S^D and appoints it vocally) up to the tact (the student labels the nonverbal stimulus vocally).

Braam and Sundberg (1991) comprehensively illustrated the difference between a pure tact and a tact under multiple control. In their study, they examined two procedures for the functional teaching of a tact repertoire to young adults with severe intellectual disabilities and limited verbal repertoire. Tact teaching included verbal prompts ("What is this?"), the correct response model, and one of two types of reinforcement: "specific" and "non-specific." In the condition of "specific reinforcement," participants who properly emit food image tact receive the corresponding edible as reinforcement by placing the response under multiple control (mand/tact). In the condition of "non-specific reinforcement"participants receive an edible other than the stimulus of which they properly emit the tact acquiring the response as pure tact. From the emerged results, the two conditions were equally effective in both acquisition rates and extinction resistance; however, the "specific" strengthening condition produced less latency in the responses, a higher percentage of mand compliance in probe sessions as well as the fact that all participants have shown that they prefer this condition. Teaching verbal operants under multiple control may result in higher compliance and be more rewarding than teaching pure operants, without sacrificing the speed of acquisition and strengthening of the student's response repertoire (Sautter & Leblanc, 2006). In a recent study, degli Espinosa et al. (2020), investigated the effectiveness of a multi-component approach in establishing generalized tacting controlled by multiple sources on two children with autism. In the first condition, an echoic priming has been used to establish the intraverbal control of the fixed term (e.g., "color") on the variable term (e.g., "green") of some autoclitic frames (e.g., "*color* green," "*number* 3," "*it is a* dog"). In the second condition students were taught to produce the tact of the object using an autoclitic frame, in which the fixed part had a formal relation with the antecedent verbal stimulus ("What *color* is it? *Color* green"). In the third condition, discrimination was established in the tact of stimuli with the respective autoclitic frame. Following the intervention, the response of both students was generalized to new members of the stimulus classes and, for a child, to a new stimulus class.

In the literature there are numerous procedures aimed at the development of generative responses involving different verbal operants as well as responses of the listener. Some of these can fall into the categories of interventions multiple exemplar training and multiple exemplar instruction (see Chap. 22 for more).

Stimulus equivalence: Procedures derived from stimulus equivalence theoretical framework are used to produce a wide range of new behaviors without direct teaching. A study in this area is that conducted by Sprinkle and Miguel (2012) which evaluated the use of conditional discrimination (listener) and tact training (speaker) in establishing equivalence classes containing spoken words, images, and printed words with children with autism. During the listener training, relations were taught in the following order: AB (to select image [B] in the presence of the spoken word [A]), AC (to select printed word [C] in the presence of the spoken word [A]) and trials are presented in a mixed way AB-AC. During the speaker training, the following relations were taught: BD (label [D] images [B]), CD (read [D] the printed word [C]) and trials are presented in a mixed order BD-CD. The results of the intervention show the emergence of untaught stimulus classes. While listener training did not necessarily lead to the emergence of speaker skills (BD and CD) and to formation of equivalence classes (BC and CB), speaker training led to the emergence of both the skill of the listener (AB and AC) and the equivalence class (BC and CB). It is possible that during speaker training the auditory stimulus produced by their own response may have acquired discriminative control over the orientation toward the image, which is a form of behavior of the listener.

Naming: Horne and Lowe (1996) define naming as a *higher order operant*, in which the same individual acts as speaker and listener in a bidirectional relationship. An example of naming reported by the authors is that of a child who sees a shoe and labels "shoe" (as a private or public event), therefore he hears himself saying "shoe" and emits a behavior of the listener (e.g., orienting toward the shoe or touching it).

Miguel and Kobari-Wright (2013) conducted a study to determine whether tact training leads to the emerging acquisition of the ability to categorize and whether naming is necessary for acquiring the ability to categorize. The results support previous research (Miguel et al., 2008) and confirm how tact training leads to the emergence of the ability to categorize (matching pictures accordingly to their category). Furthermore, after the tact training (tacting the category of an item), the participants selected the correct image according to the name of the category requested (e.g., the child selects the picture card "elephant" when instructor asks: "Touch an animal"), demonstrating a clear transfer from the speaker to the listener behavior (naming). A participant, however, failed to categorize, acquiring the ability only after requesting the tact of the samples, suggesting that he may not have made the tact of the samples. Based on the analysis of naming, during the task of categorization the student must emit the tact of the sample in a private or public way, so as to produce a discriminative stimulus for the selection of the correct comparison stimulus. The results of the study confirm that categorization depends both on naming, that is, the interaction of the listener's and the speaker's behavior.

Relational Frame Theory: a relational frame analysis of tacting behavior distinguishes between derived and directly taught tacts in the following way. Imagine that a square occasions the response "square" because, in the past, the response has been reinforced in the presence of squares. This is very different from a derived tact, for which no explicit history of reinforcement is required for the tact relation to emerge. In derived tacting, a child may respond with "square" in the presence of a square box, for example, because the box participates in a relational frame with the word "square" and other square objects and explicit reinforcement has never been provided for the tact "square." Imagine, for instance, that the child was taught to tact a box (by saying "cereal box" or "box") and was then told that a box is often square (the word "box," the word "square" and actual square boxes now participate in a relational frame of coordination). As a result, when presented with a square box and asked: "What is this?," the child may produce a derived tact by responding with "square," rather than the explicitly reinforced tact ("box" or "cereal box"). In the natural environment, "box" was explicitly reinforced as tact, but on a subsequent occasion the tact "square" was emitted in presence of a box. Distinguishing between derived and directly taught tacting will help to predict and to control these apparently unexpected behavioral outcomes (Barnes-Holmes et al., 2000).

The Intraverbal

Not all verbal relationships which present a verbal antecedent are characterized by the correspondence described above. Take as example the verbal behavior of a man repeating the alphabet or that verbalizes the address of a person after hearing her name. Skinner calls this kind of verbal relation *intraverbal*, where there is no point-to-point correspondence between the response and the discriminative stimulus that evokes it. A student could say "Rome" when his teacher asks him: "What is the capital of Italy?." An intraverbal response produces a generalized conditioned reinforcement. Skinner provides many examples of intraverbal behavior including word associations (dream, bed, pillow, rest, yawn could be appropriate responses to the verbal stimulus “sleep”); social responses under the control of verbal stimuli (“How are you?” “Fine thanks”); responses that manifests themselves as parts of a chain: (“Ready, set……” “Go”); metaphors (“He is the light of my eyes”) and translations.

Michael et al. (2011) describe how intraverbals result from a history of differential reinforcement and state that, like all verbal behaviors, these responses are not under stimulus control until they are reinforced. The first time a person hears “Ready, set…” and says: “Go!,” the response is not an intraverbal. It will become so after the response “Go” will contact the reinforcement in the presence of the stimulus “Ready, set…”.

Therefore, intraverbal behavior allows the development of a more complex verbal repertoire, because if with the acquisition of mands and tacts the speaker learns respectively to ask questions and to show verbal behavior on an object or event that is present, thanks to the intraverbal he is able to answer questions and talk (or think) about objects and events that are not present. Moreover, intraverbal can create additional opportunities to contact reinforcement through interactions with peers and adults. That is why this verbal operant is a critical component of many other aspects of human behavior, such as memory, thought, problem solving, creativity and other academic skills.

Applications in the Assessment of the Intraverbal

The *VB-MAPP Intraverbal Assessment Subtest* (Sundberg & Sundberg, 2011) is an assessment tool based on the typical development of intraverbal behavior and consists of the presentation of tasks with increasing difficulty. The assessment starts from the evaluation of simple stimulus, as for example to give some animal sounds (e.g., “the cat says…”); next comes verbal conditional discrimination (VCD). The latter becomes progressively more complex, with the addition of qualifying verbal stimuli (modifiers) such as adjectives, prepositions, pronouns, conjunctions and more articulated concepts (e.g., negation, time, position).

Sundberg (2016) classifies verbal stimuli that evoke intraverbal behavior in four different types of discrimination. In *simple discrimination* a single verbal component evokes a response (e.g., a speaker says “meow” after hearing “a cat says…”). In *compound verbal discrimination* several antecedent verbal stimuli independently evoke behaviors. When, however, these S^D are presented in the same configuration of the previous stimulus, they assume a different function (e.g., a speaker says “blue” after hearing “red, white and…”). In *verbal condition discrimination*, the antecedent consists of two verbal stimuli, in which one S^D alters the evocative effect of another S^D (e.g., a speaker answers “spoon” after hearing “*What* do you *eat* with?). Finally, in *verbal function altering discrimination*, a verbal stimulus alters the function of another stimulus or MO (e.g., “when I call your name, sing your part”) (Schlinger & Blakely, 1994).

Applications in the Teaching of the Intraverbal

To avoid intraverbal behavior from becoming a “rote” response, there are a variety of prerequisites that the students must have before starting with teaching, such as tact and listener (Sundberg & Sundberg, 2011). Among the numerous proposals for teaching intraverbal behavior, Aguirre et al. (2016) confirm the effectiveness of stimulus control transfer procedures in the intraverbal teaching in a direct way and their effect in facilitating emerging intraverbal repertoires in people with and without disabilities.

Direct Teaching the guidelines for direct teaching of intraverbal behavior involve the use of stimulus control transfer strategies (Ingvarsson & Le, 2011; Goldsmith et al., 2007; Kisamore et al., 2013). Prompting and prompt fading strategies that can be used in teaching, include the use of verbal operant already present in the student's repertoire, such as tact, echoic or textual. Some authors (Ingvarsson & Le, 2011), compared three types of prompts in order to verify which could be more effective. Although participants show better performance using an echoic prompt, the results can be considered inconclusive, as they disagree with another similar study by Ingvarsson and Hollobaugh (2013). A possible explanation for this is suggested by the authors of the articles themselves and corroborated by Coon and Miguel (2012), who confirm that, in all probability, there is no hierarchy of effectiveness between types of teaching prompts. What is really important would be familiarity with a given prompt, namely having had greater exposure to it in one recent learning history. A further factor to emphasize in the intraverbal direct teaching is the passage from acquisition to fluency. On the basis of the principles of precision teaching, in fact, Johnson and Layng (1996) say that some skills, including especially the intraverbal, must necessarily be fluent, in order to lay solid foundations on which to build more complex skills. Emmick et al. (2010) confirm this theory through the demonstration that an intraverbal training condition with the addition of fluency training is more effective than simple intraverbal training in the maintenance and acquisition of new responses.

With the increase in the complexity of the intraverbal training, Ingvarsson et al. (2016), finally suggest the effectiveness of block trials procedures, especially when other types of approaches fail. This procedure involves the presentation of stimuli in blocks of trials, in which the same question is asked (e.g., "What do you eat?," "What do you eat with?") until the criterion is reached (e.g., 4 blocks of trials with a maximum of 2 errors per blocks). Afterward, the trial blocks are reduced (e.g., from 10 to 8 consecutive correct answers) until the presentation of the questions in a random order.

Indirect Teaching indirect approaches include all those currents that have developed teaching strategies aimed at ensuring that intraverbal behavior emerges in a derived way from other training. It is possible to distinguish three main currents: that of stimulus equivalence, that of bidirectional naming and that of relational frame theory.

Stimulus equivalence: Sidman defines stimulus equivalence as a direct result of the reinforcement contingencies (Sidman, 2000) in those specific cases where there are conditional stimuli, that is, where the type of contingency present is at least four terms. The stimulus equivalence paradigm provides for the teaching of a small set of stimulus-stimulus relationships that led to the *emergence* of relations not directly taught between the stimuli in question (Zaring-Hinkle et al., 2016). The strategy used in teaching aimed at bringing out derived responses is called Equivalence-Based Instruction (EBI). Through this tool the potential of teaching increases exponentially, on the basis of the principles of reflexivity (A equals A), symmetry (If A equals B, then B equals A) and transitivity (If A equals B and B equals C, then A equals C). From the direct teaching of at least two relationships between stimuli can be obtained many more in a derived way. Thus, time and effort are reduced. In teaching intraverbal behavior this approach has made a great contribution, as it lays the foundations for the construction of a generative repertoire.

Widely validated results come from that part of literature that has used the prerequisite of the tact within EBI strategies aimed at bringing out intraverbal responses. The procedure provides that, after learning the correct response based on a conditional stimulus between the AB and AC relationships, derived intraverbal responses emerge (May et al., 2013; Ordonez, 2019). For example, after teaching to respond in the presence of the image of a tree and in the presence of the conditional stimulus "in the English" with the response "tree," and in the presence of the same image and the conditional stimulus "In French" with the response "arbre," the result is a series of emerging responses, such as the "arbre" response to the question "what do you call tree in French?." In agreement with May et al. (2013) it is evident how the fact of including in the educational sequence all three experimental stimuli (in the example: [A] image, [B] tree and [C] arbre), facilitates the emergence of new responses beyond those directly taught.

A new current of research has instead applied the approach of EBI to the emerging teaching of intraverbal responses through the use of other intraverbals. This implies all stimuli that make up the equivalence class are vocal stimuli (Zaring-Hinkle et al., 2016). In one study (Perez-Gonzales et al., 2008, as cited in Zaring-Hinkle et al., 2016), the vocal stimuli included were related to states, cities and parks. Two intraverbal relations between these stimuli have been taught directly, for example, "Buenos Aires is a city of Argentina" and "El Botanico is a park of Buenos Aires," from which all the other intraverbal relations could emerge in a derived way, for example, "El Botanico is a park in Argentina."

The emergence of so derived intraverbal relations has been further supported by the achievement of positive results not only through *Linear Series* strategies (LS), that is, by teaching the AB and BC relationships, as in the example shown, but also trough *One-To-Many* strategies (OTM), that is, teaching AB and AC and *Many-To-One* (MTO), teaching BA and CA (Zaring-Hinkle et al., 2016).

Carp and Petursdottir (2012) have pointed out the importance of some prerequisites necessary for such a strategy to succeed, such as those of the multiple control of the stimulus. The authors showed how the use of an exemplar training (e.g.: "Tell me one State; tell me another") and a category training (e.g., "What is Buenos Aires?"), where this ability is lacking, is necessary and sufficient for the emergence of derived intraverbal relationships, when these don't come up on their own. In addition, DeSouza et al. (2019) confirm the importance of some prerequisite skills already described by Sundberg & Sundberg (2011), for the emergence of convergent intraverbals (e.g., "A mammal from the savanna is…"): multiple tacts (e.g., "Name it," "it is a…," "this is from…"), multiple listeners (e.g., "point to all mammals"), intraverbal categorization (e.g., "Tell me some mammals") and listener compound discrimination (e.g., "Point to the mammal from the savanna").

Intraverbal bidirectional naming: Horne and Lowe (1996) define naming as a higher order operant behavior, consisting of a bidirectional relationship between the speaker's and listener's behavior. The teaching of only one of these components is sufficient to acquire both. Intraverbal bidirectional naming (Horne & Lowe, 1996), is a type of naming in which *matching to sample* (MTS) training contingencies can establish bidirectional intraverbal relationships among specific names. The latter, in turn, mediate the correct response on a subsequent test of stimulus equivalence. For example, when a student is taught to select an image of a triangle in the presence of a star, he can intraverbally connect the stimuli by saying: "The star goes with the triangle." In subsequent trials, the responses of the participant to the MTS test can be verbally mediated when he labels the sample saying "star," a response that automatically will evoke the previously learned relationships, namely that the star goes with the triangle, that controls the behavior of selecting the correct comparison (e.g., image of triangle) (Santos et al., 2015).

Santos et al. (2015) assessed whether intraverbal training is effective in performing MTS tasks in college students. In the first experiment, it was assessed whether the participant were able to match arbitrary visual stimuli (AB) after learning to tact the two classes (A and B) and connect them intraverbally (e.g., "A goes with B"). Following tact training and intraverbal training, all participants carefully matched the stimuli and emitted the taught intraverbals, showing how the conditional relationship between A and B can only be established trough intraverbal naming. In the second experiment, it was evaluated whether the same training would produce the bidirectional intraverbal in the form of "B goes with A" and MTS performance consistent with the principle of symmetry (BA). The results showed that intraverbal training AB (A goes with B) is sufficient to produce new intraverbal bidirectional (B goes with A), but also to perform MTS performance consistent with the principle of symmetry (BA). Hence, stimuli that are intraverbally linked can be replaced by others, such as when seeing or hearing one member evokes the other's selection or tact.

Relational frame theory: RFT uses multiple exemplar training (MET) extensively in order to offer broad opportunities for generalizing skills that require an increasing discrimination of the stimulus, ultimately useful for conversation development. RFT revisits the subject of arbitrary relations and highlights that these relations are based not only on equivalence relations but also on non-equivalence ones. The equivalent relations, in fact, as the word itself emphasizes, are based on the concept of similarity, but in reality, a large number of stimulus relations are based on non-similarity (Barnes-Holmes & Hayes, 2003). Therefore, in considering all types of relationships derived indirectly from experience, the RFT proposes an extension of the vocabulary in place for the description of the same (Hayes & Wilson, 1993). Then, it includes the concept of symmetry within a wider class defined as *mutual entailment*, which incorporates all emerging relations of a bidirectional, similar, opposite, comparative, space-time or casual type. Relations of mutual entailment result both those derived after learning that A is equal to B and therefore B is equal to A, but also those derived from learning that A is different from B and B is different from A. Even more interesting are those derived relations of comparative type, which are necessarily configured as asymmetric. For example, learning the concept that a tree is taller than a bush, the emerging bidirectional relation will be that a bush is lower than a tree. Even the concept of transitivity is inserted within a class called *combinatorial entailment*, in which the relations emerging from the link between two stimuli with a third stimulus in common cannot be based only on the concept of similarity or interchangeability. For example, once you have learned the concept that the word "employment" and the word "work" are the opposite of the word "rest," it emerges, in a combinatorial way, that "employment" is equal, not different from "work." In addition to this reclassification of existing derived relations, the authors of RFT also point out the importance of reconsidering the *transfer of function* process, characteristic of the equivalent classes, classifying it as a specific case of the wider process of *transformation of stimulus function*. In the previous example, we can easily deduce that if "employment" and "work" can acquire the same function, the word "rest" will assume exactly the opposite function, by virtue of the type of relationship between such stimuli.

The relationships described, although they define different types of what Hayes calls "relational frames" do not explain the process, but only the outcome. The relational frames are in fact real "generalized operants," the construction process of which is represented by the whole history of reinforcement contingencies that have led to the formation of certain relational responses that are under contextual control (Hayes et al., 2001). Unlike Sidman, however, the relations derived as a result of this process are not a "side effect" of the implemented teaching, but the main goal. As a consequence of the principles set out above, this alternative perspective proposes the distinction for each operant described by Skinner between verbal and nonverbal responses, where among *nonverbal* there are all those learned by direct teaching in an isolated way, whereas *verbal* responses include all those that, at different levels, involve a transformation of the function of the stimulus in accordance with a specific relational frame (Barnes-Holmes et al., 2000). In the context of intraverbal behavior, the RFT therefore makes a clear distinction between what is defined as nonverbal and verbal intraverbal. When any intraverbal response is taught in isolation and then separated from other words or specific events, in fact, it does not become part of any relational frame. Consequently, it is configured as an intraverbal response that has no point-to-point correspondence or necessary formal similarity with the antecedent verbal stimulus, but is not verbal. On the contrary, when an intraverbal response is connected with other words or with specific events, it automatically becomes part of a set of relationships that allow that same response to be defined as verbal (Barnes-Holmes et al., 2000). For a clearer understanding, we refer, in conclusion, an example reported by the above-mentioned authors: a parrot is taught to respond to the instruction "count up to three" with the response "one, two three," with direct reinforcement. In this case the response is separated from any relational frame and is therefore configured as nonverbal. The same identical response becomes verbal when connected not only to the antecedent stimulus in question, but also to a series of other stimuli that make the response part of a specific relational frame. In our example, the numbers one, two and three can be part of a comparison frame that including the concept that two comes after the one and before the three.

The Codic: Reading Text

After fully defining the echoic behavior, Skinner introduces *textual behavior*: "a familiar type of verbal stimulus which controls verbal behavior is a text" (Skinner, 1957 p.65). More commonly, the printed text is the visual control variable of text behavior, called simply reading. According to the same author, the reader is "a speaker under the control of a text."

Michael introduces the term *codic* to refer to responses controlled by a verbal stimulus with presence of point-to-point correspondence in the absence of formal similarity between stimulus and response, including precisely the reading and the behavior of writing under dictation. In reading, in particular, the stimuli that control behavior are visual (in a sensory mode), while the response is auditory (in another sensory mode), but the auditory response corresponds to visual stimuli.

A text can also be presented in the form of images and in that case the reading will simply consist of emitting an appropriate vocal form for each image; or we can have pictograms, hieroglyphics, phonetic symbols or Braille. Moreover, in reading, printed stimuli can be explicitly named or "covered" (silent reading). If the stimulus control is not accurate, there will be faulty textual behaviors, which is an incorrect reading.

Application in the Teaching of Reading

In the application area there are several approaches based on experimental methods, although unfortunately there is not much research. DeSouza et al. (2009) developed a research program, based on a variation in the matching-to-sample procedure, which starts with teaching simple words with sequences of consonants and vowels (bad, fan, nap), followed by the teaching of more complex word sequences (breads, chair, snake); at the same time the children also learned to read the same words. Always starting from a matching to sample procedure, Miguel et al. (2009) first taught some children with autism to select printed images and words, and then the participants, without further instructions, were able to read the written words aloud.

These studies show that textual behavior can be established indirectly through educational procedures that promote derived relations between printed words, images and dictated names; this is especially important when one of the goals is to optimize the time spent teaching. On this subject a study by Hopewell et al. (2011) uses a treatment package based mainly on the use of direct instruction together with flashcards, to increase reading skills in two primary school students with severe behavioral problems. Results showed that the independent variable led to an increase in the correct student responses and improved fluency and compliance with teachers (thanks in part to the application of the token economy), beginning to consider reading an easier task to accomplish.

The Duplic: Copying a Text

Until now we have only considered the vocal verbal behavior in which the speaker produces an auditory response that is reinforced when it has an effect on the listener as an auditory stimulus. But according to definition of verbal behavior that we explained initially, when a speaker produces a visual response with similar effects, the behavior in question is also verbal. Since writing can also be counted as verbal behavior, another relationship between antecedent stimulus and the response must be considered. Skinner calls it "copying a text," translated more simply as *copying*: the antecedent stimulus is visual (the text to be copied), the response is written (the copied text) and the reinforcement is generalized. The same author explains this verbal operant in a meaningful way, through two comparisons that also involve echoic behavior: "just as echoic behavior approaches mimicry, so what we may call copying approaches drawing" (Skinner, 1957 p. 70). The final reinforcement always depends on the correspondence between the response and the stimulus, but in copying could lack the correlation among the motor acts that reproduce the text and those that generated it, just as there could not be the correspondence between the two graphic signs. On this subject, Skinner states that the repertoire of behaviors required to copy a text can produce different visual forms from the antecedent stimulus.

Teaching Applications to the Copying

The verbal operant of copying a text, although is one of the most important skills, has been the subject of little research from an applicatory point of view. In one study, DeSouza et al. (2009) implemented matching to sample procedures to teach copying skills. In detail, in the mentioned study, a group of letters ("A," "B," "D," "R," "C"), was presented to the subject at the same time as the sample stimulus (the written word CAR) and then asked to "build" a word identical to the sample. Obviously at the time when the stimulus was represented by a printed word, the task required was essentially to copy.

Typically, in the context of education, having a repertoire that allows you to copy a text is a basic skill in text writing or rather is precisely a precursor behavior of independent writing. More specifically, in the process of teaching/learning a foreign language, copying a text has probably been one of the most used strategies in the past and its effectiveness has been the subject of several studies. Some authors (Uda & Sasaki, 2010) argue that copying a text in L2 (a language that is learned after the acquisition of mother tongue) can allow improving spelling in general, acquire new communication skills and learn basic vocabulary. In today's teaching method, however, hand-copying has often been replaced by the use of multimedia tools within an e-learning teaching, in which students and teachers communicate within a collaborative virtual environment. It seems, therefore, that there is a gap between manually copying and the exclusive use of multimedia devices to improve learning.

A very interesting study (Miyake & Owoku, 2012) demonstrated that it is possible, within an e-learning teaching method, to introduce the verbal behavior of copying a text, with positive results, regarding the learning of a foreign language. Some Japanese students were asked to manually copy what was proposed on the screen of a laptop, related to the lexicon and some aspect of English grammar. It has been shown that by copying by hand, students have acquired more easily words or phrases in L2, the percentage of correct responses has increased compared to the acquisition obtained copying not by hand but typing to the laptop. It must be said that it was not measured if the effectiveness of copying a text has changed depending on the language ability of the students.

Undoubtedly this verbal operant also becomes in the domain of application a strategy to be used to achieve additional goals and skills, such as the understanding of a text: copying a text can represent the first educational step to comprehend what we read, especially in the presence of specific learning difficulties.

The Behavior of the Listener

The listener is an important part of the contingency that governs verbal behavior. Skinner defines the listener as a discriminating stimulus for the speaker who constitutes an audience for his own verbal behavior.

> The listener is again a discriminating stimulus. He is part of an occasion upon which verbal behavior is reinforced, and he therefore becomes part of the

> occasion controlling the strength of behavior. [...] We may speak of him as the audience. The audience, then, is a discriminating stimulus in the presence of which verbal behavior is characteristically reinforced (Skinner, 1957 p. 172)

The effects of listener behavior on the speaker's behavior can be multiple: for example, if the listener constantly looks at the speaker, nodding or praising him, he will undoubtedly be a social reinforcer; on the contrary, if he constantly shakes his head looking elsewhere, it will have a punitive effect; the listener who answers to the speaker's requests will act as the mediator of the reinforcement. A verbal discriminatory stimulus can evoke echoic, intraverbal, and textual responses even in the listener who becomes a speaker in his turn.

Applications to the Teaching of the Listener Behavior

The use of a taxonomy of verbal behavior, based on Skinner analysis, has emerged in the planning of interventions for children with autism or other intellectual disabilities since the 2000s. Historically, even within the behavioral analysis, language was distinguished into *receptive* or *expressive*. The first curricula of intervention based on the UCLA model (Lovaas, 1977, 1981), suggested as a priority the intervention, starting with the teaching of the receptive language before inserting a formal training for the expressive language on the same targets previously taught (e.g., learn first to touch the image of a dog and then to name it). Although these recommendations are part of some operational manuals of intervention (Leaf & McEachin, 1999; Lovaas, 2003; Taylor & McDonough, 1996), the results derived from the literature suggest instead how starting from the teaching of listener skills does not necessarily encourage the development of responses as a speaker and how it is more likely that it is the acquisition of speaker responses to facilitate the emergence of listener responses (Contreras et al., 2020; Cuvo & Riva, 1980; Petursdottir & Carr, 2011; Delfs et al., 2014). Teaching programs of listener skills, based on a Skinner's analysis of verbal behavior, suggest instead to start from teaching answers as speakers (e.g., mand, tact, or intraverbal) and then to assess the issue of listener responses, or possibly teach the listener skills along with the responses as a speaker on the same stimuli (Barbera, 2007; Greer & Ross, 2007; Schramm, 2006; Sundberg & Partington, 1998). One of the first skills usually included in an ABA intervention program for children who have not acquired responses as a listener contacting natural environmental contingencies (e.g., attention from the audience as conditional generalized form of reinforcement for the behavior of following simple instructions) concerns responding with a nonverbal behavior to verbal S^D presented by a speaker (e.g., touching a ball when someone asks "where is the ball?"). In the literature there are mainly two ways to establish these first responses as listener: the simple-conditional method and the conditional only method. A *simple discrimination* is characterized by a three terms contingency: antecedent, response, and consequence. Responses contact the reinforcement if they are emitted in the presence of the antecedent stimulus and not in its absence (Green, 2001). An example of a simple discrimination is to follow simple instructions (e.g., to respond as a listener to the instruction "raise" or to touch the image of a ball when it is the only image present and after receiving the instruction "ball"). A *conditional discrimination* (also called manded stimulus selection, Michael, 1985) requires a four terms contingency: a sample stimulus, the presentation of comparison stimuli, a nonverbal response, and a consequence (Grow et al., 2011). An example of conditional discrimination consists in selecting an object (e.g., a glass) in the presence of other objects (e.g., a plate and a spoon) and of a verbal stimulus (e.g., "reach me the glass?"). The verbal stimulus presented momentarily makes one of the objects an S^D and other objects S^Δ.

Using the *simple-conditional method,* we start with the teaching of simple discriminations through mass trials. For example, in a set of three images, initially the correct answer is to select always the image 1, while images 2 and 3 never represent the correct answer; then the correct response always requires the selection of image 2 and not of images 1 and 3, and finally the selection of image 3. In the following phases of the intervention, we arrive at a conditional discrimination among the stimuli identified as targets, with all three stimuli that in rotation represent the correct response (Leaf et al., 2017; Lovaas, 2003). With the *conditional-only method*, instead, you start directly teaching a conditional discrimination (also called auditory-visual conditional discrimination) presenting two or more nonverbal stimuli (e.g., images or objects) which in rotation represent the correct response and a specific verbal stimulus for each target (called auditory conditional discriminative stimulus) to evoke the correct response (Kodak et al., 2015). The reader is suggested to read Chap. 15 for more information.

Comparing the two modes of teaching, the conditional-only method is easier to promote the acquisition of responses under correct stimulus control and reduce the probability that patterns of errors may develop during the acquisition phases, resulting also a more efficient teaching method when compared to the simple-conditional method (Green, 2001; Grow et al., 2011, 2014; Vedora & Grandelski, 2015; Lin & Zhu, 2020). Given the relative complexity of showing answers that provide for an auditory-visual conditional discrimination, it may be advisable to evaluate the presence of other simpler skills that can be characterized as pre-requirements for acquiring this response class. For example, Kodak et al. (2015) investigated the correlation among matching skills, visual discrimination (touching one between two images produces reinforcement, touching the other image does not produce reinforcement), auditory discrimination (to show a specific response in the presence of a sound and not in its absence), imitation of pointing, and scanning on the acquisition of responses from listener that required conditional discrimination. In seven of the nine participants in the study, the authors found a correspondence between the presence of these skills and the acquisition of responses as a listener. Despite proper teaching of these skills, additional curricular changes or training may be required to allow the acquisition of target responses under the control of the correct environmental variables (see Grow & Leblanc, 2013 and Lamarca & Lamarca, 2018, for a review).

For example, it is possible to insert a differential observing response (DOR) in the early stages of teaching (Dube & McIlvane, 1999), asking the student to show a response that demonstrates the sensory contact with the sample stimulus (e.g., after receiving the instruction "Touch the house" the child repeats "house" as echoic or mimetic). Another important part of the teaching to be carefully controlled is the prompting and fading mode, since the way in which the prompt is supplied, such as the tone of the voice used or inadvertently looking at the object to be selected, could lead to the development of faulty stimulus control (over selectivity). For example, in a study on the identification of the best strategies to establish an initial repertoire of auditory-visual conditional discriminations, Fisher et al. (2019) used an identity-match prompt (an image identical to the correct comparison) as a prompt to increase the probability that participants respond to the correct comparison. After the presentation of the antecedent stimulus ("touch the apple") and after having requested a DOR (e.g., "repeat apple"), in case of error in the selection, the experimenters showed an image identical to the correct image to be selected (e.g., image of an apple) to evoke the target response.

During the intervention, the complexity of the stimuli controlling listener responses is gradually increased by requiring increasingly specific responses for different configurations of the preceding verbal stimulus. For example, a greater difficulty of responses is required in the presence of antecedent *compound verbal stimuli*, that is, when the same response is controlled by two or more antecedent stimuli or by more elements of the same stimulus, as in the selection response of an empty container during a work activity within a supermarket, in response to the instruction of a work colleague "pass me an empty container" (Eikeseth & Smith, 2013). This type of response is under convergent multiple control exerted by all components of the antecedent stimulus, which together control the selection response (Michael et al., 2011). To issue the correct response, it will be necessary to respond as a listener to both parts of the verbal S^D, with a discriminative response controlled by the salient characteristics of the antecedent stimuli (full or empty container). The training usually involves initially the isolated teaching of listener responses for the different antecedent stimuli in isolation (e.g., responding as listener to the antecedent "container" and separately to the antecedent "empty") and then the presentation of the compound stimulus. The complexity of the previous stimuli is gradually increased by inserting more components into it (e.g., "Pass me a small yellow empty container"). A further level of complexity is given by listener responses for which a conditional discrimination is needed, where the presence of one or more verbal stimuli alters the function of other verbal stimuli (Catania, 2007; Michael et al., 2011; Eikeseth & Smith, 2013). Skinner (1957) uses the phrase "If your name is Charlie, stand up!." In this example, the first part of the verbal stimulus (if your name is Charlie) alters the function of the second part of the verbal stimulus (stand up) transforming it into a S^D or a S^Δ based on the listener's learning history (i.e., if he is called Charlie or in a different way). The literature has shown how it is possible, through specific intervention procedures, to teach responses as listener that require a verbal conditional discrimination l (e.g., "Find a sea animal" vs. "Find a savannah animal") and how the acquisition of such responses can facilitate the emergence of other verbal responses under multiple control (e.g., intraverbal or tact control) (DeSouza et al., 2017, 2019).

Despite the currently available teaching technology, it is impossible to teach explicitly and with discrete trials all possible components of the language. The research investigated the possible mechanisms underlying the emergence of untaught responses and generative language (Greer & Ross, 2007). Over the years, three different theoretical currents have developed to identify the possible mechanisms responsible for the generative language: Stimulus equivalence (Sidman, 1971), Naming (Horne & Lowe, 1996) and Relational Frame Theory (Barnes-Holmes & Roche, 2001). From these three different conceptual currents, united by the attempt to explain the same process, different strategies of intervention have derived. For example, the presence of Naming is demonstrated when, from the direct reinforcement of a listener response, as the behavior to bring a chair to an adult in response to S^D "Bring me a chair," also emerges a response as a speaker (a tact) of the same stimulus, such as the response "it is a chair" to S^D "What is that?," together with the presence of the chair, without the same response being directly reinforced. In the same way it is possible that direct reinforcement of responses as a speaker produces the emergence of responses as listener. More recently, the term Bidirectional Naming (BiN) has been used to identify the integration of both listener and speaker behavior (Miguel, 2016). During typical interactions between a child and his caregivers there are frequent opportunities to respond with listener behavior to verbal stimuli. For example, a mother can indicate a bird to fly and say: "Look there's a bird!." The child will then orient himself toward the bird receiving attention (a conditioned social reinforcement) from the mother. With the emergence of echoic responses and after a generalized reinforcement learning history for such responses, it is possible that the child will show, overtly or covertly, echoic responses in response to the speaker's verbal stimulus and in the presence of the nonverbal stimulus that controls the listener's response (the bird), thus also showing a speaker's response (the tact of nonverbal stimulus "bird") that will contact generalized reinforcement because shown in the same episode with the response as a listener. As a result, nonverbal stimulus can become an S^D for a response as a speaker (tact) (Miguel, 2018). Likewise, when the mother asks the child, "Do you know what this is?" indicating a dog, the child will show the tact of the nonverbal stimulus ("It is a dog"!), but at the same time also a listener response, moving toward the stimulus. Several studies have shown that the BiN can be established through teaching procedures that provide for the use of multiple exemplars (MEI), favoring the emergence of responses not taught directly (Lowe et al., 2002, 2005; Gilic & Greer, 2011; Greer et al., 2005, 2017; Olaff et al., 2017;

Delfs et al., 2014). It has also been suggested that it is necessary, for the development of BiN, that the child's behavior is sensitive to sources of conditioned social reinforcement (e.g., comments and smiles) (Greer & Du, 2015). In clinical practice, it may be useful, when such sources of control are not established by natural contingencies, to use specific procedures to make social responses conditional reinforcements (Olaff & Holth, 2020). A further possible clinical indication during the teaching of the first skills as listener during the DTT could consist, for example, in requiring a collateral echoic response (or DOR) of the salient component of the verbal stimulus presented by an instructor (e.g., to ask the child the echoic response "ball" as part of the instruction "touch the ball") and in requiring the same response when selecting the correct image (e.g., to issue the vocal response "ball" while selecting the image of a ball) (Horne et al., 2004; Miguel & Petursdottir, 2009; Petursdottir & Carr, 2011). Then you could test the emergence of responses as speaker after teaching direct responses as listener.

Similarly, Lowenkron (1984, 1988) suggested that the presence of responses of mediation may encourage the emergence of complex responses and how such responses are often under multiple control by different stimuli. For example, a listener response can be emitted under the simultaneous control of two different sources of stimulus control and then emerge as an effect of joint control exercised by the interaction between tact and echoic responses. The listener response will then be issued through the mediation of verbal responses. Imagine a child who has to respond for the first time to a complex instruction like "Go to your room and get your backpack and your jacket!." It is possible that the child shows, overtly or covertly, echoic responses of the salient parts of the instruction received (e.g., backpack... jacket...). When these self-echoic responses are shown in the presence of the corresponding nonverbal stimuli (e.g., the child repeats backpack and jacket in its presence) and then issued as a tact of the same nonverbal stimuli, an increase in response strength, or "saltation," (Palmer, 2006, 2009) occurs as a result of the introduction of the second of the two discriminative stimuli. The control exercised by the jump in the strength of the response establishes nonverbal stimuli such as S^D by evoking the response of selection (the child takes the backpack and the jacket). In accordance with a mediated stimulus selection account, as described by Joint Control, it is possible to explain the emergence of listener responses for which there is no past history of direct reinforcement and therefore to encourage the emergence of new responses without the need for formal teaching. Several studies have assessed the effect of teaching procedures using Joint Control as an independent variable (see Ampuero & Miklos, 2019 for a review). For example, Causin et al. (2013) used procedures based on the joint control analysis to teach selection responses (select multiple pictures from a larger set) mediated by verbal responses without the need for formal teaching for the specific selected target. Vosters and Luczynski (2020) used similar procedures to teach three children with ASD to complete novel two-step instructions to generalize and maintain acquired skills. In addition, these authors performed a component analysis of joint control to demonstrate how both sources of joint stimulus control and verbally mediated responses are needed to explain the results obtained, in line with previous results of transnational researches on the same topic (Clough et al., 2016; Degraaf & Schlinger, 2012; Gutierrez, 2006; Sundberg et al., 2018).

Skills as a listener, of course, are not limited to following a simple instruction or discriminating a simple command. The role of the audience within a verbal episode is much more complex, as the listener mediates reinforcement for the speaker's behavior, determining the future probability of a given response. For example, the use of a technical language will be more likely if you speak to professionals or the use of the Italian language will be more likely in the presence of people who speak Italian. In addition, within a conversation, the listener exchanges his role with the speaker, becoming in turn speaker and showing verbal behavior mediated by the audience present at that time (Michael et al., 2011).

Listener behavior may be affected by the speaker (Palmer, 2005, 2007; Schlinger, 2008). Let's take as an example the behavior of buying the latest album of a new rock band because a friend of ours told us that they play great music. This listener behavior (later transformed into a speaker behavior at the time of purchase) is not explainable by direct contingencies that could increase the probability of buying the new album (the rock band album has never been heard before). A possible hypothesis is that the speaker's verbal behavior has transformed the function of some stimuli (music store, new album) into discriminative stimuli and reinforcements and that such stimuli have entered equivalence classes with other stimuli (e.g., the new album with excellent music) bypassing direct reinforcement contingencies (Schlinger & Blakely, 1987; Sidman, 1994; Hayes et al., 2001). It is also conceivable that the listener is not "passive" agent within the verbal episode, but instead shows an active role as a covert speaker (Palmer, 2005, 2014) through possible mediation responses composed, among others, by echoic responses and responses under intraverbal control of the speaker's behavior, which allow discriminatively to respond to both verbal and nonverbal stimuli (Dugdale & Lowe, 1990; Miguel et al., 2008; Randell & Remington, 2006).

In recent years, researchers have investigated the underlying mechanisms of acquiring skills from complex listeners and proposed specific teaching strategies, taking into account skills such as to respond properly in the presence of metaphorical language (Persicke et al., 2012) or sarcastic (Persicke et al., 2013), to respond to implicit requests (Najdowski et al., 2017) or to respond to a disinterested listener during a conversation (Peters & Thompson, 2015). Among these more advanced abilities is also included the ability of perspective taking or "Theory of Mind" (see Peters & Thompson, 2018 for a review of applied studies and Schlinger, 2009 for a theoretical account). These new areas of research show that the contribution of the Skinner's analysis of verbal behavior is fundamental not only to explain relatively simple phenomena but also extremely complex responses without the need to use conceptual explanations from other disciplines.

The Autoclitic

So far, we have seen how it is possible to outline a taxonomy of verbal relationships on the basis of the environmental events that precede and follow verbal behavior. However, not all of them fall into the categories described: there are complex verbal relationships in which linguistic expressions are ordered in precise sequences or base themselves on the possibility of transforming such sequences into others, thus changing the effect that a sentence has on a listener. This particular relation of transformation and organization of the verbal event is defined autoclitic by Skinner: according to him, it is not a unique class of verbal relationships, but illustrates the functional characteristics of five subclasses that he calls descriptive, qualifying, quantitative, manipulative, and relational autoclitics. The event that controls the emission of descriptive autoclitics may be part of or coincide with that which controls the emission of the primary response, like the word "I hear" in the phrase "I hear Dad coming"; or originate in the subject's private sphere or emotional state as "I'm happy to...." *Descriptive* autoclitics arise from the discrimination of one's verbal behavior and for this reason they are probably implicated in what we call self-awareness (Catania, 1980); *Qualifying* autoclitics modify a tact or an intraverbal to alter the intensity or direction of the listener's behavior. In this category, Skinner includes terms that indicate affirmation or negation (Yes! No!) or the term "as" used in similarities. *Quantitative* autoclitics include article and undefined pronouns. Autoclitics can fulfill their function of changing the behavior of the listener as a function of obtaining a specific response from the listener, because they offer the speaker the possibility of manipulating a sentence in such a way as to relate precisely the elements that compose it: Skinner identifies in the *manipulative* and *relational* autoclitics such verbal relationships. The first ones include correlation expressions as if....then, or vice versa, while in relational autoclitics there are many grammatical mechanisms, such as gender distinction (masculine/feminine) and number distinction (singular/plural).

Autoclitic behavior is defined as secondary verbal behavior that depends on primary verbal operants (e.g., mands, tacts, echoics, and intraverbals) (Skinner, 1957). Within a verbal episode, the presence of autoclitics has the function of "clarify or alter the effect of verbal behavior upon the listener' '(Skinner, 1957, p. 332). For example, in the phrase "I am sure that Alessandro is bald," the part "I am sure" (descriptive autoclitic) describes the force of the primary verbal operant, (the tact "Alessandro is bald") modifying the listener's reaction accordingly, with a greater tendency to consider as certain the statement of the speaker when compared to the phrase "I think Alessandro is bald." The source of reinforcement for the autoclitic response will be an increased communicative effectiveness (Carr & Miguel, 2013).

When autoclitic responses take on a constant structure through several examples of verbal responses, we talk about *autoclitic frames*, or *intraverbal autoclitic frames* (Palmer, 2017). In autoclitic frames some parts of the statement remain constant, while other parts vary at the same time depending on environmental variables, which control the speaker's behavior. For example, in a relation "X is larger than Y," the autoclitic frame "is larger than" remains constant while the two terms in comparison vary. When autoclitic frame is controlled by different stimulus conditions and used in different verbal episodes, contributes to the generative language and to the use of verbal forms that do not need formal teaching.

Given that autoclitic behavior depends on other verbal behavior and is not emitted in isolation from the primary verbal operants, during a teaching program it is necessary that the latter are acquired before using strategies that encourage the emergence of autoclitical responses and usually the same responses are not taught directly. For example, Cengher et al. (2019) have favored the emergence of autoclitic responses by exploiting extinction-induced variability in their teaching procedure, not reinforcing simple mand (without autoclitics, such as "cookies") in favor of mand with autoclitic frames (e.g., "I want cookies please"). Luke et al. (2011) have used procedures based on multiple exemplar instruction (MEI) to promote the abstraction of spatial autoclitic frames (e.g., under, over, and on top) in children with autism and language disabilities. Speckman et al. (2012) have operated similar strategies to induce abstraction of the frame "-er," such as "bigger" or "happier" as comparative forms of "big" and "happy." Other studies have investigated the use of modeling for passive voice teaching (Wright, 2006; Østvik et al., 2012; Dal Ben & Goyos, 2019).

In their study on establishing generalized multiple controlled tacting to children with ASD who showed responses under restricted stimulus control, degli Espinosa et al. (2020) have used autoclitic frames matching the verbal antecedent stimulus, teaching a specific frame for each specific verbal antecedent (e.g., responding with "It's a X" to the verbal antecedent "What is it?" or with "Color x" to the verbal antecedent "What color is it?" for the same nonverbal stimulus).

Autoclitic frames could also be used for teaching very complex skills such as perspective taking, in order to facilitate the discrimination between the source of control of own behavior and the behavior of a third person specifying the sensory mode through which you enter or do not enter into contact with a certain stimulus (e.g., I know information because I see/feel/touch it while a third person does not know it because he does not see/feel/touch it).

In addition, autoclitic frames play an important role in the development of grammatical structures within a language, representing the fixed part of a sentence or verbal form, while other sources of motivational, contextual, or audience variables control for the variable part of verbal behavior (Palmer, 2014, 2017). These combinations of fixed and variable parts of the language are also practiced and acquired through automatic reinforcement and automatic shaping of the speaker's verbal behavior, which can set and modify its verbal behavior to match the verbal behavior of the verbal community (see the concept of achieving parity, Palmer, 1996).

In conclusion, it seems that the possibility of a human being to fully participate in his community life is directly linked to the development of his verbal behavior. Communicating one's needs, describing one's external and internal environment, and imitating and responding as a listener to the verbal behavior of others are inextricable behaviors in the development of every human being. Skinner's analysis of verbal behavior (1957) makes this clear and the scientific evidence confirms it. Similarly, the role of verbal behavior in complex behaviors such as remembering, problem solving, making inferences, responding to nonliteral forms of language such as irony and sarcasm and more seems central. The corpus of scientific research that demonstrates it is growing and Skinner's analysis is still and will be a source of guidance and inspiration for current and future trends.

Acknowledgments We thank Dave Palmer, Vincent Carbone, and Nicole Rodriguez for their helpful suggestions in the preparation of this chapter.

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58 Vocational Skills for Individuals with Autism and/or Intellectual and Developmental Disabilities: Implications for Behavior Analysts

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Much behavior analytic research has been directed toward early intervention of individuals with autism spectrum disorder (ASD) and less emphasis has been placed on preparing individuals with ASD and intellectual and developmental disabilities (IDD) for the workforce (Hurlbutt & Chalmers, 2004). Many adults with ASD and/or IDD remain underemployed or unemployed after completing high school (Howlin & Moss, 2012; Shattuck et al., 2012; U.S. Department of Labor, 2020; Winsor et al., 2018). When these individuals are employed, their job quality and earnings are often lower than that of their neurotypical peers (Burgess & Cimera, 2014; Howlin 2000; Howlin et al., 2004; Winsor et al., 2018). Behavior analysts have the skills to create meaningful changes in the lives of individuals with ASD and/or IDD by better preparing them for employment and supporting them in these employment activities. Employment not only allows an individual to contribute to the community but also allows for greater autonomy. Individuals who are employed can contribute to their own financial support (Cimera & Burgess, 2011; e.g., buying their own groceries, paying their own bills) and pursue their own interests (e.g., going to the movies, dating, buying video games). In this chapter, we will guide readers through each stage of workforce development and readiness, speak to the law regarding vocational training and services for adults with ASD and/or IDD, provide an overview of research related to teaching necessary workplace skills, and make recommendations for clinical practice and future research.

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Transition from Childhood to Adulthood

As students with ASD and/or IDD progress through the educational system, they and their caretakers may face challenges beyond that which neurotypical students and their families face. To assist with these challenges, the United States Department of Education (U.S. DOE) enacted the Individuals with Disabilities Education Act (IDEA, 2004). The IDEA (2004) is a law that ensures all children with disabilities receive a free and appropriate education (FAPE) and emphasizes access to special education and related services designed to meet their unique needs and prepare them for further education, employment, and independent living. Although many neurotypical students and students with disabilities may not seek out vocational opportu-

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_58

nities while in school, IDEA (2004) mandates that "transition services" are a part of a student's Individualized Education Program (IEP). Transition services, as outlined by IDEA (2004), refer to a coordinated set of results-oriented activities for a student with a disability that are focused on improving the student's functional achievement with the goal of facilitating movement from school to post-school activities (e.g., vocational education and integrated/supported employment). IDEA (2004) further stipulates that transition planning is based on the individual child's needs, taking into account their strengths, preferences, and interests and includes instruction, related services, community experiences, the development of employment, and other post-school adult living objectives and, when appropriate, functional vocational evaluation. Although IDEA (2004) does not specify how this planning is to be implemented, it does mandate that appropriate measurable postsecondary goals, related to training, education, employment and independent living, be based upon age-appropriate transition assessments. Planning must be started no later than the first IEP meeting that occurs once the child turns 16 years old.

In an effort to provide further guidance around the transition planning process, the U.S. DOE (2017) published "A Transition Guide to Postsecondary Education and Employment for Students and Youth with Disabilities." This guide states that a student's IEP must be developed by a team that includes the student's parents, at least one special education teacher/provider, a representative of the public agency, and, whenever appropriate, the student with a disability. Additionally, states and school districts, along with the student and the student's family member or representative, are to determine the most appropriate types of transition assessments based on a student's needs (U.S. DOE, 2017). The National Technical Assistance Center on Transition (NTACT, 2016) recommends the use of informal and formal transition assessments that involve some combination of paper and pencil tests, structured student and family interviews, community or work-based assessments (situational), and curriculum-based assessments. The NTACT also recommends that transition assessment information be gathered in the following four categories: (a) academic, (b) self-determination, (c) vocational interest and exploration, and (d) adaptive behavior/independent living. Additionally, the assessment process seeks to answer the following questions.

- Who am I?
- What are my unique talents and interests?
- What do I want in life, now and in the future?
- What are some of life's demands that I can meet now?
- What are the main barriers to getting what I want from school and my community?
- What are my options in the school and community for preparing me for what I want to do, now and in the future?

Following completion of the transition assessment process, the student's team is responsible for developing measurable postsecondary goals. Mazzotti et al. (2009) recommend person-centered planning for beginning the process of developing these goals. Members of the planning team need to be well-informed about the student's abilities, needs, and available services (U.S. DOE, 2017). To help facilitate the person-centered planning process, all members of the team should practice compassionate care, which includes interpersonal skills such as active listening, collaborating with caregivers, understanding a family's culture, being kind, asking open-ended questions, avoiding technical jargon, and caring for the entire family (Taylor et al., 2019). Through the person-centered planning process, the team should consider three questions:

1. Where is the student going to work or engage in productive activities after graduation?
2. Where and how is the student going to continue to learn and/or develop skills after graduation?
3. Where is the student going to live, and how are they going to access adult services, participate in the community, and have fun after graduation?

Measurable postsecondary goals are observable, describe an explicit skill or task for the individual to complete, and occur after high school graduation (Mazzotti et al., 2009).

After the measurable postsecondary goals have been identified, transition services that will help the student achieve these goals must be considered (Mazzotti et al., 2009) and may include a particular course of study, related services, community experiences, and possible instruction in daily living or other life skill domains. Lastly, the team develops annual IEP goals that align with the postsecondary goals and relate to the student's transition service needs, including how to access or complete the transition services.

Workforce Readiness: Post-21

As mentioned previously, it is critically important to engage in transition planning while completing secondary education. It is also vital to continue support of workforce readiness skills with transition-aged individuals. Research suggests that only 53% of youth with ASD worked after high school, holding at least one job between high school and their early 20s, compared to 63% of those with intellectual disabilities, and 89% with emotional disorders, learning disabilities, and speech-language needs (Roux et al., 2020a, b; Winsor et al., 2018). Hiersteiner et al. (2016) reported that only about 15% of adults with IDD were engaged in integrated and paid employment in the community and about 20% were engaged in paid facility-based work; the majority of adults (nearly 44%) participated in unpaid facility-based activities. In addition to underrepresentation in the workforce, data indicate that the majority of individuals diagnosed with IDD tend to work in part-time, entry-level positions with lower income compared to their neurotypical peers and have more limited access to benefits (National Core Indicators, 2017). However, data support that individuals with IDD, estimated to be about 2.5 million Americans (Equal Employment Opportunity Commission [EEOC], 2013) 19.1, express a desire to fully participate in the workforce with a growing expectation to be gainfully employed following formal education (Winsor et al., 2018).

The Americans with Disabilities Act (ADA, 1990, 2008) is a U.S. federal law prohibiting discrimination against individuals with disabilities, such as those who have impairments that significantly limit major life activities, have a history of a significantly limiting impairment, or are regarded as having a disability. Title I of the ADA covers employment under state and local government employers, as well as for private employers with 15 or more employees. While this section will review protections under ADA, it should be noted that Section 504 of the Rehabilitation Act and many states have additional protections, some of which may pertain to private employment with fewer than 15 employees.

The task of enforcing employment protections under ADA falls to the Equal Employment Opportunity Commission (EEOC), which oversees when an employer asks an applicant, employee, or family member questions about IDD, types of accommodations, and safety concerns. The EEOC is also concerned with how employers ensure no harassment in the workplace based on disability. All individuals who qualify should be made aware of their rights and protections. Some of these are as follows.

During the application process:

- An employer may not legally ask a job applicant about their medical conditions, if they have taken any special education classes, or if school records indicate a disability. Employers may ask whether the applicant can read and organize in a systematic manner (i.e., alphabetically or numerically).
- If an applicant discloses they have a disability, the employer may ask if accommodations are needed.

After an employment offer is given:

- An employer may now ask questions about health and disability, and they may require a medical examination, so long as all applicants for the same position are treated equally.

- A job offer may not be withdrawn if the applicant is able to perform the essential functions of the position.

During employment:

- Should performance problems appear and there is a reasonable belief that essential employee functions are not being met, an employer may ask for medical information including whether the employee has previously been diagnosed with a disability.

Accommodations:

- Applicants and employees are entitled to reasonable accommodations in the application and interview process, as well as during employment. These may include reallocation of marginal tasks, modeling, vocal verbal rather than written prompts, allowing additional time, task analyses, and visual prompts. Documentation may be required if an accommodation is requested; employers are not required to grant every accommodation request but must make a reasonable effort to accommodate at least some. In a scoping review, Khalifa et al. (2020) found successful accommodations to include reducing noise, outlining predictable job responsibilities, and minimizing distractions.

Safety:

- An employer may refuse to hire or terminate an employee with IDD if the employer believes they pose a direct threat, defined under ADA as posing a significant risk of harm to the individual or others that cannot be addressed through reasonable accommodations. The employer is required to collect objective, factual evidence of threat.

It should be noted that employers are required to keep all medical information confidential and must actively engage in practices to prevent harassment and discrimination. Should any of these rights be violated under state or local governments, or within a private organization, individuals with IDD, or a third party, must file a charge of discrimination with the EEOC by mail or in person typically within 180 days from the date of the alleged violation. If the violation occurs under the auspice of a federal government, the individual should contact an EEO counselor within 45 days from the date of the alleged violation.

Research strongly suggests that building trust between an employer and employee from the onset of the working relationship is critical for success in the workplace for individuals with IDD (Khalifa et al., 2020; Migliore et al., 2018). Additionally, training employers about ASD and IDD might increase interest in hiring and maintaining employment of individuals with ASD and/or IDD (Khayatzadeh-Mahani et al., 2020). Accommodations should be flexible and vary in intensity as needed; finding tasks or jobs that are the right fit for one's interest are also vital in building support.

Assessment Information

Assessment plays an integral role in the evaluation of an individual's current level of functioning and serves to assist in the selection of functional skills related to successful job performance. More so, assessment may assist in identification of appropriate vocational placements for adolescents and adults with ASD and/or IDD. Similar to the ways in which assessment aides clinicians in identifying academic skill deficits (e.g., Verbal Behavior-Milestone Assessment Placement Program; VB-MAPP, Sundberg, 2008), function of behavior (e.g., Functional Analysis, Iwata et al., 1994), or hierarchies of preferred items (e.g., Multiple Stimulus Preference Assessment; MSWO, DeLeon & Iwata, 1996), *functional-skill assessments* can be used to aide in identifying specific strengths and individual preferences required to be successful in job placements. Results of these assessments can be used in setting objectives and developing curriculum linked to terminal goals required for individuals with ASD and/or IDD to perform at their jobs.

Functional skills that are important for vocational success include independent problem solving, how to log in and out of a work clock, and performance on job-related tasks (e.g., lifting heavy objects, answering phones, following directions). Functional-skill assessments are typically indirect assessments involving interviews with caregivers, surveys completed by the individuals with ASD and/or IDD themselves, and direct observation of performance of job-related tasks. The *Assessment of Functional Living Skills* (AFLS; Partington & Mueller, 2012) serves to evaluate functional skills among adolescents and adults with ASD and/or IDD (LaRue et al., 2016).

The AFLS, is a criterion-based assessment tool, tracking system, and curriculum consisting of six assessment modules designed to evaluate an individual's performance of functional skills across *Basic Living Skills, Home Skills, Community Participation Skills, School Skills, Vocational Skills, and Independent Living Skills.* The AFLS is designed to be administered by caregivers and/or clinicians and information is typically obtained through direct observation of the individual in the natural setting, caregiver report, and contrived performance-based measures (LaRue et al., 2016).

In addition to the AFLS, practitioners interested in administering functional-skills assessments can also search their statewide agency for *vocational-rehabilitation assessments.* These vocational-rehabilitation assessments are typically administered by *Vocational Rehabilitation Counselors,* with the goal of providing supported employment to individuals with disabilities. Although the discussion of each of these statewide vocational-rehabilitation assessments is outside the scope of this chapter, we do recommend the reader see their *Vocational Rehabilitation Office* for more details (Employer Assistance and Resource Network on Disability Inclusion; EARN, 2020).

Weaknesses in *job-related social communication skills* (e.g., asking for help, notifying a supervisor when a task is completed, responding correctly to feedback) constitute an additional barrier to employment for individuals with ASD and/or IDD. In fact, research suggests that problems with job-related social communication skills may be an even greater barrier to employment than job-specific skills such as those mentioned previously (Chen et al., 2015). With this in mind, Lerman et al. (2017) employed an assessment to identify job-related social communication targets for intervention in the workplace. The assessment consisted of presenting a variety of job-related social communication skills and measuring whether participants engaged in those skills. The requirements included *confirming statements to an initial task instruction, asking for help, asking for a missing item to complete a task, responding to corrective feedback,* and *notifying the supervisor of task completion* when the environment was arranged to evoke these responses (e.g., unlearned tasks were presented, therefore requiring the participant to ask for help). The results of Lerman et al. demonstrated that most of the participants showed difficulty with one or more of the targeted skills. These results suggest that assessing and teaching job-related social communication skills is a necessary component to job planning.

Practitioners must also consider individual and family values which may ultimately lead to job satisfaction. This index, referred to as *social validity* (Wolf, 1978), measures the satisfaction of individuals and their families surrounding job choice and placement. When focusing on job placements, social validity can be measured by evaluating individual preference, family preference, and indices of satisfaction at the job setting. More so, ensuring adolescents and adults with ASD and/or IDD access jobs in accordance with their preferences represents person-centered planning in vocational training (Everson & Reid, 1997; Reid et al., 1999) and is considered a requirement in the employment legislation for individuals with disabilities (Reid et al., 1999).

Person-centered planning is an ongoing problem-solving process used to help people with disabilities plan for their future, or in this case, plan for their job-related future (Reid et al., 1999). A significant part of that planning is matching job tasks with work preferences (Reid et al., 1999), typically through the use of preference assessments (e.g., Cobigo et al., 2009;

Lattimore et al., 2003; Parsons et al., 2001). Along these lines, Parsons et al. (2001) used a paired-items preference assessment in which job tasks were repeatedly paired with each other to determine which tasks were selected most frequently across pairings and they used this as an indicator of job preference. Similarly, Lattimore et al. (2003) evaluated use of a multiple-stimulus preference assessment for predicting job preference among adults with disabilities. Results of both studies offered support for predicting preference.

Ultimately, assessing and programming for job success in individuals with disabilities requires systematic planning and customized employment services. The use of functional-skills and vocational-rehabilitation assessments in combination with social-validity assessments (e.g., measures of preference, choice, and satisfaction) ensures that individuals are in desired job placements where they can be most successful. Researchers should continue to develop and create varied forms of reliable functional skill-based assessments. For example, Chen et al. (2015) suggested that future assessments geared toward employment for individuals with disabilities incorporate resources such as the *World Health Organization's International Classification of Functioning, Disability, and Health (ICF)*, which provides an understanding of the variables that impact an individual's employment in a functional way. Furthermore, research on the development of valid, reliable, and efficient employment preference assessments for use with individuals with ASD and/or IDD is necessary. Results of these preference assessments can be used to further evaluate the ways in which preference influences skill performance on the job.

Vocational Skills Training

To prepare clients for the workforce, not only do we need the results of assessments to help us identify preferred jobs, necessary job-related skills and skill deficits, but we also need to identify effective strategies for teaching these skills. Vocational skills can be categorized into two main areas: *essential prevocational skills* and *employment skills*. In this section, we will share behavior analytic research related to essential prevocational skills and employment skills and we will provide recommendations for future research.

Essential Prevocational Skills

Much of what behavior analysts do to prepare individuals for the workforce occurs within the boundaries of the educational system. For the most part, this involves prevocational training. Prevocational training provides learning and work experiences that include volunteer work, where the individual can develop several general, non-task-specific skills that will increase the likelihood of employability in competitive and paid integrated community settings. These essential skills include the ability to behave independently (e.g., follow directions, follow a schedule, tell time, attend to work tasks for an extended period of time), communicate effectively with supervisors, co-workers, and customers (e.g., ask questions when necessary, seek help, answer questions adequately), solve common work-place problems and make decisions, engage in leisure skills during breaks, select and wear appropriate attire for the job, navigate the community (e.g., prepare their own lunch or order and pay for their own lunch while in the community, take public transportation), and engage in general workplace safety.

Increased Independence

Acting independently and following directions are often cited as important for employability (Agran et al., 2016; Hendricks, 2010; Ju et al., 2012). Activity schedules include pictures or words that cue an individual to engage in a sequence of tasks or activities independently. Activity schedules have increased independence in individuals with ASD and/or IDD across a variety of activities including leisure (e.g., MacDuff et al., 1993), social (e.g., Krantz et al., 1993; Krantz & McClannahan, 1998), and vocational tasks (e.g., Johnson & Miltenberger, 1996; Sances et al., 2018; Wacker & Berg, 1983). Sances et al. (2018) used activity schedules and contingent reinforcement to increase the number of independent beekeeping steps completed by an adult with ASD. Interestingly, the participant had a keen interest in bees and his interest played a role in his job selection. This is noteworthy as Hendricks (2010) noted that appropriate job placements for individuals with specific, restricted interests may produce successful employment outcomes. Additional research is necessary to address the role restricted interests play in job success.

Researchers have also evaluated the use of technology for increasing vocational independence among individuals with ASD and/or IDD across a variety of tasks including using a visual assistant program to teach time management and personal scheduling (e.g., Davies et al., 2002); using computer-based video instruction to teach the completion of multiple step, job tasks (e.g., watering plants, delivering mail, changing paper towels; Mechling & Ortega-Hurndon, 2007); and using video prompting or video modeling to teach meal preparation (e.g., Bereznak et al., 2012; Mechling et al., 2009b; Rehfeldt et al., 2003; Van Laarhoven et al., 2012), using a microwave (Sigafoos et al., 2005), loading a dishwasher (Van Laarhoven et al., 2012), using a washing machine (Bereznak et al., 2012), using a copy machine (Bereznak et al., 2012), recycling at a restaurant (Van Laarhoven et al., 2012), and janitorial tasks (Van Laarhoven et al., 2009). Several of the prior studies evaluated video-based instruction. Video-based instruction can include video modeling and/or video prompting. Video modeling involves showing a video in which someone models a behavior for a viewer such that the viewer might imitate the behavior in an appropriate context (Catania et al., 2009). Video prompting involves viewing a video of a model performing a task, but in this case, it is not necessary for the viewer to watch the entire video, rather they can watch specific steps of the tasks, as needed (Cihak et al., 2006). For example, Bereznak et al. (2012) evaluated the effects of a video prompting procedure on the independent completion of several essential prevocational skills (i.e., using a washing machine, making copies, making noodles). The videos were readily available on an iPhone®. Participants could watch and rewind the videos to prompt their own behavior, as necessary. Results of this study showed that the video prompting procedure was effective at increasing independent performance to mastery level and that responding maintained, when the iPhone® remained available. Although the authors did not assess social validity, they reported that the caregivers were thrilled their children were using the same technology as their siblings and the participants reported to have interest in obtaining iPhones® of their own.

Self-management has been used to teach a variety of essential prevocational skills including independent performance of individuals with IDD (Lagomarcino & Rusch, 1989) and time-management skills (Newman et al., 1995; Sowers et al., 1980). Self-management is the personal application of behavior change tactics that produce a desired improvement in behavior (Cooper et al., 2020). Newman et al. (1995) sought to transfer control from an instructor, who indicated when it was time to switch activities, to three individuals with ASD by teaching them to identify transition times. A classroom activity schedule was present throughout the study and included the time of day each activity was to occur. A digital clock was present and in view of all participants. Participants were also taught to self-reinforce successful transitions. All participants learned to transition at appropriate times and self-reinforcement increased with the intervention but was variable. Responding maintained at 1- and 3-month post-intervention and self-reinforcement remained high for two of the participants.

Social-Communication Skills

Social skills are often noted as a primary factor for obtaining and maintaining employment (e.g., Agran et al., 2016; Chen et al., 2015; Ju et al., 2012; Lerman et al., 2017). These include knowing when to seek help when an instruction is unclear, notifying a supervisor when assistance is needed, responding appropriately to critical feedback, and interacting well with coworkers and customers (e.g., Baldwin et al., 2014; Herbert & Ishikawa, 1991; Hurlbutt & Chalmers, 2004; Müller et al., 2003). Individuals with ASD often have difficulties with social interactions, perspective taking, understanding sarcasm and humor, using and understanding figurative language, and with lies and deceit (see Kisamore et al., 2019 for a review of the literature in these areas). Few researchers have evaluated strategies for teaching job-related social skills. Those who have done so have used video modeling to teach adults with IDD how to make coffee, serve coffee, and sit down beside a peer (Bidwell & Rehfeldt, 2004), used prompts and reinforcement to teach teamwork with activity schedules to individuals with ASD (White et al., 2011), and used behavioral skills training (BST) to directly teach job-related social skills (Grob et al., 2019). BST involves instructions, modeling, rehearsal, and feedback in which training continues until the trainee acquires the skill and demonstrates the ability to perform it independently (Parsons et al., 2013). BST begins with some form of instruction (e.g., written, verbal, video) provided to the trainee on the target behavior. This step is followed by a demonstration of the target response either in-vivo or through a video model. The trainee is then given the opportunity to rehearse the response while the practitioner provides feedback until mastery is demonstrated. For example, Grob et al. (2019) evaluated the efficacy of a treatment package that consisted of BST and stimulus prompts with three individuals diagnosed with ASD. Their results showed that the procedure resulted in an increase in job-related social skills, but that stimulus prompts were necessary for generalization. They did not see generalization across social skills underscoring the importance of carefully programming for generalization.

Problem Solving Skills

Another skill that is particularly valuable on the job is problem solving (Agran et al., 2016; Ju et al., 2012). Problem solving occurs when an individual is presented with a problem for which they have no immediate solution; thus, they must engage in mediating or precurrent responses (e.g., looking in a variety of places for a missing stapler, obtaining paper towels to replace an empty roll) that increase the likelihood of emitting a successful response (e.g., finding the stapler, cleaning spilled water on the floor; Skinner, 1984). Being able to problem solve increases the likelihood of identifying a correct response and might decrease maladaptive behavior of individuals with ASD and/or IDD (e.g., engaging in stereotypy or disruptive behavior). A variety of problem-solving skills have been taught in prior vocational skills research including training adolescents with ASD how to approach an instructor, describe a problem, and request assistance (Dotto-Fojut et al., 2011), training individuals with IDD to solve common workplace problems using self-instructions (Hughes et al., 1996; Hughes & Rusch, 1989), teaching adolescents with IDD rules for problem solving social situations in the workplace (Park & Gaylord-Ross, 1989), teaching individuals with ASD and/or IDD a decision-making framework on an iPad to problem-solve common work tasks (Van Laarhoven et al., 2018), and teaching adolescents with ASD to independently problem solve common workplace problems using textual/pictorial activity schedules (Lora et al., 2020). For instance, Lora and colleagues (2020) identified three types of common workplace problems (e.g., missing, broken, mismatched items) and they created an activity schedule that contained textual stimuli to cue the participant to engage in a series of mediating responses (e.g., identify the missing, broken, or mismatched item; go to the location where the item is kept; get the item; return to your room; finish your work). To ensure differentiated responding, the researchers presented both establishing operation (problem present) and abolishing operation (problem absent) trials. The researchers programmed for generalization by teaching to multiple scenarios within each category of problems and they assessed generalization with novel scenarios in each category. The researchers used reinforcement systems similar to those established in each participant's school programming to reinforce successful problem solving. Their results showed that the problem-solving procedure was effective, that participants demonstrated differential responding, that responding generalized to novel scenarios, and that responding maintained.

Leisure Skills

Although most people do not directly equate leisure skills with work-activities, employees do get breaks from work and require leisure skills to keep entertained during these breaks. Prior research in this area has focused on teaching individuals with IDD generalized use of vending machines (Sprague & Horner, 1984) and teaching individuals with IDD to listen to music on an iPod Touch (Kagohara et al., 2011). Kagohara et al. (2011) used video models presented on the iPod Touch® to teach three individuals with IDD how to find and listen to music on the iPod Touch®. Participants were instructed to watch the video and after viewing the video, they were given the iPod® and the experimenter asked the participant to complete each step of the "listening to a song" task analysis that included eight steps. The video was removed following successful performance with the video model. Responding for all participants increased to mastery level following introduction of the video model and responding maintained between 4 and 10 weeks for all participants even though participants did not have access to the iPod Touch® in the interim.

Self and Community Care

It is important to teach individuals with ASD and/or IDD how to take care of themselves while at work or in the community. The ability to successfully navigate transportation, pay for food, prepare food in advance, and heat food at work is one more area in which individuals with ASD and/or IDD should demonstrate some, if not total, independence. Researchers have evaluated strategies for teaching individuals with IDD how to navigate public transportation (Davies et al., 2010; Price et al., 2018; Stock et al., 2013), training individuals with ASD and/or IDD to use cell phones or to respond to a pager and share a communication card when lost (e.g., Hoch et al., 2009; Purrazella & Mechling, 2013; Taylor et al., 2003; 2004), teaching individuals with IDD to count change (Borakove & Cuvo, 1977; Lowe & Cuvo, 1976) and make change (Cuvo et al., 1978a, b), teaching individuals with IDD to prepare meals (Rehfeldt et al., 2003), and teaching individuals with IDD to use a microwave (Sigafoos et al., 2005). For example, Price et al. (2018) evaluated the effects of teaching four individuals with IDD how to use the Google Maps® application on a smart device via a total-task chain to take the bus to locations around a college campus and the community.

Workplace Safety

Employers have also rated workplace safety an important job skill for employees (e.g., Agran et al., 2016; Ju et al., 2012). Workplace safety includes avoiding inappropriate touching of others, avoiding problem behavior (e.g., arguing, aggression, self-injury, use of inappropriate language), and responding appropriately to job-related emergencies. Researchers have addressed problem behavior of individuals with IDD during vocational tasks (e.g., Barker & Thyer, 2000), trained individuals with IDD how to handle broken material (Winterling et al., 1992), and also taught individuals with IDD how to extinguish cooking-related fires (Mechling et al., 2009a). Mechling et al. (2009a) evaluated the effects of video models for teaching three individuals with IDD three fire extinguishing behaviors (i.e., scooping and releasing flour, placing a lid on a pot or pan, using a fire extinguisher). The researchers programmed for generalization of fire extinguishing behavior across a variety of stimuli (e.g., skillet, double boiler, stop top burner, microwave oven, fire pit, deep fryer) and assessed generalization of fire extinguishing behavior with novel stimuli (i.e., trash can, toaster oven, wok). Their results showed that the video modeling procedure was effective at teaching fire extinguishing behavior to all participants and results generalized to novel stimuli. Additionally, extinguishing behavior maintained from 22 to 52 days.

Employment Training

When behavior analysts work with individuals post-21-years-old, we might still dedicate some time to prevocational training, but we are also likely to assist individuals as they engage in sheltered and supported employment.

Sheltered Employment

Sheltered employment can involve *transitional employment programs* in which the goal is to provide training in non-integrated settings with the goal of increasing necessary skills for successful integrated employment. Some of these necessary skills might include learning how to type, file, answer the phone, and write down messages for a clerical position or how to clear a table, wipe the table down, wrap silverware, fill salt and pepper shakers, and set tables for a restaurant position. Sheltered employment can also involve *extended employment programs* in which the goal is to teach individuals to use their existing skillsets (trained in prior prevocational or transitional employment programs) to earn wages in non-integrated environments.

Supported Employment

Supported employment entails helping a learner obtain and maintain competitive or customized compensated employment in an integrated or general work setting. This might include job placement and development in which the behavior analyst (a) uses assessment results to target jobs available in the local labor market that are consistent with the learner's interests, abilities, and work goals, (b) negotiates with a prospective employer and educates the prospective employer about the benefits of hiring individuals with ASD and/or IDD, (c) assists the learner in the development or improvement of job seeking skills (e.g., resume development, interview skills, networking, completing applications), (d) engages in training and systematic instruction directly with the learner (e.g., teaches job-specific skills), and (e) conducts job coaching with the learner.

Development of Job Seeking Skills

When seeking an appropriate and desired job, the individual should begin by preparing a resume that speaks to their specific skill sets. Then the individual can begin the job search (with or without assistance). If the individual is expected to do this independently, they will need basic computer skills (e.g., using a mouse, using a search engine) and more advanced search skills including identification of relevant job ad sites, how to navigate such sites, how to identify relevant jobs, how to complete the job application, how to create a cover letter that speaks to their interest in the job and how they are uniquely qualified, and uploading a resume. Research on how best to teach these skills to individuals with ASD and/or IDD is warranted.

If contacted by a potential employer via email, the individual must respond with proper email etiquette including using a proper salutation, writing in full sentences and responding to any questions in the body of the email, using an appropriate closing, and signing their name. Some necessary skills here include typing, reading comprehension, and writing. Cihak et al. (2015) evaluated the effects of total task chaining on teaching four individuals with IDD how to access email, respond to email, and send an email. The researchers programmed for generalization using sequential modification across three devices (i.e., desktop, laptop, iPad). Results showed that the training procedure resulted in acquisition of the email task, but that training was necessary for mastery level performance across all three devices. Responding did maintain at 9 weeks for all participants. It is worth noting that the participants were allowed to continue accessing, responding to, and sending emails during the 9-week interim.

When invited for a job interview, it is important that the candidate prepare to answer standard job interview questions and dress appropriately. On the day of the interview, the candidate should arrive on time and adequately answer questions. Some skills necessary for success here include general interview skills, tolerating dress clothes, selecting appropriate attire, conversation skills, self-management, navigating transportation, and time management (Zalewska et al., 2016). Several researchers have evaluated teaching interview skills to individuals with ASD and/or IDD using virtual reality (Burke et al., 2017; Smith et al., 2014; Walker et al., 2016), selection-based responding (O'Neill & Rehfeldt, 2014), video modeling (Hayes et al., 2015), and BST with (Rosales & Whitlow, 2018) and without (Brazeau et al., 2017; Hall et al., 1980; Kelly et al., 1980; Mozingo et al., 1994; Roberts et al., 2020) video-based feedback. Roberts et al. (2020) evaluated the effects of BST for teaching three types of interview behaviors (i.e., asking questions, answering questions, appropriate body language) to three individuals with ASD. BST was sufficient for two of the participants to reach mastery level responding and the third participant was successful with the addition of textual cues and reinforcement. They programmed for generalization by incorporating multiple interviewers into training and assessed generalization of interview skills with a novel interviewer. Their results showed that the skills generalized to a novel interviewer. The researchers also assessed social validity of their findings by having community members rate the interviewee behaviors from pre- and post-training videos. Overall, the raters scored the post-training videos higher.

Task Engagement

Task engagement is often cited by employers as an essential skill (e.g., Ju et al., 2012). Difficulties in task engagement have been reported in individuals with ASD (e.g., Hume & Odom, 2007; Shields-Wolfe & Gallagher, 1992). Desired task engagement behaviors include attending to task materials, using task materials in the manner for which they were designed, and engaging in appropriate, task-related behavior. There are only a few studies that have evaluated strategies for increasing task engagement with adults with ASD. These include delivering specific instructions (Bouxsein et al., 2008), offering choice in activity order (Watanabe & Sturmey, 2003), and BST (Palmen & Didden, 2012). Watanabe and Sturmey (2003) noted the importance of choice for adults with ASD and they evaluated the effects of choice-making opportunities that were embedded within activity schedules combined with contingent praise on task engagement with three adults with ASD. Their results showed that participants' task engagement was higher during the choice opportunities compared to the no-choice opportunities. Additionally, task engagement maintained for all participants.

Training and Systematic Instruction

Following (or sometimes concurrently with) the acquisition of prevocational skills, job-specific skills are also trained. Job-specific skills might include those necessary for specific positions (e.g., clerical positions: reading, writing, typing, filing, answering the phone and taking messages; restaurant positions: removing dishes and silverware, wiping tables, wrapping silverware, filling salt and pepper shakers or adding individual packets to silverware wrappers, setting tables). These skills can be taught in transition programs or in supported employment environments. A variety of strategies have been used to train and provide ongoing instruction to individuals with ASD and/or IDD.

BST Research evaluating the effects of BST for teaching job-specific skills has included teaching individuals with IDD how to stamp a return address on envelopes (Schepis et al., 1987), teaching restaurant skills to an individual with ASD (i.e., setting up and running a commercial dishwasher, polishing and rolling silverware, bussing a table, cleaning the bathroom; Morgan & Wine, 2018), training individuals with ASD how to deliver a fire safety program as a mascot (Burke et al., 2010), training individuals with ASD behavior technician skills for working with children with ASD (Lerman et al., 2015), and teaching an individual with ASD basic computer skills (Sump et al., 2019). Sump et al. (2019) evaluated the effects of BST on acquisition of basic computer skills using Microsoft Word®, Microsoft Excel®, and Microsoft PowerPoint® by an individual diagnosed with ASD. Their results showed that BST was effective for teaching the individual how to use basic functions within the three programs and following the intervention, the participant was able to use the programs to independently complete schoolwork.

Video Modeling/Video Prompting Video modeling and video prompting have been used to teach a variety of job-specific skills to individuals with ASD and/or IDD including mascot tasks (Allen et al., 2010a, b); gardening (English et al., 2017), phone skills (Rausa et al., 2016), clerical skills (e.g., Bennett et al., 2013a, b), washing dishes (Sigafoos et al., 2007), chained job tasks (Goh & Bambara, 2013; Heider et al., 2019), and multiple-step tasks (e.g., folding multiple sizes of towels, sort recycling, prepare a buffet table with serving stations; Mechling et al., 2014). Allen et al. (2010a) evaluated the effects of video modeling to teach individuals with ASD nine target skills to entertain customers and promote a product in a retail setting while they were dressed as the product mascot. They assessed generalization from the training setting to an actual job opportunity and generalization was observed. Additionally, participants reported they enjoyed the work and their supervisors made positive comments about the experience.

Prompting and Chaining Procedures Prompts are supplementary antecedent stimuli used to occasion a correct response and behavior chains are a sequence of responses leading to a terminal outcome in which the response for one part of the chain serves as the conditioned reinforcer for that response and the discriminative stimulus for the next response in the chain (Cooper et al., 2020). Chaining, linking specific sequences and responses to form a new behavior, is one strategy to use to teach a complex skill. Researchers have evaluated backward chaining, in which the last response in the chain is taught to mastery before preceding responses (Cooper et al., 2020), to teach cleaning tasks (e.g., cleaning a sink, cleaning a locker) to individuals with ASD (Kobylarz et al., 2020) and they have evaluated guided compliance for teaching a variety of skills to individuals with IDD including janitorial skills (Cuvo et al., 1978a, b), mending skills (Cronin & Cuvo, 1979), and researchers have also incorporated instructive feedback into guided compliance procedures for teaching laundry skills (Taylor et al., 2002). Instructional feedback is the presentation of additional targets during antecedent or consequence portions of learning trials (Reichow & Wolery, 2011). These additional targets are not directly taught or reinforced but are assessed to determine if responding to these targets emerges as a result of exposure to them. For example, Taylor et al. (2002) used guided compliance to teach individuals with IDD how to wash and dry laundry. They also embedded nontarget, functional sight words on the appliances and the products used by the participants. Their results showed that participants not only learned how to wash and dry laundry but also responded appropriately to the sight words following the intervention.

Sometimes it is difficult to know what to teach or prompt before an individual is behaving in the work setting. Parsons et al. (2009) trained support staff to implement a least-to-most prompting strategy (say, wait and watch, act out, touch to guide) with reinforcement in the natural environments as a means for addressing these “in the moment tasks” that needed to be trained. Their results showed that there was an overall increase in independent completion of tasks by the participants and that overall, results maintained up to 33 weeks.

Job Coaching Job coaching involves on the job prompting and reinforcement for completion of vocational tasks. It can be somewhat stigmatizing for individuals to have someone beside them providing prompts and reinforcement, covert strategies such as the use of a “bug-in-ear” or covert audio coaching (CAC) might decrease some of this stigmatization because several people walk around with Bluetooth devices and/or headphones in their ears on a regular basis. CAC consists of a two-way radio system in which the individual who is giving feedback is able to do so from a distance and the person receiving feedback is privately able to hear via the earpiece. With the advent in Bluetooth technology for headphones and microphones, it is now also possible for the feedback recipient to respond and ask questions to the coach or instructor. Bennett et al. (2010, 2013a, b) have evaluated the effects of CAC for delivering feedback during vocational tasks. For example, Bennett et al. (2010) examined the use of CAC to deliver performance feedback with three employees diagnosed with ASD and/or IDD. Feedback took place at the individuals' job sites and was delivered for performance on the tasks of sweeping, cleaning windows, and stacking crates. Results indicated an increase in accuracy in task completion for all participants.

Self-management Self-management is also a valuable skill in the workplace. Employers prefer employees who can manage their own time and complete tasks efficiently. Researchers have primarily evaluated strategies for increasing self-management in the workplace as a means for increasing production rates (e.g., Christian & Poling, 1997; Moore et al., 1989). For example, Christian and Poling (1997) evaluated the use of a self-management strategy on the productivity of two individuals diagnosed with IDD. The self-management strategy included self-instruction, self-monitoring (with a timer to ensure speed of performance and written notes in a notebook), and self-reward (with individualized reinforcement). Tasks included weighing and bagging individual servings of various frozen foods, setting tables, and rolling silverware. Throughout the study their productivity was assessed and compared to their coworkers. While the results did show some improvement in productivity and participants were completing tasks at the same level of productivity as their coworkers, the most meaningful part of this study is that the participants reported they liked the procedures and both maintained their jobs. One participant even earned a raise.

Research Recommendations: Training Vocational Skills

Although there is a growing body of research on strategies for teaching essential prevocational skills, additional research is needed in all areas. For example, there are a handful of studies that have evaluated teaching problem-solving skills for the workplace, but those strategies are simply scratching the surface. Additional research is needed on teaching more complex problem-solving strategies (e.g., seeking a supervisor when there is a problem, what to do if the supervisor is not available, how to continue working when there is a problem) and using other strategies (e.g., mnemonics, flowcharts) to teach problem solving to individuals who have more limited language repertoires.

We are familiar with only one study that evaluated a strategy for teaching individuals with ASD and/or IDD to select clothing that matched popular fashion (Nutter & Reid, 1978). Although some jobs might allow for wearing of fashionable street clothes, most people have "work clothes," "leisure clothes," and "social clothes." Additional research is needed that addresses how to teach individuals with ASD and/or IDD to select and wear work-appropriate attire. This is considered an essential prevocational skill because workplaces often have dress codes and violations of those dress codes might result in feedback and/or termination. Researchers might evaluate teaching differential responding (e.g., I wear scrubs to work, I wear jeans at home) and problem solving for appropriate attire (e.g., it's raining, I should wear my raincoat). Additionally, research is necessary on teaching mask wearing while at work in some settings and adhering to social distancing guidelines in the workplace. Researchers might evaluate the effects of discrimination training (e.g., this is 6 ft. away, this is less than 6 ft. away, you do not wear a mask while eating lunch, you do wear a mask while at your desk).

Individuals with ASD are more likely to end up in sheltered employment than supported employment due to their behavioral difficulties, cognitive functioning deficits, and restricted interests (Hendricks, 2010; Müller et al., 2003; Richards, 2012; Taylor & Seltzer, 2011). However, with adequate supports, individuals with ASD can progress from needing moderate and intensive levels of support to needing minimal levels (Brooke et al., 2018; Ditchman et al., 2018). Barriers to successful employment for adults with IDD include problem behavior and interpersonal problems (Lemaire & Mallik, 2008). These findings support the need for continued research on effective prevocational and employment training procedures.

Increased use of technology to guide the day-to-day movements and activities of neurotypical individuals gives rise to additional training possibilities in which we can incorporate technological supports for individuals with ASD and/or IDD without stigmatizing them. Most people use Google and YouTube for supports as they attempt to complete tasks (e.g., clean a coffee maker, change the oil in a car). As noted above, technology can be used to share video models or video prompts with individuals in the community and the use of personal smart devices does not make them stand out from others in the community. Additional technological supports include applications that can be downloaded on personal smart devices to guide navigation (Price et al., 2018), assist in self-management (e.g., calendar applications, reminders), and help ensure that tasks are completed on certain days and by particular times (e.g., reminders, lists; Gentry et al., 2012). Additional research is needed to fully identify the ways in which we can incorporate technology into the lives of individuals with ASD and/or IDD.

Although there is an increased emphasis on the use of higher technology or "high-tech", such as iPads and other tablets (Bennett et al., 2013a, b; Bereznak et al., 2012; Mechling et al., 2014; Van Laarhoven et al., 2018), it is still important to consider teaching toward acquisition with lower technology or "low-tech" tools, such as picture and written prompts or less sophisticated software, as higher technology tools may break, lose power, or simply might not be a good fit for the individual.

Generalization and Maintenance

Much of what behavior analysts do to support employment of the individuals we work with occurs within the boundaries of the educational system and day habilitation programs. For the most part, this involves prevocational or transition program training in which we train the aforementioned skills in analogue settings. Because many of these skills are trained in analogue settings, it is important to program for and assess generalization and maintenance.

Generalization

According to Stokes and Baer (1977), a therapeutic behavior change is demonstrated only when behavior occurs over time, persons, and settings, and the effects of the change must spread to a variety of related behaviors. Individuals should be taught the types of vocational skills noted here and strategies should be used to promote the generalization of these responses across time, persons, settings, and also to promote varied topographies of responding. Clinicians and researchers can maximize the potential for generalization by incorporating common stimuli into training, teaching with multiple exemplars, ensuring skills contact natural consequences, reinforcing generalized responding, and teaching strategies to mediate generalization (Stokes & Baer, 1977). Training that requires varied response forms helps to ensure the acquisition of varied responding and also increases the likelihood that untrained topographies will emerge (Cooper et al., 2020).

Johnson and Miltenberger (1996) evaluated the effects of picture prompts and self-instruction (covert or overt verbal prompts generated by oneself to prompt specific responses or behaviors) on vocational task performance with three participants who were diagnosed with IDD. Participants were requested to overtly state four prompts consisting of the task sequence (i.e., "look at the picture," "point to the picture," "do picture" and "next picture") while pointing to or looking toward the targeted picture prompt. The authors used sequential modification to program for generalization. Results of the study indicated an increase in accurate task completion following training in using both picture prompts and self-instruction. Additionally, generalization was also observed in two of the three participants.

Wacker and Berg (1983) also investigated the effects of picture prompts on the completion of complex vocational tasks, which included packaging in addition to valve and circuit board assembly with five young adults diagnosed with IDD. Picture prompts were presented in a bound book and consisted of pictures of the parts to be selected and how the parts fitted together. They programmed for generalization by teaching to multiple exemplars. Results indicated each participant mastered the vocational task and that the skills generalized to two novel tasks.

Maintenance

In addition to generalization across environments and behaviors, it is important that we think about how we can create lasting changes in behavior, otherwise, the intervention is not truly effective (Baer et al., 1968). Self-management strategies might prove useful for enhancing generalization and maintenance (Ninness et al., 1991) of vocational skills. If behavior change does not maintain, it is important to ask if the new behavior is being supported in the environment outside of the intervention (Kennedy, 2002). If support is not present, it is necessary to determine if the target behavior is of importance to the individual and others in the environment. Kennedy (2002) suggested that maintenance of skills might be used as an index of social validity. When skills are used regularly (due to multiple opportunities in daily life), they are more likely to be maintained than skills that are used rarely.

Fluency training, or teaching behaviors to a rate criterion, might also be an important consideration in promoting maintenance. Lee and Singer-Dudek (2012) examined the effects of fluency versus accuracy training on the completion of vocational tasks (e.g., assembling a doorknob, assembling an object hanger) by individuals with IDD. Accuracy training consisted of the instructor modeling each step while providing vocal verbal directions and delivering verbal feedback after each attempt made by the participant to complete the step; to move on in the sequence the participant was required to accurately complete previous steps. In the fluency training condition, continuous modeling and step-by-step vocal verbal prompts were given for how to complete a different targeted behavior chain than taught in the accuracy condition. A timer was placed within the participant's view, the participant was informed that the duration of the task completion would be recorded, and encouragement was given for fast completion. Praise was delivered when the participant completed the chain of behaviors accurately as well as when the student performed the task faster than their previous record. If an error was made, a correction was provided for the missed or inaccurate step and the instructor continued providing prompts for the remaining tasks. Post-training assessments were conducted following both training conditions and consisted of 20-min sessions observed two days after criterion was met with training as well as 40-min time periods observed 6 weeks after training. During post-training assessments, participants were given a task to assemble independently. Results of the study indicated three of the four participants completed a higher number of correct fluency-trained tasks than accuracy during 20-min sessions and all four participants demonstrated better performance during 40-min assessments for fluency-trained behaviors.

Research Recommendations: Generalization and Maintenance

While research supports implementation of fluency training on the success of academic skills (Johnson & Layng, 1994; Singer-Dudek & Greer, 2005), limited investigations have been conducted on the use of fluency training to teach vocational skills. Although the findings from Lee and Singer-Dudek (2012) are promising, additional research is needed to assess implementation of fluency training for vocational and workforce readiness skills.

It can be difficult to identify common stimuli, relevant exemplars, natural consequences, appropriate and inappropriate contexts for behavior, and appropriate topographies of responses. One way to identify these variables is by using a general-case analysis (Cooper et al., 2020; Ducharme & Feldman, 1992). It is important to note that with the general case model, you plan for and program for generalization from the beginning of training rather than after some set criterion is met (O'Neill, 1990). Steps in the general case analysis include (a) defining the instructional universe (identifying where, with whom, and with which stimuli the behavior should occur), (b) defining the range of relevant stimulus and response variations within the instructional universe (determining variability desired in conditions under which the behavior occurs and variability in the types of responses made; including exceptions), (c) selecting examples for teaching and testing (ensuring that examples represent the variability noted in b), (d) sequencing teaching examples (using multiple exemplars, teaching to opposing examples, reviewing previously taught exemplars, teaching exceptions last), (e) teaching the examples (use techniques demonstrated effective in the literature), and (f) testing for generalization with novel examples (Horner & Albin, 1988; Horner et al., 1986; Horner et al., 1982; O'Neill, 1990). The only study we identified that relied on a general case analysis was conducted by Sprague and Horner (1984). The authors evaluated training in three conditions: Condition 1 involved training to a single vending machine, Condition 2 involved training to three similar machines, and Condition 3 involved training to a variety of vending machines that sampled the range of stimulus and response variations that might be present in the class of vending machines. Their results showed that Condition 3 (the one that relied on a general case analysis) was the most effective for obtaining generalization. Considering that vocational skills are often trained in analogue settings with the desire for them to occur in real-world work settings, it seems that general case analysis would prove useful for assisting in producing this desired generalization. We recommend that researchers keep this in mind in the future.

Social Validity

Wolf (1978) noted that as applied behavior analysts, we strive to solve problems of social significance. In order to achieve this goal, Wolf said that researchers must determine if: (1) the goals of our research and practice are socially significant, (2) participants, caregivers, and others find the treatment procedures acceptable, and (3) all parties are satisfied with the results. Hanley (2010) suggested that indirect measures of social validity should be combined with measures that are direct and objective (e.g., concurrent chains arrangements, measure allocation of time spent) in order to better assess social validity with young children. These procedures might also be useful for assessing social validity with individuals who are preparing for vocational training. For example, researchers and clinicians might design a concurrent chains arrangement (see Hanley et al., 1997; Hanley et al., 2005; and Luczynski & Hanley, 2009 for examples) to directly assess the preference for procedures related to teaching vocational skills. The researcher or clinician might expose the learner to rehearsal and feedback opportunities with an experimenter or instructor and rehearsal and feedback opportunities with a peer and then ask them to choose which format they would like to experience prior to each subsequent teaching session. In addition, Kennedy (2002) suggested that maintenance of skills might be used as an index of social validity. When skills are used regularly (due to multiple opportunities in daily life), they are more likely to be maintained than skills that are used rarely. This notion supports our previous recommendation regarding more thorough follow-up information.

In order to directly assess social validity at a societal level, researchers might follow the four-step social validation process used by Minkin et al. (1976). For example, to assess social validity regarding work-related behavior a researcher might: (1) gather samples of appropriate and inappropriate work-related behaviors by sampling the verbal and nonverbal behavior of neurotypical adults, (2) show the samples to potential employers and have the potential employers rate the samples, then develop operational definitions of the behaviors that are correlated with the subjective ratings compiled by the potential employers, (3) teach the target behaviors to the learners, and (4) have the potential employers rate the new behaviors.

Applications of Organizational Behavior Management to Vocational Skills Training

Within the field of applied behavior analysis (ABA), there is a sub-discipline of organizational behavior management (OBM) that refers to the application of behavior analytic principles to organizational settings (Bucklin et al., 2000). OBM contains three sub-fields: behavior-based safety, behavioral systems analysis, and performance management. Specific to an employee's performance, the sub-field of performance management focuses on the analysis of antecedents and consequences operating on the behavior of employees and employers and the development of interventions designed to affect these variables to change employee performance (Sigurdsson & McGee, 2015). When a performance deficit is identified in the workplace, a staff-level functional behavior assessment (FBA) may be used to identify the barriers to the employee's performance. The completion of a staff-level FBA prior to identifying and implementing interventions may lead to the development of function-based interventions that result in quicker-acting and longer-lasting effects than non-functional interventions (Austin et al., 1999).

A variety of staff-level FBAs have been developed within the sub-discipline of OBM. The PIC/NIC Analysis is a framework developed by Daniels and Daniels (2006) that hypothesizes antecedent and consequent events operating on an individual's behavior. It is called a PIC/NIC because it specifies whether the consequences are *P*ositive, occur *I*mmediately or in the future, are *C*ertain or uncertain, or are *N*egative. Information may be gathered through interviews or observations and, through completion of this analysis, the practitioner is able to identify and, subsequently, modify environmental conditions to increase or decrease a behavior of interest. Similarly, Austin (2000) presented the Performance Diagnostic Checklist (PDC), which is an informant method of functional assessment for use in an organizational setting to address employee performance problems. The PDC provides a series of questions that a practitioner answers by interviewing the employees' supervisor(s) and directly observing employee behavior. Through the completion of the assessment, the practitioner identifies variables maintaining a performance problem and uses this information to develop an intervention to ameliorate the employee's performance issues.

Although the PDC has been successfully adopted in various settings to address performance problems, more recently, it has been revised to better align with specific settings and performance problems. Martinez-Onstott et al. (2016) developed the Performance Diagnostic Checklist—Safety (PDC-Safety) that was specifically designed to examine the environmental variables that affect safe and at-risk performance. Similarly, Carr et al. (2013) revised the PDC to better align with the unique needs of a human services setting, where employees are responsible for providing care to others (e.g., schools, clinics, group homes, employment settings for individuals with disabilities), and developed the Performance Diagnostic Checklist—Human Services (PDC-HS). The PDC-HS has been implemented in a variety of human service settings to address various employee performance problems (Wilder et al., 2020). To date, there is only one published study that demonstrates the effectiveness of the PDC-HS with people with IDD. Smith and Wilder (2018) used the PDC-HS with two supervisors with IDD to increase the accurate pricing in a thrift store of two supervisees with disabilities.

Research suggests immediate performance feedback and goals may also have a positive impact on workforce skills. In a study with 36 neurotypically developing employees split into four groups, Goomas et al. (2011) found that productivity in a large retail distribution center increased by a mean of 10.25% across all groups compared to baseline when goals were set, and group-based immediate feedback was delivered. The authors hypothesized that employees should be given guidelines focused specifically on their roles and job tasks and should receive training in standards and expectations for their responsibilities; these recommendations are aligned with reasonable and successful accommodations for individuals with IDD described by Migliore et al. (2018). Betchel et al. (2015) further assessed the effects of temporal placement of feedback with 45 undergraduate-level students. They found that any feedback was strongly preferable to none. Data further indicated that feedback before performance (i.e., feedback given after one task but before the next in a sequence) was more desirable than feedback following the full completion of a behavior chain.

Increasingly, individuals with ASD and/or IDD are calling for increased support in the workplace. Winsor et al. (2018) found an increased expectation of higher paying positions following formal education with job satisfaction linked to the type of employment (e.g., individualized competitive careers). Research outside of the field also suggests that focus on the strengths of employees and encouragement of self-efficacy, which might be behaviorally defined as the covert reinforcement for meeting job expectations, are of high import in job satisfaction (Lorenz et al., 2016). While the literature described here gives some sense of how we might implement OBM principles to address workforce readiness and productivity, potentially leading to increased job satisfaction for individuals with IDD and ASD, a significant need for these investigations exists as OBM research has been heavily predicated with those who implement behavior analysis (Gravina et al., 2018) rather than with individuals diagnosed with disabilities.

Future Implications

Individuals with disabilities are estimated to make up at least 15% of the world's population, which equates to roughly 1 billion people (World Bank/World Health Organization, 2011). However, as discussed earlier in the chapter, few of these individuals are in paid, integrated employment positions within the community (Hiersteiner et al., 2016), suggesting that a significant number of individuals with ASD and/or IDD are without employment.

Research suggests that barriers for employment for individuals with ASD and/or IDD mirror barriers experienced by other minority populations, including negative attitudes and stereotypes that impact access to skill development (Krzeminski et al., 2019), inequity in assessment procedures for potential employees (e.g., a written exam taken by someone who may need an accommodation for written prompts; Sumner & Brown, 2015), and lack of training for human resource personnel and other professionals in the workplace (O'Connor et al., 2007). Other barriers may include performance-based criteria that are inequitable, inadvertent discrimination against employees who are neurodiverse, requiring training for which accommodations and alternative pathways to learning are not given, and hesitancy to share one's diagnosis for fear of discrimination (Sumner & Brown, 2015). While these barriers certainly exist, there are advantages for employers who hire individuals with ASD and/or IDD. These include increases in positive public relations, employees who have the ability to focus intensively on one task, opportunities to learn about illogical systems that require change, and the ability to hire employees who have strong interests, knowledge, and expertise in specific areas (Krzemisnki et al., 2019; Pisano & Austin, 2016).

For those with ASD and/or IDD, sustainable, integrated employment may have a strong impact on quality of life, cognitive functioning, and overall mental health, including reduced anxiety and depression and improvements in peer relationships (Walsh et al., 2014). These outcomes underscore the importance of educating potential employers on the advantages of hiring more neurodiverse employees and ensuring that accommodations (e.g., training and systematic instruction) are available in the workplace such that workplace environments are equitable (Wilczynski et al., 2013). As part of this process, it is also important that we consider how to best teach potential employees about job protections (e.g., minimum wage, health coverage, employment-based discrimination).

Moving forward, there is an impetus for behavior analysts to take a broader role in creating better pathways for employment of individuals with ASD and/or IDD (Lombardi et al., 2018). This includes an increased awareness of social justice issues, including race discrepancies in disability employment, which suggests that more White than Black individuals who have ASD and/or IDD are gainfully employed (Landa & Migliore, 2019). The behavior analytic literature reflects that typical employment for individuals with ASD and/or IDD commonly consists of menial jobs such as cleaning bathrooms, sweeping floors, and packaging materials. Individuals with ASD and/or IDD have expressed a strong desire for more meaningful employment (Winsor et al. 2018) rather than low-paid, entry-level positions (Hedley et al., 2017). Self-determination and person-centered planning (Bannerman et al., 1990; Zalewska et al., 2016) are of vital importance in meeting the needs of those with ASD and/or IDD. We call upon the behavior analytic field to help meet the growing demand for integrated employment by teaching toward, and researching, higher order vocational skills and the varied essential prevocational skills required for sustained, competitive employment.

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Part IX

Challenging Behaviors

59

A Review of Behavioral Intervention for Treating Tics

Keelin Norman-Klatt and Kevin P. Klatt

A tic is defined as a sudden, rapid, recurrent, nonrhythmic motor movement or vocalization and can be categorized as simple or complex (American Psychiatric Association, 2013). Simple tics are short in duration (i.e., less than a second) such as a quick shoulder shrug or facial grimace (motor) or sniffing (vocal). Complex tics usually involve more than one muscle group and can even look like the person is engaging in the tic to obtain attention. Examples of complex tics include making a tic-like obscene gesture (motor) and repeating their own or others' words (phonic). There is no current diagnostic test to objectively diagnosis a tic disorder, and therefore diagnoses are made by observation and verbal report using criteria in the Diagnostic Statistical Manual of Mental Disorders (5th ed.; American Psychiatric Association, 2013).

Tics are separated into four related but different diagnostic categories. The first three disorders include an onset before age 18, and the tic cannot be attributable to the physiological effects of a substance or another medical condition. The tic disorders are hierarchical in order, starting with Tourette disorder (TD). This disorder includes multiple motor *and* at least one vocal tic (not necessarily concurrently with the motor tic), and the tics must have persisted for more than a year since the onset of the first tic. Someone who does not meet these criteria might meet the criteria for the second tic disorder, persistent (chronic) motor, or vocal tic disorder. This disorder includes single *or* multiple motor or vocal tics, but not both motor and vocal, and the tic(s) must have persisted for more than a year since the onset of the first tic. The third tic disorder, provisional tic disorder, includes single *or* multiple motor and/or vocal tics. In this case, the tic(s) have been present for *less* than 1 year since the first tic onset. Both persistent (chronic) motor or vocal tic disorder and provisional tic disorder can only be diagnosed if the person has never been diagnosed with TD. If the criteria cannot be met for the three tic disorders, a diagnosis could be made of other specified tic disorder or unspecified tic disorder.

The occurrence of isolated and transient tics range between 11% and 20% for school-aged children, with males much more likely than females to be diagnosed. There is a wide range of prevalence estimates for TD and all tic disorders in general, likely due to different sample sizes and assessment methods. An estimate of prevalence for TD in school-aged children is likely to fall between 4 and 8 cases per 1000 (Scahill et al.,

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2014). The occurrence of tics often coincides with other medical and psychiatric conditions. For example, both attention deficit hyperactivity disorder and obsessive-compulsive disorder are particularly common. Tics have been reported as early as age one, but usually start around age five, and often increase in frequency and intensity until about age 10 (Leckman et al., 1999). Many individuals with a tic disorder experience alternating increases and decreases in frequency of tics over time, with a peak often in the early teens (Woods et al., 2008a). Most individuals diagnosed with TD report an "urge" to engage in a tic. These internal subjective somatosensory sensations are usually referred to as "premonitory urges," and they usually precede tics (McGuire et al., 2016). Engaging in a tic then appears to temporarily reduce the urge to tic. In one study, adults reported an average of eight to nine distinct urges over 1 week (Leckman et al., 1993).

Treatments

Several behavioral interventions have been investigated to treat tics. Many of them, however promising, have not been investigated in enough studies and with the experimental control necessary to recommend as a sole treatment for tics, and therefore are not discussed in this chapter. Some of these treatments include massed practice (Yates, 1958), relaxation therapy (Turpin & Powell, 1984), self-monitoring (Billings, 1978), acceptance and commitment therapy (Franklin et al., 2011), and contingency management (Himle et al., 2008). Several behavioral treatments that have been shown to successfully treat tics and are discussed in this chapter include habit reversal (HR), comprehensive behavioral intervention for tics (CBIT), and differential reinforcement of other behavior (DRO). In addition, functional behavioral assessment (FBA) has been used in identifying contextual variables affecting tics that lead to behavioral intervention and is a key component of CBIT.

Habit Reversal

The most effective treatment for tics researched to date is habit reversal (HR), sometimes referred to as habit reversal training (HRT). The purpose of HR is to teach participants to become aware of their tic(s), self-monitor the tic(s), and learn to engage in a competing response either before or right after a tic occurs. Habit reversal is a training package that has included various procedures across studies. In the original study, HR was used to treat motor tics and nervous habits (Azrin & Nunn, 1973). The treatment consisted of first teaching the participant to become aware of the tic. Awareness training was conducted by beginning with a response description procedure. This required the participant to describe the movement of the counselor while the counselor modeled the tic. Then a response detection procedure was implemented whereby the counselor taught the participant to detect each instance of the tic by pointing out whenever one occurred. Following these two procedures, an early warning procedure was implemented requiring the participant to practice detecting the earliest sign of the tic.

Following these three procedures, a competing response was identified and taught. A competing response included a specific response pattern that was incompatible with the tic. The participant was instructed to engage in the competing response for about 3 min following either the temptation to perform a tic or the actual occurrence of a tic. The incompatible response was designed to be the opposite of the tic and capable of being maintained for several minutes. An attempt was made to make the incompatible response unnoticeable and easily completed within ongoing activities. A fifth awareness training procedure, situation awareness training, required the participant to recall all situations, persons, and places where the habit was likely to occur and describe how the tic was performed in these situations.

In addition to the five awareness procedures, three motivation procedures were implemented in an attempt to help the participant decrease their tic. The first motivation procedure was habit inconvenience, requiring the participant to review the inconveniences and embarrassment that resulted from the tic. In addition, social support procedures were added whereby family and friends commented favorably on progress and gave reminders to practice the competing response. Finally, generalization training was promoted using a symbolic rehearsal procedure that required the participant to imagine common situations where the tic occurred. The participant then imagined both detecting a tic and engaging in the competing response. The results of this study showed rapid reduction in tics and habits, although the study had some limitations. These included having participants self-report tics, presenting the data as a mean percentage change across the 12 participants, and using a non-experimental comparison design.

Subsequent studies using the HR procedure also showed a reduction in tics. For example, Azrin et al. (1980) compared habit reversal to negative practice using a larger number of participants, a greater variety of tics, and a longer follow-up period. Although the study had methodology shortcomings, HR appeared to have an immediate and substantial effect on the occurrence of tics.

The HR procedure was also demonstrated to be effective in treating TD (Azrin & Peterson, 1988). In this study, three adult males exhibiting the diagnostic criteria for TD (two were diagnosed) were treated with HR. The HR procedure included awareness training, self-monitoring, relaxation training, and a competing response. The frequency of tics was drastically reduced for all three participants and for two of the participants, at both home and clinic settings. Although the results from this study showed that tics could be reduced using HR, there were several methodological shortcomings including the use of a comparison design. Moreover, it should be noted that self-monitoring and relaxation procedures were added to the original HR procedure in this study.

Another investigation of HR was conducted for six adult males diagnosed with TD (Peterson & Azrin, 1992). In this study, however, HR was compared to self-monitoring and relaxation training. Note here that habit reversal was now considered separate from both self-monitoring and relaxation training. The results showed a reduction in tics from all three treatments when compared to baseline levels. The average reduction in tics across all six participants was 32% for relaxation training, 44% for self-monitoring, and 55% for habit reversal. Despite these percentages, the HR procedure was most effective for only two of the six participants. The self-monitoring procedure was most effective for three of the six participants. Despite methodological shortcomings, the results from this study showed the effectiveness of both HR and self-monitoring.

The procedures included in the HR training package varied in these early studies. Despite the differences in the HR training package, four main components have been identified (Miltenberger, 2016). These four components include awareness training, teaching a competing response, involving family and friends in social support, and strategies to motivate the use of this package. In addition to these HR training procedures, a book on treating TD and tic disorders recommended teaching relaxation training to patients with tic disorders (Woods et al., 2007).

Although the procedures used in the HR training package have varied, some studies have revealed that tics sometimes can be reduced without using the all the main components. For example, Ollendick (1981) used only self-monitoring for one participant and a combination of self-monitoring and a competing response practice procedure for a second participant. The self-monitoring alone was enough to reduce tics for the first participant. The other participant's tics were moderately reduced with self-monitoring, but the combined procedures were necessary for further reduction. In another study, Miltenberger et al. (1985) compared HR with a simplified package consisting of only awareness training and competing response training. The five participants receiving the simplified package all had drastic reductions in tics that maintained across 15 weeks. The successful reduction in tics using two components of HR suggests that the full package might not always be necessary, perhaps reducing the time and expertise needed to implement the full package.

Wright and Miltenberger (1987) used only awareness training to treat muscle tics for a 19-year-old college student. The tics were reduced using only awareness training and generalized to another setting. Wiskow and Klatt (2013) used only awareness training to treat four motor tics for a 9-year-old boy diagnosed with Asperger syndrome, TD, and attention deficit hyperactivity disorder. All four tics were reduced to zero with only awareness training. Woods et al. (1996) used a sequential application of the main HR components including awareness training, self-monitoring, social support, and a competing response for four children. Their results showed that the components necessary to reduce tics varied across the children, and awareness training alone was effective for one of the four children. Another study investigated a simplified HR procedure by comparing awareness training and competing response training to a combination of awareness training, competing response training, and social support using a pre-post group design (Flessner et al., 2005). Although the researchers hypothesized the addition of social support would result in greater treatment effects, there was no significant differences between the two groups.

The results of these studies demonstrate that not all components of the HR package are always necessary to decrease tics. In some cases, tics are reduced with only awareness training or awareness and a competing response training. To determine whether the competing response needs to be topographically similar to the tic as usually recommended, a topographically dissimilar response was investigated (Sharenow et al., 1989). The application of a dissimilar competing response resulted in a reduction in tics for all three participants. The data from this study suggests, and partially confirms, the topography of the competing response might not be as important as engaging in some response contingent on the occurrence of a tic or the urge to engage in the tic.

The competing response procedure in HR has been historically taught to occur contingent on either a tic or the urge to engage in a tic. This contingency, however, was investigated to evaluate whether the competing response needs to be contingent or whether nervous habits would reduce if done noncontingently (Miltenberger & Fuqua, 1985). The results indicated that the noncontingent competing response was mostly ineffective while the contingent competing response greatly reduced the habits. The study was conducted on nervous habits, not tics, so further research needs to be done to determine whether it also applies to vocal and motor tics.

Habit Reversal Literature Review

The HR training package, including various procedures, has been demonstrated to be an effective treatment for reducing tics (and other related behaviors) for almost 50 years. Several reviews have discussed the merits of the HR procedures (e.g., Carr & Chong, 2005; Cook & Blacher, 2007; Himle et al., 2006; Miltenberger et al., 1998; Woods & Miltenberger, 1995). The results from these reviews have led to different conclusions regarding the effectiveness of HR. In one review, Carr and Chong (2005) used guidelines from the Division 12 of the American Psychological Association (APA) Task Force on Promotion and Dissemination of Psychological Procedures to determine the empirical support for HR. In their review of 20 studies, only 12 included appropriate experimental designs and objective measurement of dependent variables. These 12 studies were reviewed in relation to the APA guidelines that stipulate a successful treatment effect must be demonstrated with at least two between-subjects designs or nine within-subject designs and include a treatment manual. The results from the 12 reviewed studies met the criteria for both between and within-subject criteria. The 12 studies, however, did not include the guideline requirements of the use of treatment manuals. Moreover, the studies fell short of another APA guideline in not sufficiently describing participant characteristics. These shortcomings led Carr and Chong (2005) to conclude the HR procedure did not meet the criteria for *well-established* but rather for *probably efficacious*. Two years later another literature review was conducted that included five additional studies

(Cook & Blacher, 2007). In this review, a conclusion was made that HR met the criteria to be classified as a *well-established* treatment.

To address the HR literature since the last reviews of studies using single-subject designs (Carr & Chong, 2005; Cook & Blacher, 2007; Himle et al., 2006), a review of the literature was conducted by both authors of this chapter. Similar to Carr and Chong (2005), the terms habit reversal and tics or Tourette and competing response and tics or Tourette were searched (for titles only) in both PsycINFO and Medline databases. A total of 41 studies were identified, and the reference sections of each article were reviewed. Seven studies were eliminated because they were not published in English. The number of studies was further refined by eliminating studies using a between-subject design (comprehensive list of between-subject designs is listed in Table 59.2. One study prior to 2005 was included because it was not included in the Carr and Chong (2005) review. Unlike past reviews, studies were included even if no experimental design was implemented. This was done to give a more comprehensive view of what studies have been published since the previous reviews. A final list of 12 studies were included in the review and presented in (Table 59.1).

The 12 studies included in the review were evaluated for information across 14 categories. The first five categories included several participant characteristics including age, gender, diagnosis, motor or phonic tics, and the tic topography. The other categories included the study settings, independent and dependent variables, whether inter-observer agreement, procedural integrity, and social validity were assessed, and the experimental designs utilized. Finally, the last two categories included the reported results and whether a functional assessment was conducted.

The results from the literature review showed there were 22 participants included across the 12 studies. Only one participant was included in 7 of the 12 studies. The participants ranged in age from 7 to 49, with 19 males and 3 females. Motor and phonic tics were addressed in 9 studies, only motor tics in 2 studies, and only phonic tics in 1 study. The settings in which studies were conducted included school (4), clinic (6), home (5), and university program (1). The dependent variables were assessed for interobserver agreement in 8 of 12 studies, treatment integrity in 5 of 12 studies, and social validity was assessed in 3 of the 12 studies. An experimental design was used to assess the effectiveness of HR in 5 of the 12 studies. A functional analysis was conducted in 4 of the 12 studies. The full HR package, including awareness training, competing response training, social support and motivation strategies was not included in any of the 12 studies. A variety of combinations of the HR strategies was used across the studies. The results showed a reduction in tics was reported for 20 of the 22 (91%) participants. This conclusion, however, should be interpreted with caution given the number of studies that did not use an experimental design along with other methodological flaws.

This review of studies over nearly 20 years shows that HR procedures have been used in a variety of combinations. The procedures that comprise HR have differed across studies since its inception. Two procedures used consistently in HR, however, include awareness training and teaching a competing response. Where studies differ includes what other procedures constitute HR including social supports, relaxation training, and motivation strategies. The studies reviewed treated a variety of tic topographies across mainly three settings, including clinic, school, and home settings. Studies have not been conducted in community settings such as recreation or workplaces. The studies also primarily investigated HR with males at a ratio much higher than would be expected based on a diagnosis ratio between males and females. The results of these studies showed a reduction in tics for almost all the participants. This finding, however, is inconclusive due to major methodological shortcomings found across many of the studies. Close to 60% of the studies did not use an adequate experimental design to assess the effects of the HR components on the occurrence of tics nor checked treatment integrity. Interobserver agreement was not assessed in one-third of the studies. Only three studies used an adequate experimental design and assessed both interobserver agreement and

Table 59.1 Review of studies using habit reversal components to treat tics

Title	Author(s)	Year	Journal/book	*N*	Age and gender	Diagnosis	Motor or phonic tics	Tic topography	Settings	Ind var	Target behavior (DV)	IOA	Treat-ment integrity	Social validity	Exp design	Func assess?	Results
Behavior therapy for youth with Tourette disorder	McGuire, McBride, et al.	2016	*Journal of Clinical Psychology*	1	14-F	TD	Both	Eye, head jerks, neck rolling, arm movements, leg kicking, sniffing, snorting, throat clearing, animal noises	Clinic	HR: awareness training, competing response, relaxation training	YGTSS scores	No	No	No	No experimental design utilized	No	YGTSS scores decreased across sessions
The effects of awareness training on tics in a young boy with Tourette syndrome, Asperger syndrome, and attention deficit hyperactivity disorder	Wiskow & Klatt	2013	*Journal of Applied Behavior Analysis*	1	9-M	TD, Asperger, ADHD	Motor	Eye, facial, mouth, shoulder	School	HR: awareness training	Tics per minute	Yes	Yes; 84%	No	A combined multiple baseline across tics and reversal design	No	Decrease in all four tics
Functional analysis identified habit reversal components for the treatment of motor tics	Dufrene, Lestremau, et al.	2013	*Child and Family Behavior Therapy*	2	13-M, 13-M	Asperger, TD, ADHD, OCD	Both	Eye, arm jerking, throat clearing	Clinic and school	HR: awareness training, competing response, social support (relaxation training added for one)	Tics per minute	Yes	Yes; 100%	Yes	Reversal	Yes	Components of HR reduced tics
Integrated behavior therapy in the treatment of complicated Tourette's disorder and its comorbidities	Bryson, Edwards, et al.	2010	*Clinical Case Studies*	1	49-F	TD, OCD	Both	Coprolalia, grunting, squeaking, slapping face, leg shifting	Clinic	Awareness training with relaxation training (as a competing response)	YGTSS scores	No	No	No	No experimental design utilized	No	YGTSS scores decreased across sessions
Habit reversal treatment of repetitive hand writing in a 7-year-old child with a learning disability	Shumaker	2009	*Clinical Case Studies*	1	7-F	OCD	Motor	Air handwriting	Clinic	Awareness training, self-monitoring, relaxation training, competing response training, medication	Frequency of air handwriting	No	No	No	No experimental design utilized	No	Air hand writing frequency decreased across weeks (no experimental control)

Title	Author(s)	Year	Journal/book	*N*	Age and gender	Diagnosis	Motor or phonic tics	Tic topography	Settings	Ind var	Target behavior (DV)	IOA	Treat-ment integrity	Social validity	Exp design	Func assess?	Results
Habit reversal treatment of vocal and motor tics in a child with Tourette's syndrome	Woods & Luiselli	2007	*Clinical Case Studies*	1	10-M	TD	Both	Sniffing, clicking, squeaking, eye blinking and rolling, facial grimace, head jerking	Clinic and home	Awareness training, self-monitoring, relaxation training, competing response training	Tic frequency	No	No	No	Comparison design	No	The occurrence of vocal tics decreased with HR components
Using brief experimental assessment of reading interventions for identification and treatment of a vocal habit	Valleley, Shriver, et al.	2005	*Journal of Applied Behavior Analysis*	1	11-M	Chronic motor tic disorder, intellectual disability	Both	Facial tensions, pulling arms to chest and making fist, adding "ah" to the end of words	Clinic and home	Phrase error correction (resembled habit reversal)	Vocal habits per min	Yes	Yes	No	Multielement for the brief experimental analysis, A/B for treatment	No	PEC was the most effective for decreasing rate of verbal habits
Brief antecedent assessment and treatment of tics in the general education classroom	Watson, Dufrene, et al.	2005	*Behavior Modification*	2	14-M, 11-M	TD	Both	Coprolalia, throat clearing, whooping, eye opening, hard blinking, head turning	School	Simplified habit reversal (awareness training and competing response training)	Tics per min	Yes; 97%	Yes; 100%	No	Comparison design (A/B)	Yes	Specific antecedents for tic occurrence were identified and SHR reduced tic occurrence
A school-based application of modified habit reversal for Tourette syndrome via a translator	Gilman, Connor, et al.	2005	*Behavior Modification*	1	14-M	TD	Both	Coprolalia, punching ribs and neck	School	Modified habit reversal (awareness training, competing response training, and motivation)	Motor tics per 45 min session	Yes; 98.4%	No	No	Comparison design (A/B)	Yes	HR was effective in reducing tics in the two settings observed
Functional analysis and habit-reversal treatment of tics	Carr, Sidener, et al.	2005	*Behavioral Interventions*	3	8-M, 12-M, 9-M	TD, ADHD, OCD	Both	Throat clearing, coughing, saliva swishing, gulping, squealing, whimpering, head nodding and shaking, arm jerking and extensions, mouth opening, eyebrow raising, nose twitching	University and home	Simplified habit reversal (awareness training, competing response training, and social support)	Responses per min, percentage of intervals	Yes	Yes	Yes	Nonconcurrent multiple baseline across subjects	Yes	HR was effective in reducing the tics for both participants

(continued)

Table 59.1 (continued)

Title	Author(s)	Year	Journal/book	*N*	Age and gender	Diagnosis	Motor or phonic tics	Tic topography	Settings	Ind var	Target behavior (DV)	IOA	Treat-ment integrity	Social validity	Exp design	Func assess?	Results
Treatment of vocal tics in children with Tourette syndrome: Investigating the efficacy of habit reversal	Woods, Twohig, et al.	2003	*Journal of Applied Behavior Analysis*	5	11-M, 13-M, 12-M, 12-M, 10-M	TD, major depression	Both	Head jerking, eye blinking, neck stretching, arm extension, mouth and nose movements, eyebrow raising, shoulder rolling, coughing, grunting, rapid exhaling, squeaking, throat clearing, sniffing	Home	Simplified habit reversal (awareness training, competing response training, and social support)	Percentage of intervals with tics	Yes; 98.6% (motor), 99% (phonic)	No	No	Nonconcurrent multiple baseline across subjects	No	HR resulted in a reduction in vocal tics for four of the five children
Using habit reversal to treat chronic vocal tic disorder in children	Woods & Twohig	2002	*Behavioral Interventions*	3	7-M, 16-M, 9-M	CVT, ADHD	Phonic	Coughing, throat clearing, grunting, rapid exhale or sniffing	Home	Simplified habit reversal (awareness training, competing response training, and social support)	Percentage of intervals with vocal tics	Yes; 98%	No	Yes	Nonconcurrent multiple baseline across subjects	No	SHR was effective in reducing vocal tics for two of three children

Table 59.2 Between-group studies investigating habit reversal for tics

Title	Author(s)	Year	Journal/book
A method of eliminating nervous habits and tics	Azrin & Nunn	1973	*Behavior Research and Therapy*
Habit reversal versus negative practice treatment of nervous tics	Azrin, Nunn, et al.	1980	*Behavior Research and Therapy*
Habit reversal for the treatment of Tourette syndrome	Azrin & Peterson	1988	*Behavior Research and Therapy*
Treatment of Tourette syndrome by habit reversal: A waiting list control group comparison	Azrin & Peterson	1990	*Behavior Research and Therapy*
A comparison of a behavioral and a cognitive-behavioral approach to the management of chronic tic disorders	O'Connor, Gareau, et al.	1997	*Clinical Psychology and Psychotherapy*
Habit reversal versus supportive psychotherapy in Tourette's disorder: A randomized controlled trial	Wilhelm, Deckersbach, et al.	2003	*The American Journal of Psychiatry*
Exposure with response prevention versus habit reversal in Tourette's syndrome: A controlled study	Verdellen, Keijsers, et al.	2004	*Behavior Research and Therapy*
Habit reversal versus supportive psychotherapy in Tourette's disorder: A randomized controlled trial and predictors of treatment response	Deckersbach, Rauch, et al.	2006	*Behavior Research and Therapy*
Behavior therapy for children with Tourette disorder: A randomized controlled trial	Piacentini, Woods, et al.	2010	*Journal of the American Medical Association*
Randomized trial of behavior therapy for adults with Tourette syndrome	Wilhelm, Peterson, et al.	2012	*Archives of General Psychiatry*
Habit reversal training and educational group treatments for children with Tourette syndrome: A preliminary randomized control trial	Yates, Edwards, et al.	2016	*Behavior Research and Therapy*
A randomized controlled trial comparing behavioral, educational, and pharmacological treatments in youth with chronic tic disorder or Tourette syndrome	Rizzo, Pellico, et al.	2018	*Frontiers in Psychiatry*
Combined habit reversal training and exposure response prevention in a group setting compared to individual training: A randomized controlled clinical trial	Nissen, Kaergaard, et al.	2019	*European Child and Adolescent Psychiatry*

treatment integrity (Carr et al., 2005; Dufrene et al., 2013; Wiskow & Klatt, 2013).

Habit Reversal Summary

The HR treatment package appears to meet the "well-established" treatment given the number of between and within-group designs. There are now at least 13 between group studies showing HR effectiveness (see Table 2) and more than 20 single-subject studies with adequate experimental designs. Habit reversal is effective, rapid, and long lasting in treating nervous habits and tics, including those tics associated with TD. Moreover, various combinations of HR procedures have been successful in reducing tics in most cases. In fact, research has demonstrated that the two most important procedures in HR include awareness training and teaching a competing response (Miltenberger et al., 1985; Woods & Miltenberger, 1995).

Functional Behavioral Analysis

The cause of tics is unknown, however, there is evidence of dysfunction in the cortico-striatal-thalamo-cortical pathway that is a brain circuit that controls movement execution (Mink, 2003). In addition to this known neurobiological basis, research has also demonstrated that tics can be influenced by environmental conditions. For example, environmental factors that can affect symptoms of TD were investigated for 14 children aged 6–14 (Silva et al., 1995). Each participant completed a questionnaire and was interviewed to comprise the factors that had the most and least effect on symptoms. The results showed 17 factors affected symptoms, and the most common were events that made the participant upset or anxious. Examples of anxiety producing events included starting a new school year, waiting for test results, moving to a new location, and family arguments.

Environmental factors associated with tic occurrence also were investigated by examining the behavioral activity during tics for people with chronic tic disorder (O'Connor et al., 2003). Participants recorded the frequency of tics, intensity of urge to tic, and situations where the tics were most likely to occur for 10 days. The results showed the highest risk for tics included social activities such as being at a party, situations requiring waiting (e.g., in line to get something), and when in transit (e.g., going to an appointment). Although the study did not demonstrate these activities caused tics, it suggested environmental variables can affect tic occurrence.

Further investigation of environmental variables affecting tics was completed using a function-based assessment of tics (FBAT; Woods et al., 2008a) to describe the frequency with which various antecedent and consequence variables were reported to exacerbate tics in youth aged 9–17 diagnosed with a chronic tic disorder (Himle et al., 2014). The results from this study showed that all the participants reported at least two tic-exacerbating antecedents, and all but two participants reported at least one consequence. The most common antecedent was watching tv and playing video games, while the most common consequence was attention in the form of being told to stop the tic. This study demonstrated again that environmental variables might affect the occurrence of tics. Using indirect assessment of environmental variables potentially leads to treatments that can address antecedents that function as a signal for a tic and/or consequences that function as a reinforcer. This assumes that the assessment accurately identifies the correct variables affecting the tic. In one study, however, participants were asked to evaluate how specific contexts influenced their tics, after which they were observed in the situations to evaluate whether their reports were accurate (Barnea et al., 2016). The results showed their subjective assessments were often inconsistent with the data collected when they were directly observed.

In addition to the indirect assessments of variables affecting tics, direct assessment of environmental variables also has been conducted (i.e., functional analysis). By manipulating specific environmental variables that might affect tics, a functional relationship can be identified between the tic and the specific variable(s). A recent review of the literature summarized the results from 13 studies that experimentally manipulated consequences to identify reinforcers maintaining tics (Goldman & DeLeon, 2020). Although only 13 studies have been conducted to date, and therefore the results should be interpreted with caution, there are some interesting data. First, differences in tic function were found between participants diagnosed with an intellectual disability or communication impairment (ID/CI) versus those not diagnosed. The participants not diagnosed with ID/CI were much more likely to have an automatic function for their tics, where those with an ID/CI diagnosis had tics more distributed across automatic, attention, and escape functions. Second, looking at the number of datasets, participants with TD were less likely to also be diagnosed with an ID/CI compared to those not diagnosed with TD. Third, differences in tic function were found between the participants diagnosed with or without TD. Participants with TD were much more likely to have an automatic function for tics, and the non-TD participants were more likely to have an attention function, or to a lesser degree, an automatic function. Fourth, the tic topographies most commonly maintained by automatic reinforcement included throat clearing/coughing and arm movements. The topographies most maintained by social consequences included head movements and throat clearing/coughing.

The results of this review provide further evidence that although tics have a neurological basis, environmental conditions could affect the tics over time. The results also have an important implication for treating tics. That is, treatment for tics maintained by social consequences might be more effective when the particular social consequence is manipulated. For example, tics maintained by attention from parents might not completely reduce with habit reversal alone. In this case, treatment might be more effective if the parents are taught how to reinforce appropriate behavior rather than tics.

Comprehensive Behavioral Intervention for Tics (CBIT)

Researchers from the Tourette Syndrome Association's Behavioral Sciences Consortium developed a treatment approach called comprehensive behavioral intervention for tics (CBIT) and published both a therapist guide (Woods et al., 2008a) and treatment workbook (Woods et al., 2008b). The CBIT treatment package is comprised of habit reversal training, a functional assessment of tic reinforcement, and relaxation training (see Table 59.3). These behavioral interventions are used together to address TD in children at least 9 years old and adults in a 11-session package, perhaps as either an adjunct or an alternative to medication. The first phase in CBIT training consists of eight sessions delivered over 10 weeks. The second phase consists of booster sessions that occur once per month for 3 months to increase maintenance and generalization of the treatment.

The CBIT treatment was investigated in a randomized controlled trial for 126 children diagnosed with TD or chronic tic disorder (Piacentini et al., 2010). The CBIT treatment was compared to a control group receiving supportive psychotherapy and education. The study included eight sessions of 60–90 min each across 10 weeks. The results showed tics were significantly reduced in the CBIT group compared to the control group. Moreover, the magnitude of reduction in this study was comparable to results of controlled trials with antipsychotic medications for TD (Scahill et al., 2003). Overall, 53% of CBIT participants were rated as much or very much improved by independent clinical evaluators compared to 19% in the control condition. The tics in this study were also indirectly measured

Table 59.3 Important resources pertinent to CBIT

Title	Author(s)	Year	Journal/book
Effectiveness of a modified comprehensive behavioral intervention for tics for children and adolescents with Tourette's syndrome: A randomized controlled trial	Chen, Wang, et al.	2020	*Journal of Advanced Nursing*
Development and open trial of a psychosocial intervention for young children with chronic tics: The CBIT-JR study	Bennett, Capriotti, et al.	2019	*Behavior Therapy*
A meta-analysis of behavior therapy for Tourette syndrome	McGuire, Piacentini, et al.	2014	*Journal of Psychiatric Research*
Comprehensive behavioral intervention to improve occupational performance in children with Tourette disorder	Rowe, Yuen, et al.	2013	*The American Journal of Occupational Therapy*
Randomized trial of behavior therapy for adults with Tourette syndrome	Wilhelm, Peterson, et al.	2012	*Archives of General Psychiatry*
Behavior therapy for children with Tourette disorder: A randomized controlled trial	Piacentini, Woods, et al.	2010	*Journal of the American Medical Association*
Managing Tourette syndrome: A behavioral intervention for children and adults: Therapist guide	Woods, Piacentini, et al.	2008a	*Oxford University Press*
Managing Tourette syndrome: A behavioral intervention: Parent workbook	Woods, Piacentini, et al.	2008b	*Oxford University Press*
Treating Tourette syndrome and tic disorders: A guide for practitioners	Woods, Piacentini, et al.	2007	*The Guilford Press*

using the Yale Global Tic Severity Scale (YGTSS; Leckman et al., 1989) showing a 31% reduction in the CBIT condition and 18% in the control condition. Despite using indirect measurement, the scope of this randomized control trial suggests that the CBIT treatment package can be effective in reducing tics for some children and perhaps as effective as some medications.

Another randomized trial comparing CBIT to psychoeducation and supportive therapy was conducted for 122 adults diagnosed with TD (Wilhelm et al., 2012). The study was similar in design to the first randomized control trial (Piacentini et al., 2010) except for adult participants. The results were also similar, with the CBIT treatment resulting in a significant reduction in tics. This study, however, found the treatment was less robust, with a positive response found for 38% of adults compared to 53% for children in the previous study.

The outcomes of these two large random controlled trials suggest CBIT is effective for many children and adults. The effectiveness of the CBIT treatment, however, has been limited to children aged 9 and older, presumably assuming younger children would be unable to engage in HRT because of limited awareness of tics and urges. Given the onset of tics often occurs at an earlier age, however, a recent study investigated an adaptation of CBIT for children 5–8 years old (Bennett et al., 2019). In this study, 15 children aged 5–8 with clinically significant tics received a modified version of CBIT. While the basic structure and components of CBIT remained, changes were made to make the treatment age-appropriate for younger children. For example, the HRT component was taught using “The Opposite Game” (TOG). This game was used to teach and assess each child’s awareness and control of bodily sensations and movements and to teach the concept of opposite body actions. Tics were then measured using the YGTSS, a parent questionnaire, and a treatment acceptability questionnaire. The results showed a significant decrease in tic severity as evidenced by scores on the YGTSS and the parent questionnaire. The improvements in the YGTSS scores also maintained at a 3-month and a 1-year follow-up assessment. The degree of changes in tic occurrence was found comparable to those found in the first CBIT trial (Piacentini et al., 2010). The treatment was also shown to be acceptable to the children and their parents. These results suggest that a modified CBIT for younger children is feasible and effective, although future studies need to be conducted.

Other modifications to the original CBIT protocol have been investigated. For example, concerns about the lack of qualified therapists and the length of travel distances to get treatment in some countries led to investigating a modified treatment length of CBIT. Recall in the original protocol, the first phase consists of eight sessions delivered over the course of 10 weeks (Woods et al., 2008a). Several studies have been conducted investigating different ways to shorten CBIT treatment from the original protocol. In one case study, a 25-year-old male diagnosed with TD was given a massed version of CBIT (Flancbaum et al., 2011). A total of seven sessions were administered in a 2 week rather than 10-week period. Reduced frequency for two tics were noted; however, several methodological flaws and lack of maintenance at a 5-month follow-up prevent concluding that a massed trial version of CBIT was effective.

In another study, two males aged 10 and 14 diagnosed with TD were given the CBIT treatment in an intensive outpatient program (IOP-CBIT) that included several hours of daily treatment across 4 days (Blount et al., 2014). Both participants had a reduction on the YGTSS assessment, reported treatment satisfaction, and maintained tic reductions at follow-up sessions (except one participant had some regression at a 6-month follow-up). A replication of this study was then conducted with a small sample of five children and adults diagnosed with TD and who had a wider range of tic severity (Blount et al., 2018). The IOP-CBIT protocol was administered in the same fashion and tics were again measured using the YGTSS. The results showed similar reductions in YGTSS scores.

To expand the availability of the CBIT treatment, non-therapist health care providers (i.e., nurse practitioners) were taught how to administer a modified CBIT (CBIT-NP) protocol (Ricketts et al., 2016b). The nurse practitioners were trained using a multifaceted training program intended to maximize treatment fidelity. Once trained, the nurse practitioners delivered CBIT-NP in six sessions or less, all under 25 min, across 6–8 weeks. Nine participants, average age 11.9, completed the CBIT-NP treatment. The results showed significant reductions in tic severity. Six of the nine participants were rated as having no tic-related impairment at posttreatment. In a posttreatment survey, nurse practitioners reported that the shorter session length was feasible but not preferable. Moreover, even though the CBIT-NP treatment was incorporated into their clinics, logistical barriers existed such as limited clinic space, billing, and poor patient attendance.

Another approach to providing CBIT training includes videoconferencing (VC) technologies. In a pilot study, VC was used to provide CBIT training to three children with TD (Himle et al., 2010). All three participants showed significant reductions in tic severity. In a follow-up study, 20 children were randomly assigned to receive CBIT delivered either through VC or traditional delivery (Himle et al., 2012). The results showed tic reductions in both groups, with no significant differences in mean reductions between groups. More recently, CBIT was provided using Voice over Internet Protocol telephony or web-based VC (Ricketts et al., 2016a). In the second of two studies, the feasibility, acceptability, and preliminary efficacy of delivering CBIT treatment with this technology were evaluated for four participants aged 10–13 diagnosed with TD. Families in this study were given a web camera during the study if needed and were helped in downloading Skype software. The results showed a 29.4% average decrease in YGTSS tic severity from pre to posttreatment. Moreover, parent satisfaction ratings were high and over 70% of sessions did not have any technology problems. There were some technology problems, however, such as a computer virus, variable sound quality, and keeping participant attention.

Finally, a randomized controlled trial was conducted investigating a modified four session CBIT treatment for 42 children and adolescents aged 6–18 (Chen et al., 2020). The participants in the treatment group received four sessions of CBIT over a 3-month period (rather than the eight sessions over 10 weeks). Both treatment and control groups received psychoeducation and 50 mg pyridoxine (standard treatment in Taiwan where study was conducted). Tics were measured using YGTSS scores. The results showed significantly reduced tic scores in the treatment group compared to the control group. This study was another demonstration that a modified CBIT treatment can be used to reduce tics.

The CBIT treatment protocol was initially developed using components already demonstrated to be effective (e.g., HRT). Several random control trials have been conducted demonstrating CBIT to be effective across children and adults. In fact, guidelines from the American Academy of Neurology now recommend CBIT as a first-line treatment when symptoms interfere with daily activities (Pringsheim et al., 2019). In addition, studies have demonstrated that CBIT can be modified to treat children younger than 9, the number of sessions can be reduced, sessions can be spread across time, the treatment can be provided online, and the treatment can be taught to and provided by nurse practitioners in clinical settings. Furthermore, the tic reductions maintained for most participants months after treatment ended.

Differential Reinforcement of Other Behavior (DRO)

Differential reinforcement of other behavior (DRO) is a procedure where a putative reinforcer is delivered contingent on the absence of a target behavior. The DRO procedure involves reinforcing the absence of the target behavior after a predetermined interval of time, and potentially involves several behavioral processes (see Cooper et al., 2020). In other words, reinforcement is delivered for not engaging in the target behavior (Reynolds, 1961). The reinforcer can be delivered contingent on the target behavior not occurring throughout intervals of time (interval DRO) or at specific moments of time (momentary DRO). Moreover, in both cases, the putative reinforcer can be delivered using a fixed or variable schedule of reinforcement.

The DRO procedure has been used to treat a variety of tics. For example, in an early case study, a boy aged 12 diagnosed with TD who engaged in inappropriate vocal and motor behavior was treated with an unidentified procedure (Rosen & Wesner, 1973). The procedure included an electric light being lit every 30 s period without the occurrence of vocal or motor responses. The boy was told that he would receive a piece of candy for every time the light came on. Although the procedure was not identified as DRO, the implementation meets the definition. The vocal and motor responses were reduced; however, other treatments were also implemented which prevented any conclusion on the effectiveness of the DRO.

In another study, a 5-year-old boy diagnosed with TD was treated for multiple motor and phonic tics (Miller, 1970). The boy was given two pieces of candy for each 1-min period that he was not making barking noises. The frequency of barking noises was reportedly reduced compared to the baseline rate. In this study, however, data were not reported, and there was not an experimental design. Moreover, neither a preference nor reinforcer assessment was conducted to determine whether the candy functioned as a reinforcer prior to the study. The procedure, however, meets the definition of differential reinforcement using a fixed-interval duration of time.

DRO Literature Review

The DRO procedure has been used in a variety of ways to treat tics. To evaluate these studies, a review of the literature was conducted by the authors. To conduct the search, the terms differential reinforcement of other behavior and tics or Tourette were searched in both PsycINFO and Medline databases. A total of eight studies were identified, and two were eliminated because they were not published in a peer-reviewed journal. The reference sections of each article were reviewed to obtain a total of 14 studies. Four studies were eliminated due to individual data not being reported. A total of 10 studies were identified to be reviewed (see Table 59.4).

The 10 studies included in the review were evaluated across nine categories. The first four categories included the number of participants, ages, gender, and diagnosis. The next three categories included the type of DRO (interval or momentary interval), whether the schedule of reinforcement was fixed or variable, and the length of the DRO interval. Given a reinforcer is delivered following time periods without tics, another category included whether a preference or reinforcer assessment was conducted to identify stimuli that functioned as a reinforcer. The last two categories included whether maintenance was assessed and the reported results (including the experimental design if utilized).

The results from the literature review showed 26 participants were included across the 10 studies (the 5 oldest studies were case studies each with 1 participant). The participant ages ranged from age 4 to 38, with 19 males and 7 females. Most of the participants were diagnosed with TD and engaged in both motor and phonic tics. All 10 studies delivered the putative reinforcer based on intervals of time (interval DRO). The intervals of time used appeared to be chosen arbitrarily or based on previous studies. The schedule of reinforcement was fixed across 8 studies. The fixed intervals ranged from 5 s to 5 min. In one exception, the schedule varied between 3 and 7 min (Wagaman et al., 1995). In the second exception, the DRO was implemented by providing a putative reinforcer (music) until a tic occurred. The music was removed and if no tic occurred for 1.5 s the music was returned until the next tic occurred. In effect, no occurrence of a tic for 1.5 s resulted in the music continuing until the next tic occurred. In this case, there was no predetermined set intervals (Barrett, 1962).

The reported results, supported by visual analysis, showed a reduction in tics for 23 of 26 (88%) participants. This reduction, however, included participants from studies without adequate experimental designs. Looking at only studies with experimental designs, 15 of 18 (83%) of participants had reductions in tics.

Table 59.4 Review of studies implementing differential reinforcement of other behavior (DRO)

Title	Author(s)	Year	Journal/book	*N*	Age and gender	Diagnosis	DRO (interval or momentary)	Schedule (fixed or variable)	DRO interval	Preference or reinforcer assessment	Follow-up assessed?	Results
Comparing fixed amount and progressive amount DRO schedules for tic suppression in youth with chronic tic disorders	Capriotti, Turkel, et al.	2017	*Journal of Applied Behavior Analysis*	4	16-F, 10-M, M-15, M-15	Tic disorder	Interval	Fixed	10 s	No	No	Tics were reduced for all four participants using both fixed and progressive-amount schedules of reinforcement using a multielement design
Comparing the effects of differential reinforcement of other behaviors and response-cost contingencies on tics in youth with Tourette syndrome	Capriotti, Brandt, et al.	2012	*Journal of Applied Behavior Analysis*	4	9-M, 10-M, 11-M, 13-M	Tourette disorder	Interval	Fixed	5 s	No	No	Tics were reduced in both DRO and a response cost condition compared to baseline for three of four participants using a multielement design
Evaluating the role of contingency in differentially reinforced tic suppression	Himle, Woods, et al.	2008	*Journal of Applied Behavior Analysis*	4	8-M, 9-M, 8-M, 10-F	Tourette disorder	Interval	Fixed	10 s	No	No	Tics were reduced more in the DRO condition than other conditions for three of four participants using a multielement design
Investigating the effects of tic suppression on premonitory urge ratings in children and adolescents with Tourette's syndrome	Himle, Woods, et al.	2007	*Behaviour Research and Therapy*	5	17-M, 14-F, 13-M, 10-M, 8-F	Tourette disorder and other diagnoses	Interval	Fixed	10 s	No	No	Tics were reduced for four of five participants using DRO in a withdrawal design

(continued)

Table 59.4 (continued)

Title	Author(s)	Year	Journal/book	*N*	Age and gender	Diagnosis	DRO (interval or momentary)	Schedule (fixed or variable)	DRO interval	Preference or reinforcer assessment	Follow-up assessed?	Results
Creating tic suppression: comparing the effects of verbal instruction to differential reinforcement	Woods & Himle	2004	*Journal of Applied Behavior Analysis*	4	10-M, 10-M, 11-M, 9-F	Tourette disorder and other diagnoses	Interval	Fixed	10 s	No	No	Tics were reduced using the DRO procedure for all four participants, although the DRO condition always followed a verbal instruction condition
Brief functional analysis and treatment of a vocal tic	Watson & Sterling	1998	*Journal of Applied Behavior Analysis*	1	4-F	None reported; participant had phonic tic	Interval	Fixed, increased across sessions	15 s (increased to 300 s)	No, but FA done	Yes	Tics were reduced with DRO procedure; comparison design was used
Treatment of a vocal tic by differential reinforcement	Wagaman, Miltenberger, et al.	1995	*Journal of Behavior Therapy and Experimental Psychiatry*	1	9-M	Chronic vocal tic	Interval	Variable	3–7 min	No	Yes	DRO resulted in reductions for both phonic tics using a reversal design
Using behavioral interventions to decreases coprolalia in a student with Tourette's syndrome and autism: A case study	Earles & Myles	1994	*Focus on Autistic Behavior*	1	9-F	Tourette disorder and autism	Interval	Fixed	2 min	No	No	Tics were reduced in DRO condition but a comparison design was used
A behavioral approach to Tourette's syndrome	Rosen & Wesner	1973	*Journal of Consulting and Clinical Psychology*	1	12-M	Tourette disorder and brain injury	Interval	Fixed	30 s	No	No	Tics were reduced when procedure was used (a competing response was also used) but no experimental design
Reduction in rate of multiple tics by free operant conditioning methods	Barrett	1962	*Journal of Nervous and Mental Disease*	1	38-M	None reported	Interval	Neither	Duration between tics	No	No	Less tics occurred in differential condition, but no experimental design

Although no study included a preference or reinforcer assessment to identify stimuli that functioned as a reinforcer, that might be of less concern given the high percentage of participants with tic reductions. Whether the tic reductions maintained was assessed in only two studies. Tic reduction maintained for 6 months in one study (Watson & Sterling, 1998), and over 9 months in the other study (Wagaman et al., 1995).

The processes responsible for the reduction in tics using differential reinforcement were not investigated nor identified. Several possible processes could explain tic reduction. For example, a disruption in the response-reinforcer contingency could result in extinction. That is, if a tic does not occur, presumably the reinforcer maintaining the tic is not delivered. Only one study in this review, however, did a functional assessment to determine the reinforcer maintaining tics (Watson & Sterling, 1998). In this study, a coughing tic was found to be maintained by social attention. Then in the DRO procedure, attention was given for tic-free periods that increased from 15 s to 300 s. No longer providing the reinforcer (i.e., attention) for engaging in tics suggests extinction might be a process responsible for some tic reduction. This does not rule out, however, other potential processes that also could be responsible for tic reduction. For example, delaying access to reinforcement (e.g., gradual increase in the interval that must be tic free) could suppress tics through punishment. The processes involved in the DRO procedure need to be investigated in future studies.

The DRO procedure was also used in a study not included in this review (individual data not presented) to investigate tic suppression and the urge to engage in a tic (Spect et al., 2013). The DRO procedure was implemented by telling the 15 participants, aged 10–17, that a token exchangeable for prizes could be earned for every 15 s period with no tics. The frequency of tics was measured in baseline and DRO conditions within a reversal design. The data collapsed across participants showed a 72% reduction in tics in treatment compared to baseline conditions. This study, along with the 5 single-subject studies with experimental designs in the review, suggests the DRO procedure is potentially effective in at least a temporary reduction in tics.

Future research studies are needed to investigate whether DRO should be used in isolation or in combination with other procedures (e.g., HR). For example, a DRO could be implemented in HR by delivering a putative reinforcer during a no tic period while the participant practices the competing response. Studies are also needed to investigate guidelines for setting the DRO interval to ensure that participants not engaging in tics will contact reinforcement when the DRO is in place. For example, whether an initial short interval gradually increased across time would be more effective or result in more participant tic reduction needs to be investigated.

Summary

The occurrence of tics often begins in childhood, waxing and waning in frequency across time. Most cases of chronic tic disorders are mild and decline by the late teen years. Tics have a genetic and neurological cause but also can be affected by environmental conditions. Research has shown that motor and vocal tics can change in frequency, intensity, and form. This suggests that tics can be treated in part by identifying the environmental variables maintaining the tics and developing treatment plans that modify these variables.

Regardless of whether specific environmental variables are maintaining tics, they are treatable. There does not yet seem to be one best treatment for all cases of tics. Rather, treatment depends on several variables including age, severity, number of tics, and perhaps communication ability. In general, however, HR training and CBIT are the most researched and therefore best treatment options. At a minimum, treatment should begin with awareness training. This step alone has, in some cases, resulted in a reduction in tics. In most cases, however, a competing response should be identified and taught to the individual. Although these two steps sometimes result in tic reduction, treatment could be bolstered by including social support from friends and family members. Furthermore, treatment can include increasing motivation by planning when these strategies can be practiced and implemented in natural situations. In some cases, tics can be further ameliorated by teaching the individual relaxation procedures. These procedures also have been adapted to a variety of community situations, such as in environments with limited access to trained therapists or when there is reduced training time.

Although much research on tics has produced a robust treatment protocol, future research could be done to continue to identify procedures that might be more efficient and effective. More research is needed to determine what specific treatments, or treatment components, are predictive of tic reduction for individuals. Research is also needed to determine how to provide treatment in areas where services are limited or do not exist. For example, what are the best ways to treat tics in elementary schools or in rural areas where expertise on tic treatment protocols is often lacking.

Conflicts of Interest The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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60 Stereotypy

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Stereotypy is a commonly occurring category of behaviors. They include a wide range of behaviors with repetitive, fixed movements being core observable features (Oakley et al., 2015). Many of you, while reading this chapter, are demonstrating similar responses, such as tapping your pen or pencil, twirling a lock of hair, or swinging your leg. Although these behaviors are present in many people's repertoires, deviation from a typical developmental course and sequence often draws additional attention from key stakeholders invested in a person's life or care, warranting consideration of additional assessment and intervention. In this chapter, we provide (a) a brief overview of the operational definition of stereotypy, prevalence, and course; (b) a discussion of ethical and social considerations when determining the applied value of intervention; (c) a description of assessment and treatment procedures; and (d) considerations when implementing treatment.

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Overview

Stereotypy is an umbrella term describing a wide range of repetitive responses or activities with no apparent goal or purpose (Rapp & Vollmer, 2005; Singer, 2009). This collection of behaviors is sometimes colloquially referred to as "stimming," "stims," or self-stimulation due to the hypothesis that the responses most often produce a form of arousal reduction (e.g., escape from stimulation) or arousal induction (e.g., access to sensory stimulation). Table 60.1 presents a list of common topographies of stereotypy and considerations unique to each topography category.

For most young children, stereotypical behavior commonly occurs during the early developmental period and typically decreases in frequency and intensity as children develop language, functional play skills, and other adaptive behaviors into childhood, adolescence, and adulthood (Goldman et al., 2008). Although common for some topographies of these behaviors to persist in most individuals' behavioral repertoires, stereotypy doesn't commonly continue at a level, severity, or frequency that impacts daily functioning (e.g., nail biting, hair twirling).

Stereotypy becomes a clinical concern if frequency and intensity do begin to interfere with social interactions, language, daily living skills, and leisure activities. Clinically significant stereotypy disproportionately occurs in individuals with autism spectrum disorder (ASD), intellec-

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_60

Table 60.1 Common examples of stereotypy and considerations for each topography

Categories	Examples
Fine motor	Finger rubbing, hair twirling, head nodding
Gross motor	Body rocking, spinning, pacing, jumping
Vocal	Humming, singing, noncontextual laughter, echolalia
Object-directed	Spinning objects, page rubbing, object mouthing
Higher-order or complex	Lining up objects, routines/rituals, conversation topics

tual disability, certain genetic disorders, and other neurodevelopmental disorders (Bodfish et al., 2000). A review of the literature found the prevalence of stereotypy to be approximately 61% in individuals with developmental disabilities. Prevalence of stereotypy was highest (88%) among those with ASD (Chebli et al., 2016). Stereotypy is also very common in individuals with psychiatric conditions, such as OCD, or neurological conditions, such as Parkinson's Disease (Bodfish et al., 2000).

Restrictive and repetitive behaviors (RRBs) are one of the diagnostic criteria for ASD, and stereotypy is one subtype of RRB. Identification of the occurrence of stereotypy is often captured using the Repetitive Behavior Scale-Revised (RBS-R; Mirenda et al., 2010), the stereotypy subscale of the Problem Behavior Inventory (PBI-01; Rojahn et al., 2001), or the repetitive behavior score on the Autism Diagnostic Interview-Revised (ADI™-R; Lord et al., 1994). Because stereotypy may occur at a high rate, behavior analysts typically record stereotypic behavior using duration measures or discontinuous sampling procedures, such as partial interval recording or momentary time sampling (Matson & Nebel-Schwalm, 2007).

Although it is easy to label a response as stereotypy, one cannot determine if a response is *stereotypic* based on topography alone. A stereotypic behavior, by definition, has no social purpose; thus, a repetitive response hypothesized to access some sort of social reinforcement would not be considered stereotypy. Take, for example, a child that repetitively licks objects. This behavior could be considered stereotypy if it serves no functional social purpose, or is maintained by automatic reinforcement. However, if this behavior occurs in order to gain access to social attention, then it would not qualify as stereotypy. The only way to make this determination is, of course, through functional behavioral assessment, described in the Functional Assessment Section of this book (see section "Behavioral Interventions for Stereotypy").

Individuals can display stereotypy both with and without physical injury; however, for the purpose of the present chapter, we turn our attention to stereotypy classified as non-injurious. For a detailed description of repetitive behavior with self-injury, we direct the reader to Chap. 66. Although some other repetitive behaviors may share features with stereotypy, they are also better discussed separately due to their unique features. Therefore, a discussion of tics can be found in Chap. 63, trichotillomania in Chap. 64, and toe walking in Chap. 68.

Clinicians and researchers classify stereotypy in a number of different ways, including topography (e.g., motor or vocal), the hypothesized sensory function that may be obtained through the behavior (e.g., vestibular, auditory), or number of stereotypies displayed (e.g., simple or complex). Topographies of stereotypic behaviors can be vocal or nonvocal, include gross or fine motor movements, and be performed with or without objects.

Is Stereotypy an Appropriate Target Behavior?

Behavior analysts have developed a highly effective technology that can affect change on a wide range of behaviors. Function-based assessment and intervention have indeed revolutionized our field and allowed for much more targeted, efficacious interventions for decreasing problematic behaviors. However, the existence of such powerful behavioral technology does not automatically indicate that practitioners should readily apply such tools for any behavior deemed problematic by another individual. Behavior analysts must avoid selecting target behaviors for the sole benefit of non-client individuals or to normalize society (Behavior Analyst Certification Board, 2014).

Although practitioner accountability is relevant across all target behaviors, this accountability is particularly important when considering stereotypy as a target behavior. Individuals with ASD and intellectual and developmental disabilities are often subject to normalization attempts due to decreases in autonomy and increased prevalence of maladaptive behaviors. Normalization refers to "the use of progressively more typical environments, expectations, and procedures to establish and/or maintain personal behaviors which are as culturally normal as possible," (Wolfensberger, 1972, p. 28). Further, stereotypic behavior ranges greatly in topography and severity, raising ethical considerations of whether intervention is warranted across all situations.

Across the behavior analytic literature, multiple guidelines have been disseminated for selecting appropriate target behaviors (e.g., Bosch & Fuqua, 2001; Hawkins, 1984; Komaki, 1998). A common thread throughout all of these guidelines is the critical importance of identifying whether the change in behavior will meaningfully improve the individual's life. As behavior analytic practitioners, it is imperative that any target behavior we select for change must have direct or indirect benefits to the individual.

To help make this determination, practitioners may consider asking several questions when deciding whether to target stereotypy:

- *Does the behavior result in functional impairment?*
- *Can functional impairment be reduced by changing the behavior of others?*
- *Is there a potential for the behavior to become harmful to the individual or others?*
- *Are there other behaviors to target that result in a decrease in stereotypy?*

Does the Behavior Result in Functional Impairment?

When stereotypy is identified as a target behavior by stakeholders (e.g., parents, teachers, direct support providers), the behavior analyst must question whether intervention on the stereotypic behavior constitutes a socially significant change for the client. Practitioners are first charged with determining whether the persistence of stereotypy results in functional impairment for the individual. Potential sources of functional impairment may include, but are not limited to, cases in which stereotypy interferes with skill acquisition, interferes with task completion, results in adverse social consequences, is unsanitary, and/or results in property destruction.

In some cases, persistent stereotypy may interfere with skill acquisition or task completion due to incompatible responses (e.g., Dunlap et al., 1983; Lanovaz et al., 2013; Matson et al., 1997; Morrison & Rosales-Ruiz, 1997). For example, persistent motor stereotypy involving the hands, such as hand flapping, may make it nearly impossible for an individual to practice a new motor skill (e.g., matching objects) or to complete a vocational activity (e.g., washing dishes). Similarly, persistent stereotypy involving the entire body (e.g., spinning) may interfere with an individual observing a therapist's controlling prompt in order to acquire a new skill. Vocal stereotypy may be incompatible with acquisition of vocal behavior or vocal responses necessary for functional community participation (e.g., providing personal information).

Further, stereotypic behaviors may be determined to have adverse social consequences (e.g., Jones et al., 1990; Wolery et al., 1985). Persistent stereotypy may result in peer isolation and rejection due to social stigmatization or interference with appropriate social exchanges. Social consequences of stereotypy may impact employment opportunities and community integration. Certain topographies of stereotypic behavior may be deemed unsanitary or potentially harmful to others (e.g., potential for spread of harmful pathogens due to saliva play; Piazza et al., 2000). Finally, repetitive behaviors may have adverse consequences on the environment, such as property destruction. For example, the participant described in a study by Mace and Belfiori (1990) engaged in repetitive object touching that resulted in occasional damage to property in the home environment.

Practitioners and researchers alike should clearly document the applied value of targeting an individual's stereotypy (e.g., degrees of functional impairment, injury, harm) to justify the need for intervention. For example, Mace and Belfiori (1990) presented the following description of the impact of motor stereotypy on their participant, describing interference with task completion, social impairment, and resulting property destruction:

> Doris engaged in repetitive, stereotypic touching of objects and, occasionally, people. The stereotypy interfered with completion of household tasks and socialization with clients and staff. Occasionally, the touching resulted in physical damage to the home (e.g., broken lamps) and to other clients (e.g., scratching). (p. 508)

In another example, Piazza et al. (2000) presented the following explanation of functional impairment that describes both unsanitary consequences and social impairment:

> Windows, floors, furniture, walls, and toys in Brad's home were covered in saliva. His saliva play was unsanitary (increased the exposure of friends and family to saliva-borne pathogens) and limited Brad's opportunities for integration into the community (community members did not want to be exposed to his saliva and the risk of infectious diseases). (p. 15)

Both examples justify the need for behavioral intervention by presenting multiple reasons why stereotypy yielded negative consequences for the individual and the environment. Although both of these examples draw from published research, similar justifications should be provided in formulation, documentation, and reports of intervention goals in clinical endeavors.

Can Functional Impairment be Reduced by Changing the Behavior of Others?

Although the goal of practitioners should be to maximize access to reinforcers in the natural environment, an important consideration is *whose* behavior should change. Practitioners should consider whether we can educate others on stereotypic behaviors rather than attempting to change behavior that others do not understand or deem acceptable (i.e., normalization). Interviews and focus groups conducted with adults with ASD who engaged in stereotypy suggested that they objected to attempts to eliminate their stereotypic behavior through intervention. A common theme that arose from these interviews was that social acceptance of their stereotypic behavior could be increased through educating others (Kapp et al., 2019).

Research has suggested that elementary (Campbell et al., 2004; Magiati et al., 2002) and middle school students (Campbell & Barger, 2011) lack adequate knowledge of ASD and its related behaviors, such as stereotypy. Campbell and Barger (2011) discussed how peers may misinterpret atypical behaviors (e.g., body rocking), which may then contribute to social distancing and social rejection of individuals with stereotypy. Peer education has been shown to improve acceptance of children with ASD in general education settings (Rao et al., 2003). Peer education that provides accurate information about autism may not only rectify global misattributions of students' behavior but may also promote acceptance of individual differences, leading to social acceptance without requiring an individual to decrease their stereotypic behavior.

Similarly, research suggests that law enforcement officers have varied knowledge of ASD and its related features (Gardner et al., 2019). Promoting education of law enforcement officers regarding behaviors such as stereotypy may promote more appropriate and safe interactions and understanding of individual differences.

Is There a Potential for the Behavior to Become Harmful?

As previously noted, this chapter highlights considerations for specific forms of stereotypic behavior that do not produce injury to the individual. However, an additional consideration that practitioners should take into account is the additive effects of consistent and pervasive stereotypy. A single instance of a response, for example, may not pose immediate concern, but frequent repetition of a response could have a deleterious impact. Other concerns may include a response becoming self-injurious over time due to its frequency and intensity. For example, pervasive hand mouthing may be characterized as self-injurious behavior when it occurs at such a level that it causes tissue damage (Richman & Lindauer, 2005). Clinicians may collaborate with stakeholders and medical professionals to fully understand the long-term effects of repeated stereotypy to guide determination of the appropriate point of intervention and reduce risk of harm to the individual.

Are There Other Behaviors to Target That May Result in a Decrease in Stereotypy?

Practitioners should also note whether stereotypy occurs more frequently in certain contexts and under certain antecedent conditions. Through structured interviews or direct observation, a behavior analyst might detect that features such as a skill deficit may contribute to the presence of stereotypy and thus teaching an appropriate skill (e.g., appropriate social conversation exchanges) may result in a decrease in stereotypy. Some research has suggested that anxiety in children with ASD may increase levels of repetitive behaviors (Hallett et al., 2013). As such, appropriate treatment of anxiety may result in a concomitant reduction in stereotypy. For example, an individual exposed to aversive stimuli in a specific setting may engage in increased levels of stereotypy; thus, stereotypy may be reduced by systematically introducing the individual to the aversive context (e.g., environment with excessive social stimulation).

Once practitioners have undertaken the task of determining whether the topography of interest is of sufficient concern to warrant intervention, they are faced with two courses. One option is to proceed to intervention. The second is to proceed to continued monitoring and turn attention to skill development or behavior reduction in other target behaviors. Although the question of *how* to intervene is discussed below, we provide one final consideration for readers regardless of the path selected. Specifically, we strongly encourage practitioners to provide detailed documentation in supporting materials (e.g., functional behavior assessment, behavior intervention plan, individualized education program) of the course of action (i.e., to intervene or not on the specific behavior of interest) and justification for the decision. As noted above, careful consideration and documentation of level of impairment, influence of the environment, risk of harm, and presence of other collateral behaviors are critical components of the treatment plan.

Behavioral Interventions for Stereotypy

As with other topographies of problem behavior, interventions for stereotypy can be broadly categorized as either antecedent or consequent interventions and may or may not be informed by identified function. Because the specific automatic reinforcer (i.e., specific sensory contribution) is often difficult to identify, function-based interventions may be less possible for stereotypy relative to socially maintained problem behavior. Further, practitioners often must employ two or more interventions in a treatment package to achieve clinically significant reductions in stereotypy (e.g., Dickman et al., 2012; Falcomata et al., 2004).

Below, we discuss the most common behavioral interventions for reducing stereotypy, as well as specific considerations for the implementation of each intervention.

Antecedent Interventions

Antecedent Exercise Physical activity has appeared in the extant literature for several decades as an antecedent intervention for reducing stereotypy, as well as other maladaptive behaviors such as aggression and off-task behavior. In most antecedent exercise interventions, the clinician prompts the client to engage in walking or jogging for a period of time prior to an interval in which lower levels of stereotypy are desirable (e.g., jogging for 10 min prior to 1:1 instruction time). Although jogging is the most common form of exercise used in antecedent exercise interventions, the intervention has been demonstrated to be successful with activities as disparate as exergaming, martial arts, and trampoline jumping (Anderson-Hanley et al., 2011; Bahrami et al., 2012; Neely et al., 2015).

Despite the numerous studies on antecedent exercise, the minimum duration of activity that is required for the activity to be effective or whether certain topographical requirements of the physical activity must be met is unknown. Further, despite the intervention's efficacy, the mechanism by which behavior reduction is obtained is unclear. One hypothesis is that antecedent exercise produces fatigue, resulting in concomitant decreases in stereotypy. This hypothesis is somewhat contradicted, however, by evidence that not all behaviors decrease following exposure to antecedent exercise. Some adaptive behaviors, such as on-task behavior, have been shown to increase after physical activity (Neely et al., 2015). A second, more viable hypothesis is that antecedent exercise serves as an abolishing operation for stereotypy, reducing the value of the reinforcers produced by stereotypy and thus reducing the likelihood of stereotypic behavior (Neely et al., 2015). Practitioners should therefore carefully consider the duration of exercise used, as longer durations of exercise do not necessarily produce greater reductions in the target behavior. At present, it is also unclear if the topography and mode (e.g., aerobic or anaerobic) of the exercise are important, and for how long the effects of the intervention are sustained postexercise.

Noncontingent Reinforcement Noncontingent reinforcement (NCR) is often recommended as an intervention for stereotypy due to its ease of implementation, the lack of potential side effects (such as those common with punishment-based procedures), and the large number of research studies documenting success in reducing target behavior. In some examples of NCR, clinicians provide continuous access to several different, preferred items or activities; this approach might also be called "environmental enrichment." For other clients, a clinician might select one specific item or activity to provide continuously or on a time-based schedule to reduce the establishing operation for stereotypy. Usually, dense schedules of delivery are needed at the start of intervention, but it may be possible to fade the schedule over time (see Chap. 6 for a detailed discussion of reinforcer thinning).

Clinicians should carefully consider the stimuli selected for use in an NCR intervention. In some cases, an arbitrarily selected item, especially one that is highly preferred, can effectively compete with stereotypy. Often, though, finding items or materials that generate stimulation similar to the hypothesized sensory consequences produced by the stereotypy is most effective. Piazza et al. (2000) were some of the first researchers to evaluate the effects of items that produced stimulation similar to the sensory consequences hypothesized to be maintaining target behavior (i.e., *matched*) compared to items that produced unrelated sensory consequences (i.e., *unmatched*). This research and subsequent studies have demonstrated that NCR interventions that included matched items produced greater reductions in stereotypy (e.g., Love et al., 2012).

Table 60.2 provides a list of sample items to consider as competing stimuli, organized by hypothesized sensory reinforcement produced by the targeted stereotypy. For example, to match the sensory consequences for vocal stereotypy,

Table 60.2 Hypothesized sensory consequences and competing stimuli for sample stereotypy topographies

Hypothesized sensory consequence	Example topography	Potential competing stimuli
Vestibular	Body rocking, spinning	Rocking horse, sit-and-spin, trampoline, exercise
Auditory	Humming, singing, tapping	Music, white noise, recording of own stereotypy, sound toys
Tactile	Squishing objects, saliva play	Slime, stress ball, shaving cream, textured or "fidget" toys
Olfactory	Sniffing, inhaling, forceful exhaling	Deep breathing exercises, blowing nose
Visual	Peering, pushing on eyes, waving fingers in front of eyes	Light up toys, flash lights, spinning toys
Oral	Hand mouthing, shirt chewing, item licking	Chewing gum, chew tube

clinicians could use different forms of auditory stimulation. Noncontingent music has been demonstrated to reduce vocal stereotypy in a number of cases (e.g., Lanovaz et al., 2014). Saylor et al. (2012) found substantial reductions in stereotypy when they noncontingently played a recording of a child's own stereotypy. The authors also included a comparison to noncontingent music, with noncontingent access to music being slightly more effective in reducing vocal stereotypy and more highly preferred by the children and their caregivers. In a similar example, Rapp et al. (2012) employed a talking robot toy as matched stimulation for vocal stereotypy. Other examples of matched stimulation used in noncontingent reinforcement interventions include a chew object for saliva play (Luiselli et al., 2004) and a vibrating pen placed on the neck for head rocking (Wilder et al., 2000).

When identifying a stimulus that may compete with the stereotypic behavior in a noncontingent reinforcement intervention, practitioners can begin with a competing stimulus assessment (CSA; Haddock & Hagopian, 2020). Similar to a preference assessment, in a CSA a variety of items or activities are nominated by the practitioner or caregiver that are hypothesized to compete with the stereotypic behavior. The stimuli are then presented for brief periods of time (3–5 min). A no-stimulus control condition, similar to the no-interaction condition of a functional analysis, should also be implemented for comparison. Data should be collected on both the target behavior (i.e., stereotypy) and engagement with the item or activity. Practitioners should select stimuli that produce lower levels of target behavior and high levels of engagement to maximize efficacy of the NCR intervention.

Figure 60.1 displays hypothetical results from a CSA that could be conducted for vocal stereotypy. Based on the results from Fig. 60.1, exposure to a self-recording produced lowest levels of vocal stereotypy and highest levels of engagement relative to the control condition. Of note, practitioners may consider frequent reassessment of competing stimuli given the ease of implementation of the CSA to proactively prevent satiation, continue to reassess additional items that may contribute to further reductions in stereotypy, and address any decrements in treatment efficacy.

Similar to the evolution of the preference assessment literature, various modifications of the CSA are noted in the literature. For example, Brogan et al. (2018) described a free-operant variation in the CSA that provides information about competing properties of the stimuli and a more direct measure of relative preference. In addition, Hagopian et al. (2020) developed an augmented competing stimulus assessment (aCSA) that involves providing prompts to engage with the item or activity while blocking the target response.

Reinforcement-Based Interventions

Differential Reinforcement Differential reinforcement of other behavior (DRO) and NCR share common features in that both interventions reduce stereotypy by delivering a reinforcer at

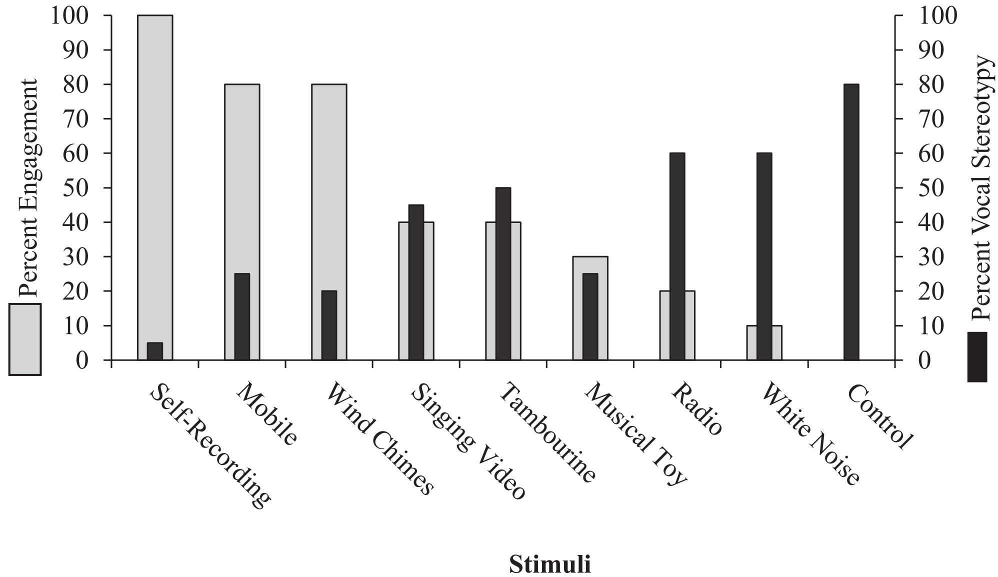

Fig. 60.1 Sample competing stimulus assessment

specified intervals; however, in DRO, the practitioner delivers the reinforcer contingent on the absence of stereotypy for a period of time rather than on a strictly time-based schedule. Although DRO is also generally most effective when the functional reinforcer is applied, nonfunctional reinforcers are often utilized in DRO procedures to reduce stereotypy due to the difficulty identifying and/or arranging contingent access to the functional reinforcer.

Practitioners should select short DRO intervals, or even better, select intervals that are based on response patterns of stereotypy. For example, if stereotypy occurs very frequently, practitioners should measure the time between bouts of behavior (i.e., inter-response time), and start with DRO intervals that are shorter than that interval (Rozenblat et al., 2009). As stereotypy decreases at short intervals, practitioners should systematically increase the DRO interval until reaching a schedule that is feasible to implement in the natural environment (e.g., Taylor et al., 2005).

In some circumstances, a practitioner may choose to implement differential reinforcement of alternative behavior (DRA) instead of, or in combination with, DRO to reduce stereotypy. In a DRA intervention, a practitioner reinforces the occurrence of a specific alternative behavior or behavior incompatible with stereotypy (Vollmer et al., 1994). For example, for a client who engages in vocal stereotypy, a practitioner may reinforce appropriate communication with access to a highly potent reinforcer. In a combined DRA and DRO, the contingency for reinforcement would be to engage in the alternative behavior while not emitting the stereotypic behavior. Researchers have shown that this combined contingency may be more effective than DRO or DRA alone (Hedquist & Roscoe, 2020).

Although not required, most applications of DRA include extinction for the target behavior (Vollmer et al., 2020). In the case of stereotypy, arranging extinction is often difficult or impossible. Therefore, most differential reinforcement interventions for stereotypy will not include an extinction component, and they may rely on delivering an arbitrary reinforcer (e.g., an edible item) rather than a functional one. In applications of differential reinforcement, practitioners should conduct a preference assessment or CSA to identify highly preferred items or items that compete with stereotypy (e.g., Taylor et al., 2005), or consider using access to stereotypy as a reinforcer as long as you are able to restrict its access to deliver contingently (Potter et al., 2013).

Sensory Extinction

In some cases, clinicians may be able to hypothesize the specific maintaining reinforcer for stereotypy. In applications of sensory extinction, the practitioner disrupts the response-reinforcer relationship by masking or preventing the sensory stimulation produced by the stereotypic action. For example, Rapp et al. (1999) hypothesized that one participant's hair manipulation was maintained by the tactile stimulation in her fingers. Wearing latex gloves modified the stimulation produced by the hair manipulation and effectively reduced this behavior.

When designing sensory extinction, practitioners attempt to mask the specific hypothesized sensory consequence maintaining stereotypy. However, even when a practitioner has a plausible hypothesis about the specific maintaining sensory consequence for stereotypy, this can be very difficult to validate. Thus, even when the implementation of sensory extinction results in reductions in stereotypy, it is often difficult if not impossible to attribute reductions to sensory extinction alone.

As with all extinction procedures, sensory extinction should be used in combination with reinforcement-based interventions. Sensory extinction should also not be attempted with all topographies of stereotypy. For example, if a hypothesized reinforcer for ear plugging is automatic negative reinforcement in the form of escape from aversive noises, it would not be ethical to arrange for sensory extinction such that aversive sound could not be minimized by the client without providing alternative access to automatic negative reinforcement. Extinction also comes with a host of side effects, such as elicited emotional responses and/or aggression that practitioners need to be aware of when they employ this procedure (Lerman et al., 1999).

Response Blocking Response blocking is a commonly employed intervention for gross motor and object-directed stereotypy (e.g., hand mouthing; Roscoe et al., 2013). In such cases, blocking is accomplished by the practitioner preventing the behavior from occurring through temporarily physically intervening in such a way that the entirety of the stereotypical response cannot be emitted. For example, if a clinician were to use response blocking to reduce hair pulling, then the clinician would prevent the client from placing their hands within a certain distance (e.g., 5 cm) of their hair; the client would otherwise be unrestrained and able move their arms freely. Because response blocking is performed by the practitioner and is not accomplished through manual or mechanical restraint, blocking is not an appropriate intervention for many topographies of stereotypy. For example, response blocking cannot be conducted with vocal stereotypy or behaviors such as posturing.

Research indicates that blocking may reduce behavior through extinction for some individuals, whereas it may serve as punishment for other individuals. Three studies have evaluated the mechanism by which blocking reduced automatically maintained self-injury, and the results collectively indicate that the effects of blocking are idiosyncratic (Lerman & Iwata, 1996; Smith et al., 1999; Wunderlich et al., 2017). This is likely also true for response blocking of automatically maintained stereotypy, although it has yet to be evaluated empirically. However, because it is possible that response blocking operates as a punisher for many individuals, appropriate safeguards and protections should be in place regarding the use of punishment whenever a blocking procedure is used (Behavior Analyst Certification Board, 2014).

Punishment

Response Interruption and Redirection Response interruption and redirection

(RIRD) is a punishment procedure in which the practitioner interrupts each occurrence of stereotypy by delivering a demand or a series of demands. Demands can be either matched to the topography of the stereotypy (e.g., asking a child to clap their hands instead of hand flapping) or unmatched (e.g., answering intraverbal questions instead of hand flapping) and can include one or multiple demands. Some practitioners require the client to both refrain from stereotypy and comply with demands before the demand sequence is terminated. More information on RIRD can be found in Chap. 16.

As first researched by Ahearn et al. (2007), RIRD is a promising intervention to reduce both motor and vocal stereotypy. However, more recent research has indicated that the data analysis procedures used in some RIRD research may impact the interpretation of treatment efficacy. It is possible that apparent intervention success in some studies may have been at least partially an artifact of the data analysis method rather than overall reductions in stereotypy (Carroll & Kodak, 2014; Wunderlich & Vollmer, 2015; DeRosa et al., 2019).

Response Cost Response cost as an intervention for stereotypy is most often implemented as the brief removal of a preferred item as part of a treatment package. For example, Watkins and Rapp (2014) implemented environmental enrichment for five individuals with problematic stereotypy by giving continuous access to a preferred item, but found no substantial decreases in the level of stereotypy. When researchers removed the preferred item for 15 s following each instance of stereotypy, behavior immediately decreased to low levels for all five individuals. Response cost has also been used to successfully reduce stereotypy with noncontingent reinforcement (e.g., Falcomata et al., 2004), differential reinforcement (e.g., Laprime & Dittrich, 2014), and differential reinforcement procedures within a token economy (e.g., Shillingsburg et al., 2012).

Other Punishers Other punishers, such as overcorrection, reprimands, and time out, have also been evaluated for use with stereotypy. Response blocking and sensory extinction procedures, described above, may also be better classified as punishment procedures depending on the mechanism by which they reduce stereotypy.

Because the effects of punishers are often idiosyncratic and the likelihood of side effects may be high, clinicians may consider using a punisher assessment to first determine what mild punisher is most effective and socially valid before implementing an intervention package containing a punishment component. Verriden and Roscoe (2019) describe a simple procedure consisting of a thorough caregiver interview and a multielement evaluation of several mild punishers (in combination with both NCR and DRA) to evaluate effects on both stereotypy and collateral behaviors. These procedures resulted in successful treatment of stereotypy with increased levels of appropriate behavior and low levels of emotional responding. Practitioners considering punishment procedures for stereotypy should review ethical safeguards and social validity measures, as well as intervention effectiveness.

Factors Guiding Intervention Selection

Practitioners should match the intervention for stereotypy to the hypothesized behavioral function whenever possible (Cunningham & Schreibman, 2008). We also recommend practitioners consider access to functionally equivalent sources of competing reinforcement (Rapp & Vollmer, 2005) or teach alternative behaviors that produce access to reinforcement. The contexts for intervention, plans for maintenance and generalization, and transition to naturalistic environments must all be considered carefully. Figure 60.2 displays considerations and potential contraindications for each of the intervention procedures described, and below we present

		Considerations				Potential Contraindications			
		Individual engages in adaptive alternative responses	May provide access to automatic reinforcement	Requires preference assessment or CSA	Stereotypy is prevented from occurring	May be effortful for implementer	Could result in emotional or aggressive responses	May not be feasible for individuals with physical limitations	May not be feasible for vocal stereotypy
Antecedent	Antecedent Exercise	X						X	
	Noncontingent Reinforcement		X	X					
Reinforcement	DRO		X	X		X			
	DRA	X	X	X		X			
Extinction	Sensory Extinction						X		X
	Blocking				X	X	X		X
Punishment	RIRD					X	X		
	Response Cost					X	X		

Fig. 60.2 Attributes and contraindications for stereotypy interventions

several additional practical recommendations to consider when selecting interventions for stereotypy.

1. *Define an appropriate treatment goal*
   After determining that stereotypy is an appropriate target for behavior reduction, practitioners should consult with the client and relevant stakeholders to determine the appropriate treatment goal. For some individuals, a decrease in the level of stereotypy across all contexts is the most appropriate goal. In other cases, clinicians may aim to reduce stereotypy only for specific periods of time or in specific circumstances. This is often the case when stereotypy is only a problem in certain environments or when stereotypy is problematic because it is interfering with access to other reinforcers. Such goals are essential to identify before choosing an intervention to implement.
   If the stereotypy is problematic due to the overall frequency (e.g., high levels of repetitive motor movement causing deterioration of joint tissue), then a reduction in the behavior throughout the client's day might be the most appropriate treatment goal and well matched with an intervention such as DRO. By contrast, if the behavior is problematic due to interference with specific contexts (e.g., learning opportunities), then teaching stimulus control should be a component of the intervention (see section on discriminative stimuli below), and the practitioner should select interventions that also support alternative adaptive behavior (e.g., DRA). For example, a teacher might request that a student's motor stereotypy be reduced, in level and/or intensity, during large-group instruction time but not during individual work time. If stereotypy is interfering with the ability to access reinforcers in social situations, then a prime goal for practitioners should be to select intervention components that prioritize social inclusiveness.
2. *Implement reinforcement-based approaches first*
   The Behavior Analyst Certification Board's Professional and Ethical Compliance Code for Behavior Analysts provides guidelines to practitioners to consider reinforcement-based approaches to intervention prior to punishment (Behavior Analyst Certification Board, 2014). More specifically, an adaptive and functional alternative behavior should be selected to replace stereotypy whenever possible. This obligation to reinforcement-based approaches is heightened for stereotypy as these behaviors may not produce immediate danger, may be more treatment resistant due to their persistence and likelihood of being maintained by automatic reinforcement, and may be more susceptible to normalization attempts.
   When the ethical application of punishment for stereotypy is justified (e.g., failure of reinforcement-based approaches, immediate danger), practitioners should only consider punishment in conjunction with reinforcement in line with ethical standards of the field. The application of punishment with individuals with developmental disabilities has been widely discussed and critically reviewed (e.g., Lerman & Vorndan, 2002; Matson & Taras, 1989). Those practitioners implementing interventions with vulnerable populations have an increased responsibility to comply with ethical standards (Pokorski & Barton, 2020).
3. *Consider Intervention intrusiveness and adherence*
   When selecting treatment approaches for stereotypy, practitioners should consider the intrusiveness for clients. We recommend consideration of degree of difficulty, degree of restrictiveness, level of autonomy, and preference when considering client characteristics that impact intervention selection. For example, although antecedent exercise is an effective intervention to reduce stereotypy for many individuals, such vigorous exercise may be especially burdensome to some clients or lead to increased frustration due to lack of coordination or muscle tone. In such circum-

stances, antecedent exercise would be contraindicated.

Practitioners should also devise interventions that maximize efficacy and durability while decreasing the likelihood of caregiver burnout. Special consideration should be provided to caregiver-specific barriers to intervention implementation (e.g., resources, education level, time). For a comprehensive review of factors impacting caregiver adherence, see Allen and Warzak (2000).

4. *Enhance Discrimination using signals*

   Practitioners may consider using unique signals to aid in discrimination of when certain treatment components are or are not in effect. Simple stimuli, such as colored cards or bracelets, can be paired with specific components of a treatment package (e.g., reinforcement, extinction, punishment). For example, Cook et al. (2014) used a red card to signal that reprimands would be delivered following each instance of stereotypy and a green card to signal that no social consequences would be delivered for stereotypy.

   Signaling periods of time in which interventions are in effect may also result in a desirable inhibitory effect when that signal is introduced in new contexts. For example, Tiger et al. (2017) reduced one child's toy car hoarding behavior with a blocking procedure. A specific-colored car was present during intervention to signal that blocking was in effect. The researchers then introduced the same car in two other contexts, and car hoarding immediately reduced without the need for blocking.

5. *Include only necessary components*

   In many cases, when approaching treatment of stereotypy, practitioners may opt to begin with isolated intervention components and build intervention packages if needed, depending on the resulting effects on behavior (e.g., Roscoe et al., 2013; Verriden & Roscoe, 2019). When an intervention in isolation does not produce the desired outcomes, practitioners might consider adding treatment components rather than changing treatment course altogether. In other situations, severity or intensity may warrant introduction of multiple interventions simultaneously in order to achieve a clinically acceptable and socially valid reduction in behavior. In scenarios such as these, we encourage practitioners to consider conducting a component analysis once successful behavior reduction has occurred to determine which intervention components are necessary to maintain low levels of behavior. Researchers have demonstrated that multiple treatment components for stereotypy can be systematically faded while maintaining treatment effects. For example, Athens et al. (2008) treated automatically reinforced vocal stereotypy with a treatment package including noncontingent attention, contingent demands, and response cost. Vocal stereotypy remained low after noncontingent attention was removed and the therapists' presence was faded.

6. *Develop interdisciplinary collaborations*

   Collaboration with caregivers and other practitioners is essential when evaluating treatment outcomes throughout the intervention process. In some cases, families may seek out medical or pharmaceutical interventions in addition to behavioral strategies. Although pharmaceutical interventions may not be an effective intervention in the treatment of restricted and repetitive behavior for many individuals (Yu et al., 2020), thoughtful and ethical collaboration with practitioners outside of behavior analysis will allow for the greatest benefits to our clients (Broadhead et al., 2018).

7. *Program for Generalization and maintenance*

   As with any interventions, behavior analysts should program for generalization and maintenance. Many studies evaluating interventions for stereotypy document immediate reductions in stereotypy but a lack of sustained treatment effects (e.g., Schumacher & Rapp, 2011). Generalization and maintenance of treatment effects are of particular importance as stereotypy often persists across contexts and is sometimes unresponsive to treatment. Thus, when efficacious interventions are identified, ensuring durability of those interventions is of great importance. For more information on methods to increase the likelihood of generalization, please refer to Chap. 15.

Conclusions

Stereotypy includes a wide range of behaviors, elusive maintaining variables, and is generally difficult to treat. It is critical to identify assessment and treatment strategies to produce meaningful change in the frequency and severity of the behavior and to improve the long-term outcomes for individuals displaying stereotypy. As highlighted in this chapter, behavior analytic approaches to the assessment and treatment of stereotypy can be a multifaceted and complex process. Thus, we aimed to provide practitioners with guidance on the importance of (a) understanding operational definitions of stereotypy, prevalence, and course; (b) ethical and social considerations when determining the applied value of intervention; (c) assessment and treatment procedures tailored specifically to stereotypy; and (d) considerations when implementing stereotypy treatment.

We urge practitioners and researchers to consider variables specific to their setting (e.g., available resources) and the target response (e.g., impact of multiple dimensions of the behavior) when employing the strategies outlined here to ensure appropriate and ethical conceptualization of intervention.

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Self-Injurious Behavior

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Adithyan Rajaraman and Joshua Jessel

The class of responses referred to as self-injurious behavior (SIB) are those directed toward oneself that pose imminent risk of harm. SIB is often conceptualized as a deliberate act of self-harm, which can take many forms, but is primarily defined by the capacity of the response to produce tissue damage (Winchel & Stanley, 1991). SIB is particularly problematic when it is chronic, seemingly intractable behavior that both inhibits one's daily functioning and is of concern to important people in the individual's life (Tiger et al., 2019). However, SIB is uniquely challenging to address because, depending on its form, a single instance of the response can result in significant injury to the individual (e.g., eye gouging, ingesting toxic substances).

SIB is heterogeneous; it describes a broad range of responses that lie along a continuum of severity, from minimally injurious (e.g., repetitive slaps to the body) to potentially fatal (i.e., suicidal; e.g., cutting wrists). It is important to emphasize that the occurrence of SIB is not limited to any diagnostic or demographic profile; SIB can be exhibited by individuals, of any age, with or without a psychiatric diagnosis. That said, compared to typically developing individuals, SIB is more likely to be observed among individuals with intellectual and developmental disabilities (IDD: Dominick et al., 2007; Maurice & Trudel, 1982) and is significantly more likely to be observed among individuals diagnosed with Angelman, Fragile X, Lesch-Nyhan, and Smith-Magenis syndromes (Huisman et al., 2018). Because the purpose of this chapter is to highlight the contribution of applied behavior analysis (ABA) to understanding and addressing SIB, our focus will be on that which has been most often reported in the ABA literature: Non-suicidal SIB exhibited by individuals with IDD, including autism spectrum disorder (ASD).

SIB is among the most often-researched types of problem behavior displayed by individuals diagnosed with IDD (Hanley et al., 2003; Minshawi et al., 2014; Shawler et al., 2019), despite not being a defining feature of any diagnosis under the IDD umbrella. Prevalence estimates suggest that about 30% of individuals with IDD engage in dangerous SIB (Cooper et al., 2009; Soke et al., 2016) and those same individuals are more likely to be hospitalized due to SIB-related injury than typically developing peers (Kalb et al., 2016). Although there are no defining topographical characteristics of SIB other than its capacity to produce bodily harm, some commonly observed examples include hand-to-head, head-to-object, hand-to-body, self-biting,

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_61

self-scratching, hair pulling, eye poking, and skin picking (Iwata et al., 1994c; Shawler et al., 2019). Head-directed SIB comes with a unique set of concerns related to the potential for concussion and neurological sequelae, whereas biting, scratching, and picking bring about concerns related to bodily fluid exposure (Minshawi et al., 2014). Individuals may also exhibit pica, a unique form of SIB wherein non-edible, sometimes toxic substances are ingested. Although not a traditional consideration of SIB, pica can result in intestinal blockage, poisoning, and death (Piazza et el., 1998).

The lives of individuals who engage in chronic SIB are negatively impacted in a variety of ways beyond the associated physical injury. The occurrence of SIB is likely to interfere with an individual's capacity to learn daily living, academic, and social skills, which may result in school-aged children falling behind their typically developing peers. If the nature of SIB is severe enough, it is likely that the individual will require a more restrictive learning environment relative to general education, including possible placement in long-term residential or inpatient medical care (Winchel & Stanley, 1991). In some cases, day-to-day management of SIB involves the routine use of physical, mechanical, or pharmacological restraint (e.g., three-person supine floor holds, arm splints that limit range of movement to prevent SIB; Fisher et al., 2013). Whether in inpatient care or not, chronic and dangerous SIB is likely to preclude an individual from participating regularly in community events and activities (Kormann & Petronko, 2004), the cumulative effect of which can hinder social and emotional development and integration. The occurrence of SIB is associated with increased stress and anxiety among caregivers, teachers, and other helping professionals. The resultant impact of increased stress on daily interactions with those displaying SIB is an overall decrease in quality of life for the individual as well as the important people in their life (Rojahn et al., 2007). Finally, it is worth noting that management and treatment of chronic SIB are expensive; families, school districts, and state governments often have to bear financial burden across many years (Cooper et al., 2009; Jones et al., 2008). In short, chronic SIB can be dangerous, highly restrictive, socially devastating, and extremely costly to those whom it affects. Approaches to the assessment and treatment of dangerous SIB require a great deal of sensitivity.

Understanding Why SIB Occurs

An important first step to treating SIB is to determine why it occurs. Several hypotheses have been put forth regarding the etiology of SIB because it can (a) take many forms, (b) be displayed by a diverse range of individuals, and (c) present as highly unusual and concerning. Understanding why SIB develops, occurs, and endures requires first prescribing to a conceptual framework through which to attribute its occurrence. To be clear, the occurrence of SIB is complex enough that there are likely multiple etiologies at play; however, a pragmatic, scientifically defensible approach to understanding SIB requires only that one understands enough about why the behavior occurs such that an effective treatment can be developed that yields socially meaningful improvements. Two frameworks that have fostered the most treatment-oriented research are biological (i.e., biomedical) and operant (i.e., ABA) conceptualizations of SIB (Shawler et al., 2019).

The biological conceptualization of SIB considers the physiological reactions that may be products of SIB—such as the release of endogenous opioids, endorphins, or hormones—to be primarily influential in the development and maintenance of the behavior (Cataldo & Harris, 1982; Huisman et al., 2018). Further, there is evidence to suggest that certain genotypes, namely, those associated with Lesch-Nyhan and related syndromes, may contribute to the development of SIB (Schretlen et al., 2016). Treatments developed upon the assumption that SIB is caused by some underlying, malignant biological process are pharmacological in nature. In other words, if SIB is considered to be caused by an aberrant biochemical process, some type of medication is presumed to intervene upon the malady and produce reductions in SIB. Indeed, individuals with IDD who engage in dangerous SIB are often prescribed psychotropic medication, sometimes in lieu of behavioral intervention (Hagopian & Leoni, 2017; Morano et al., 2017; Seigel & Beaulieu, 2012).

In contrast to looking inward for the cause of SIB, the operant conceptualization of SIB considers behavior to be primarily influenced by environmental variables external to the individual, namely, (a) reinforcing consequences; (b) the establishing operations (EOs) that momentarily increase the effectiveness of those consequences; and (c) the discriminative stimuli (S^D) that signal the opportunity for SIB to produce those consequences. The EOs, S^Ds, and reinforcers collectively comprise the *operant contingencies of reinforcement* that evoke, occasion, and maintain SIB (Carr, 1977; Iwata et al., 1994a; Tiger et al., 2019). Put another way, the operant conceptualization suggests that when SIB occurs, it produces important outcomes in one's environment that are the reasons why the behavior will continue in the future. Moreover, there are certain environmental contexts—those that temporarily increase the value (i.e., EOs) of those outcomes and signal their availability (i.e., S^Ds)—that quite literally determine the probability with which SIB will occur. Assessments informed by the operant assumption of behavior are called *functional assessments* in that they attempt to identify the important environmental changes surrounding SIB that may lead an individual to exhibit more SIB later on (Hagopian et al., 2013).

Consider a young child who does not have strong language skills and is often passively cared for in the periphery of a parent. Imagine that the child is deprived of stimulation and, one day, engages in head-directed SIB. The child's well-meaning parent, in an effort to mitigate the bizarre and concerning SIB, stops what they are doing and begins to coddle the child by enriching the environment with interactive games. The parent may find success in the momentary distraction; however, reinforcement informs that which will happen in the future and an operant interpretation may be predictive of a worsening in SIB that is now to come. In other words, a contingency has been established whereby that particular parent serves as a salient indication (S^D) that an improvement in the child's environment related to a particular state of solitude (EO) is available if SIB were to occur (reinforcement). The antecedent circumstances render SIB highly likely to occur if the child has experienced past reinforcement under similar conditions; the SIB responses are determined by environmental contingencies of reinforcement. This operant conceptualization has robust support in the ABA literature, to the extent that contemporary treatments for SIB are predicated on first identifying contingencies from those naturally occurring encounters (Hayvaert et al., 2014; Jessel et al., 2018; Shawler et al., 2019).

Toward an Operant Methodology for Understanding SIB

Schaefer (1970) provided an early empirical demonstration, albeit with a non-human primate, illustrating the manner in which SIB could be strengthened by reinforcement. Schaefer provided pieces of fruit contingent on the behavior of head-hitting with a forepaw to two male rhesus monkeys. The contingent delivery of fruit resulted in immediate and sustained increases in head hitting, and a reversal of this contingency led to extinction of the behavior. Schaefer further demonstrated that SIB in rhesus monkeys could come under the control of both S^Ds and EOs, as the responses were exclusively observed under conditions in which food had been deprived and when food reinforcers were signaled to be available contingent on SIB. This early demonstration not only validated but offered generality across species, to the account that SIB may be determined by its consequences.

Carr (1977) extended the earlier work by providing a cogent argument for why an operant conceptualization may yield pragmatic benefits in the treatment of SIB. Recall that the biomedical approach to understanding SIB fostered the development of medical interventions for SIB; however, evidence supporting their long-term effectiveness in engendering socially meaningful improvements in SIB remains somewhat scant (Siegel & Beaulieu, 2012). In synthesizing the literature on what was understood to be motivating SIB, Carr provided multiple operant hypotheses, ranging from influence by positive, to negative, to sensory reinforcement. In doing so, Carr amalgamated the biological and operant assumption to suggest that, regardless of an individual's psychiatric diagnosis or the topography of the SIB, the immediate outcomes of the behavior played the most important (causal) role in its future occurrence. It is worth emphasizing that the biomedical conceptualization of SIB; specifically, that SIB is strengthened because of its physiological consequences, is actually commensurate with the operant conceptualization. The notion that the release of endogenous opioids, for example, may serve as influential consequences that increase the future probability of SIB, is tantamount to suggesting that SIB is reinforced by "automatic" consequences (i.e., that the reinforcers for SIB are the sensory consequences inextricably linked to its emission; Cataldo & Harris, 1982). The primary contribution of the operant conceptualization has been a functional understanding of environmental consequences that can now be managed to support other more appropriate behavior.

If *functional assessment* is the broad term characterizing any approach to understanding the environmental events that influence one's SIB, *functional analysis* refers to the specific, experiment-oriented approach to determining which contingencies of reinforcement are responsible for SIB. In a functional analysis, contingencies suspected to influence SIB are manipulated systematically, across control (contingency absent) and test (contingency present) conditions in order to determine the extent to which they directly influence the likelihood of SIB (Hanley et al., 2003). A controlling contingency historically influencing SIB is identified when SIB occurs exclusively or at higher rates in a test condition relative to a control condition. Other chapters in this volume describe various procedures and considerations to be made in the functional analysis of problem behavior such as SIB, predicated on the assumption that, if behavior is occurring with regularity, it is being reinforced. Rather than reiterating those methods here, we articulate two special considerations regarding the functional analysis of SIB that warrant special mention in this chapter.

The first consideration when attempting to conduct a functional analysis of SIB is that it is possible, if not likely, that more than one reinforcing outcome has followed and has been functionally related to SIB in one's natural environment. There are dozens of studies suggesting that SIB may be reinforced, not only by one of the commonly reported contingencies responsible for problem behavior (e.g., attention, escape; Ala'i-Rosales et al., 2019), but by a combination of those contingencies as well as other, more idiosyncratic variables (Beavers & Iwata, 2011; Rajaraman & Hanley, 2021; Schlichenmeyer et al., 2013; Slaton & Hanley, 2018; Slaton et al., 2017). This may not be surprising to anyone who has spent time with an individual who engages in dangerous SIB; SIB is a highly effective and reliable way for an individual to change their circumstances—to get others to stop what they are doing, attend undividedly to the behaving individual, and to do whatever they can to thwart SIB. This may involve relenting on expectations, providing particular items or interactions, restoring environmental arrangements, resuming previous activities, providing uninterrupted opportunities to engage in certain behaviors (e.g., stereotypy), restraining the individual, or any combination therein. Those tasked with analyzing and treating SIB are most likely to derive information about the possible variables contributing to the maintenance of SIB by asking open-ended questions about such events to caregivers with intimate familiarity with the individual and the contexts in which SIB is most likely (Coffey et al., 2020b; Hanley, 2012; Hanley et al., 2014). Contemporary functional analyses take into account all of the possible variables of which SIB is a function, teaching behavior analysts not just about the specific functional classification of the behavior, but rather the variables functionally controlling the behavior in a manner that emulates the ecology of the individual's natural environment (Jessel et al., 2018, 2020).

The second consideration that warrants mention in a discussion of analyses of dangerous SIB is that the dangerous topographies of SIB need not be evoked during the analysis in order to determine the variables contributing to its maintenance. Over the past two decades, a great deal of research has been devoted to exploring strategies and tactics to promote safety in the analysis of dangerous problem behavior, including SIB (Bloom et al., 2011; Jessel et al., 2020; Smith & Churchill, 2002; Thomason-Sassi et al., 2011; Wallace & Iwata, 1999). One line of research, that which examines precursor or co-occurring responses, deserves special mention because it has allowed researchers and practitioners to infer the controlling variables for SIB without ever needing to evoke dangerous SIB in a functional analysis. Specifically, researchers have investigated less dangerous behavior—reported to precede or co-occur with SIB—and have consistently verified influence by the same contingencies of reinforcement (Borrero & Borrero, 2008; Dracobly & Smith, 2012; Fritz et al., 2013; Herscovitch et al., 2009; Hoffmann et al., 2018; Magee & Ellis, 2000; Richman et al., 1999; Schmidt et al., 2020; Smith & Churchill, 2002; Warner et al., 2020). In other words, if caregivers report that some less dangerous topography of behavior (e.g., elbow banging, stomping, body tensing) reliably precedes or co-occurs with SIB (e.g., head banging), there is insurmountable evidence to suggest that contingencies that yield differentiation of those less dangerous responses in a functional analysis are likely to be functionally related to the SIB in question.

The phenomenon of shared operant-class membership among responses clustered around dangerous behavior appears to have broad generality with respect to individuals who engage in SIB. This suggests that functional analyses of dangerous problem behavior can be conducted successfully without ever needing to evoke the dangerous topography because inferences about the function of SIB can be made by analyzing less dangerous behavior across multiple potential dimensions (see Fig. 61.1). Furthermore, there have been multiple accounts of functionally equivalent dangerous *and* non-dangerous problem behavior decreasing with a function-based treatment informed by the results of functional analyses of only precursor behavior (Dracobly & Smith, 2012; Hoffmann et al., 2018; Rajaraman et al., 2022). A proper interview with relevant caregivers is likely to reveal possible topographies of both dangerous SIB as well as co-occurring and preceding non-dangerous topographies of problem behavior, such that a functional analysis can be successfully conducted that results in the information necessary to develop a treatment—predicated on the operant assumption of SIB—that yields meaningful improvements in the behavior. Whereas the biological or biomedical approach to understanding SIB prescribes pharmacological treatments, the operant or ABA approach to understanding SIB prescribes function-based treatments that manipulate important environmental events endemic to SIB in order to support more adaptive, appropriate responses under the conditions that historically, counterintuitively supported SIB. When conducted with proper considerations, functional analyses of SIB have the potential to inform the design of interventions for problem behavior, predicated exclusively on reinforcement, that teach a complex repertoire of adaptive social skills that effectively replace SIB.

Function-Based Treatments of SIB

The treatment procedures used to reduce SIB differ depending on the results of the functional analysis. If SIB is found to be sensitive to socially-mediated reinforcers, it permits the behavior analyst to manipulate those environmental events and rearrange them in a way that no longer sustains the occurrence of SIB and possibly strengthens other alternative, appropriate behavior. Using the contingencies identified in the functional analysis to treat SIB is referred to as a function-based intervention in that the socially-mediated reinforcers manipulated are those identified as originally contributing to the SIB. This is juxtaposed with the manipulation of arbitrarily selected consequences that require the behavior analyst to make a large interpretative

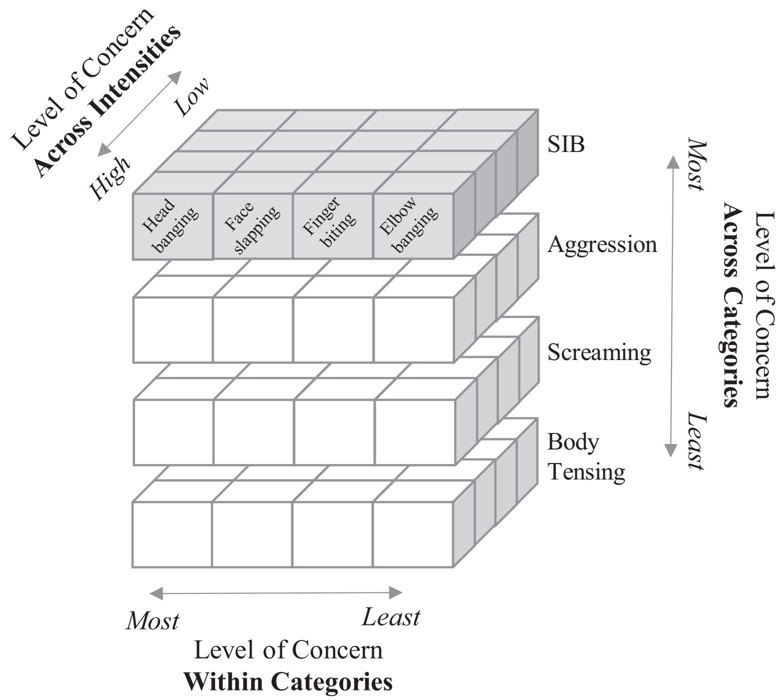

Fig. 61.1 Reinforceable dimensions of problem behavior. (Note. The behavior analyst is likely to be most concerned with reducing high intensity, dangerous topographies of SIB; however, insofar as multiple forms of problem behavior are reported to co-occur, a functional analysis targeting an open-response class of topographies and intensities of less concern can still inform effective treatment without creating an unsafe environment)

leap in determining if that treatment will be effective. The behavior analyst is making one of two potential assumptions when choosing to conduct an intervention with arbitrary consequences.

The first assumption is that the arbitrary reinforcers will compete with the functional reinforcers. Without an analysis identifying functionally relevant reinforcers, the behavior analyst cannot with any confidence interrupt the contingency between SIB and the reinforcers contributing to SIB. Therefore, the behavior analyst is left to hope that their arbitrarily chosen reinforcers strengthen other appropriate behavior that may effectively compete with problem behavior, knowing that the functional reinforcers continue to be producible by SIB. In other words, the behavior analyst may have to rely on powerful reinforcers or punishers to work as a sort of sledgehammer effect over the SIB.

The second assumption is that the behavior analyst, by chance, selected reinforcers that are, or closely align with, the functional reinforcers. This is one of the most dangerous considerations because some procedures can be contraindicative of treatment effects and may cause SIB to worsen (Iwata et al., 1994b). Therefore, arbitrarily selecting consequences without functional analyses is somewhat like a game of roulette and is not one a behavior analyst should consider when working with problem behavior as severe as SIB, especially given that function-based options are well documented (Heyvaert et al., 2014).

Function-based interventions for SIB maintain one singular unifying principle: The reinforcers identified during the functional analysis are systematically manipulated in treatment. How those reinforcers are arranged with respect to SIB is the distinguishing feature of each function-based preparation. For example, the behavior analyst could prepare a negative contingency if SIB continues to occur in the absence of socially mediated consequences. This has been defined as differential reinforcement of other behavior (DRO) and involves programming a specific interval of time in which problem behavior cannot occur if the reinforcers are to be delivered. There are multiple variations of the DRO arrangement (Jessel & Ingvarsson, 2016); however, all DROs program for problem behavior to result in a worsening in the environment (i.e., delay to reinforcement access).

The contingent relation between the functional reinforcers and the SIB could also be broken. Extinction is the process of discontinuing the presentation of reinforcers that previously strengthened SIB. Doing so ensures that problem behavior never comes into contact with reinforcement. Extinction alone is never recommended as an intervention as it is associated with a host of negative side effects (Goh & Iwata, 1994; Lerman et al., 1999) and because it creates a barren environment antithetical to ethical considerations of reinforcement-based therapeutic strategies. In addition, the contingency can still be eliminated without the complete removal of the functional reinforcers by presenting them on a time-based schedule. This arrangement is termed non-contingent reinforcement (NCR) and also has the ability to break the contingent relation between SIB and reinforcement while maintaining a relatively rich environment with continued access to the functional reinforcers. The essential element of the NCR arrangement is that SIB no longer impacts the delivery of the reinforcers.

Finally, the behavior analyst could prepare a positive contingency for some other alternative behavior. The differential-reinforcement-of-alternative-behavior (DRA) arrangement takes the reinforcers that historically strengthened SIB and provides them contingent on some alternative response. Therefore, unlike DRO that may promote docility or NCR that simply reduces the motivation to exhibit any behavior, DRA teaches an individual that their behavior can impact and improve their current circumstances. The alternative response is selected based on its appropriateness for the context and is intuitively intended to replace SIB by rendering it unnecessary for the production of important reinforcers. Moreover, DRA is commonly accompanied with extinction for problem behavior, such that reinforcers are exclusively provided contingent on the emission of alternative behavior. The alternative response may be selected based on its relation to SIB (i.e., if it is incompatible with SIB) but some form of communication is most commonly selected (Ghaemmaghami et al., 2021; Tiger et al., 2008). Behavior analysts tend to select a communication response to be strengthened using the functional reinforcers because language ability is often negatively correlated with problem behavior (Williams et al., 2018) and it enables the individual with the ability to appropriately ask for their wants and needs, a deficit skill for many individuals with IDD. Due to the contingent relation between the functional reinforcers and communication, this response has been termed a functional communicative response (FCR).

The specific DRA preparation that reinforces appropriate communication is called functional communication training (FCT; Carr & Durand, 1985). Although DRO, NCR, and DRA have robust evidence as function-based treatments for reducing problem behavior (Kahng et al., 2002; Petscher et al., 2009, Carr et al., 2009), FCT may be considered more socially acceptable among those tasked with addressing severe problem behavior. However, FCT alone is not sufficient for producing meaningful reductions in SIB and extensions to this treatment are required. FCT involves teaching a single, simple communicative response to earn the functional reinforcers on a dense, often continuous reinforcement schedule. This is merely a starting point to validate the efficacy of the reinforcers contributing to SIB identified during the functional analysis and ensure the initial success of the treatment by reducing response effort and increasing the richness of the therapeutic environment. For the treatment of SIB to be sustainable in the home or school environment, extensions must be conducted to improve the practicality of the procedures by reducing access to reinforcement (Ghaemmaghami et al., 2021).

Practical Extensions to Function-Based Treatments

First, the behavior analyst can focus on improving communication skills to extend the procedures of FCT. Caregivers are unlikely to accept the use of simple FCRs below an individual's current abilities. Shaping up more complex and developmentally appropriate language skills is likely to make communication more recognizable amongst an individual's broader community, thereby increasing the likelihood that it will be reinforced. Thus, the behavior analyst should begin FCT by teaching a simple response knowing the ultimate goal is to extend the treatment by teaching progressively more complex responses. Doing so involves the progressive extinction of previously strengthened FCRs and teaching of new, more complex responses. This often involves targeting a single omnibus mand (e.g., "My way") and building upon the sentence structure and response effort (e.g., "Excuse me, may I have my way?").

The construct of complexity can take many different forms and is specific to the individual and caregiver. For example, the complexity of the initial FCR can involve moving from a single word utterance to using a full sentence (Ghaemmaghami et al., 2018; Hernandez et al., 2007; Tiger et al., 2008). The initial FCR targeted in a treatment is unlikely to be considered socially acceptable. This is purposefully arranged to focus on the elimination of problem behavior. Once elimination is achieved, the behavior analyst can progressively improve the sentence structure to meet developmental expectations. Complexity can also be increased by requiring the individual to first obtain the behavior analysts attention before continuing with the request for her reinforcers (Hanley et al., 2007, 2014). This chain of responding establishes an added element of natural conversation and uses the context in which the functional reinforcer is delivered as a conditioned motivating operation. That is, the individual must first ask for and obtain the attention of the adult who controls the reinforcer delivery in order to be able to ask for and obtain the reinforcer. In another example, the individual could be required to specify those they are talking to or the item they would like returned (Ward et al., 2020). The complexity of the FCR now grows with the skeletal frames that incorporate multiple skills (e.g., knowing the names of adults the individual is addressing or the names of items to be requested). These strategies can also be combined to establish a seemingly more natural communicative interaction between a child and adult.

For example, Ward et al. (2020) taught three children diagnosed with an IDD who exhibited SIB to initially emit the simple FCR "My way" to have all reinforcers contributing to problem behavior at one time (i.e., an omnibus mand). The sentence structure of the FCR was expanded to require an initial request for attention (e.g., "Excuse me") and to reinforce the omnibus mand only if emitted after they had been acknowledged. Finally, in three consecutive steps the participants were then taught to ask for breaks from work ("all done"), access to leisure items ("stuff"), and interactive play with the adult ("play with me"). SIB was eliminated by the end of the study and the participants acquired multiple forms of communication including omnibus and isolated FCRs.

Regardless of the individualized specifications, the process for shaping complex communication skills remains the same: Begin with a simple response and progress the contingency to support intermediary responses until the terminal complex response is achieved. It is important that these intermediary responses are included to pace the building of the communicative repertoire because increasing the effort too quickly could result in the reemergence of problem behavior (Ghaemmaghami et al., 2018).

FCT and complexity training reduce SIB by replacing it with a developmentally appropriate form of communication that obtains the same reinforcer. However, this treatment is still limited to situations in which the reinforcer can be presented on a dense schedule (i.e., each instance of communication is reinforced). In essence, complexity training teaches new developmentally and socially appropriate skills while maintaining a sufficient reduction in problem behavior; however, the terminal goals of returning to the natural environment have yet to be met. The expectations of a teacher or caregiver often require some level of tolerance when those reinforcers are not immediately available. The second step to extending function-based treatment involves teaching tolerance to the denial of those reinforcers.

Caregivers will often present a verbal discriminative stimulus indicating that reinforcers are no longer forthcoming, referred to as a denial cue (e.g., “no you can’t have that”, “not right now; I am busy”). A specific history with denials will often leave them as conditioned aversive events that can evoke problem behavior in their own right. Denial is indicative of the end of the reinforcing context even if the individual asks appropriately. Interventions for SIB are likely to fail if this conditioning history is not addressed. In other words, tolerance training involves shifting the value of a denial to reinforcement from an S-delta signaling no reinforcement to an S^D signaling probabilistic reinforcement (Hanley et al., 2014). This is completed by including an additional response requirement before the functional reinforcers are delivered. The novel response that is taught, often referred to as a tolerance response or denial acknowledgement, is a form of awareness, acceptance of, and coping with the expectations that reinforcement may not be forthcoming. However, reinforcement continues to be presented on a rich schedule in the early stages of teaching the tolerance response to improve the efficiency of skill acquisition. For example, the chain is extended from asking and earning reinforcers to then asking, being denied, tolerating this denial, and then earning reinforcers. The delay to reinforcement is artificially extended during this time as the response chain continues to grow (i.e., it takes the individuals longer to earn reinforcers using multiple forms of communication) but continues to produce reinforcement at a level that cannot practically be maintained. Therefore, the delay to reinforcement needs to be actively thinned while maintaining a level of tolerance to the progressively less reinforcing environment.

The process for thinning reinforcement involves slowly and progressively reducing access to reinforcement with the ultimate goal being to meet social expectations or mimic proportions of reinforcement comparable to those experienced by typically developing counterparts. Similar to the variations in function-based treatments, behavior analysts have identified multiple procedures for thinning reinforcement (Hagopian et al., 2011). These procedures fall into two potential categories based on whether the return of reinforcement is irrespective of the individual’s performance (i.e., time-based progressive delays) or dependent on the individual’s performance (i.e., contingency-based progressive delays). Time-based progressive delays involve scheduling a period of time after which reinforcers are re-presented, whereas contingency-based progressive delays can fluctuate based on the engagement in targeted contextually appropriate behavior (e.g., doing homework, following adult instruction).

Time-based progressive delays simply introduce a period where reinforcement is not available, often referred to as a mixed or multiple schedules of reinforcement (Hanley et al., 2001). Therefore, the expectations are that the individual can tolerate delays to reinforcement without any additional skills being taught; SIB has no impact on the scheduled delivery of the reinforcer. These delays typically begin as brief (1 s, 5 s, 10 s) and eventually extend to more substantial durations (5 min, 10 min, 20 min). For example, a delay can be programmed in between a response and the reinforcer delivery (i.e., the reinforcer is not delivered immediately following a communication response but rather after 5 or 10 s). This is essentially fading in extinction as the delay between the contingent delivery of the reinforcer is extended following the communication response (i.e., the contingency is eventually broken). It is important to reiterate the limitations of extinction as this delay-fading procedure is likely to result in the elimination of the new communication skills learned and reemergence of problem behavior (Hanley et al., 2001). Multiple schedules can also be conducted using signaled periods of immediate reinforcement (often using a visible green card) and extinction (often using a red card) with the proportional period of extinction progressively increased. Beyond the limitations associated with the use of extinction alone, others arise when extinction is incorporated in a multiple schedule. First, the use of arbitrary signals makes it hard to integrate into the natural environment considering everyone (teachers, caregivers, therapists) has to consistently use and have access to those signals, which can introduce supplemental costs for materials. Second, an immediate contingency between the FCR and reinforcement remains in place during signaled reinforcement periods. That is, the multiple schedules arrange more of an avoidance of denials rather than a repertoire of tolerating them. Therefore, there are likely more benefits to employing contingency-based delays during reinforcement thinning (Drifke et al., 2020; Ghaemmaghami et al., 2016; Iannaccone & Jessel, 2021).

Contingency-based delays extend the performance requirements to the delay period. In addition to communication and tolerance skills, the chain to the return of reinforcement now introduces expectations of cooperation. Cooperation skills can be taught in one of two possible ways (Jessel et al., 2018). The instructions could involve engaging with available items or activities without exhibiting SIB if the individual has some alternative contextually appropriate behavior within their repertoire. In this arrangement, the functional reinforcers are delivered following the engagement in a socially acceptable task for a certain period of time with this time becoming longer as SIB remains low. This form of contingency-based reinforcement thinning is meant to emulate situations where caregivers are unavailable and the individual must independently engage with whatever is accessible. This may include not having TV available for a period of time while mom is working and having to play outside in the yard. This may also include being asked to put down the iPad to play an interactive game with siblings while dad is busy cleaning.

In other cases, the instructional requirement may involve direct supervision and teaching of the contextually appropriate behavior. Therefore, after the individual emits the tolerance response indicating their acceptance that reinforcement is not immediately forthcoming, the behavior analyst then begins to introduce instructions, the contingent completion of which results in the return of the reinforcers. The response effort remains low at first, such as providing minimal (1, 2, 3) gross motor instructions and progressively increases to larger ratios (20, 30, 40) and more difficult tasks (e.g., self-help skills, activities of daily living, academic instructions). Contingency-based reinforcement thinning with supervision allows the behavior analyst to provide reinforcers contingent on each discrete response. Thus, it can be applied in the classroom when the individual is expected to complete work, in the home when they are instructed to complete chores, or during any adult-led activities. It should be noted that the behavior analyst may want to eventually reduce the level of supervision, which could involve a combination of the two contingency-based strategies or momentary-based criterion for delivering reinforcement during scheduled supervision checks (Jessel et al., 2017).

Figure 61.2 provides a step-by-step guide outlining the interactions between the child who exhibits SIB and the behavior analyst throughout the entire treatment process teaching communication (top panel), tolerance (middle panel), and cooperation skills (bottom panel). It should be evident that, as the treatment progresses, an additional chain is added to the contingency to strengthen a comprehensive repertoire that is intended to replace SIB across a multitude of potential EOs and discriminative events that had previously evoked SIB. This includes the removal of positive reinforcers, the denial of returned access to reinforcers, and the presentation of instructions. Because of this focus on promoting skills using contingencies during every step of the treatment, the process that incorporates FCT, tolerance training, and contingency-based reinforcement thinning has come to be termed *skill-based treatment* and has been socially validated and replicated in its entirety on multiple occasions (e.g., Beaulieu et al., 2018; Coffey et al., 2020a; Ferguson et al., 2020; Hanley et al., 2014; Jessel et al., 2018; Rajaraman et al., 2022; Santiago et al., 2016).

Supplemental Treatment Procedures

In some cases, function-based treatments may not be sufficient to reduce SIB alone and behavior analysts must add supplemental procedures. It is important to point out that as the functional analysis technology continues to improve, the

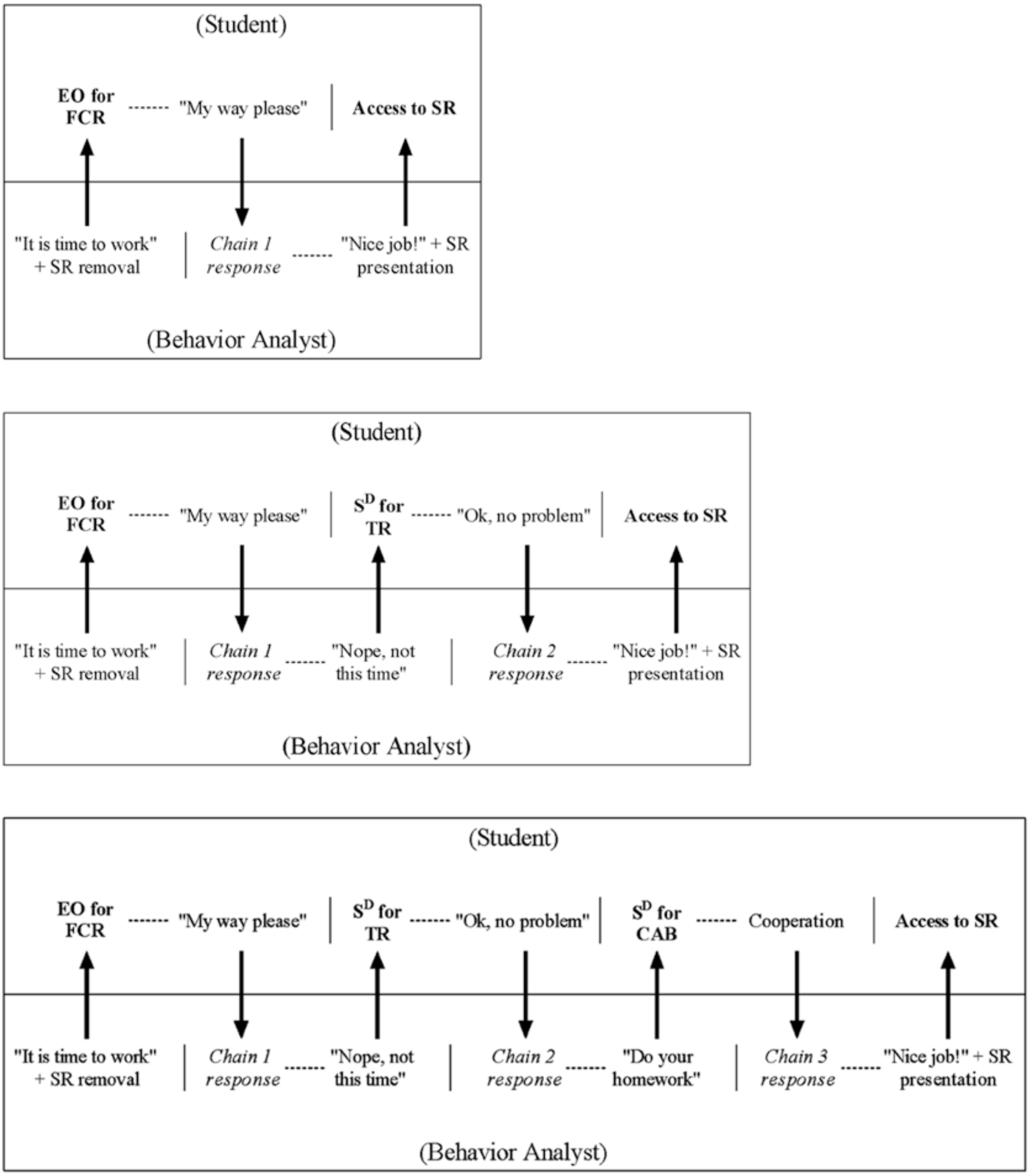

Fig. 61.2 Interactions between the student and behavior analyst when teaching communication, tolerance, and cooperation skills. (Note. EO establishing operation; SR reinforcers; S^D discriminative stimulus; TR tolerance response; CAB contextually appropriate behavior)

use of supplemental procedures beyond the function-based treatments appears to be diminishing (Hagopian et al., 1998; Jessel et al., 2018; Rooker et al., 2013). Nonetheless, the behavior analyst can include arbitrary reinforcers in a concurrent DRO, NCR, or DRA schedule when expected reductions in SIB are not achieved. For example, the child may earn the functional reinforcers of a break with a toy when exhibiting the target FCR and earn arbitrary preferred edibles every 30 s without SIB. In other cases where functional and supplemental reinforcement strategies fail, the behavior analyst may have to rely on punishment or restraint procedures to suppress SIB. However, punishment should only be considered if (a) reductions in SIB are not determined to be socially significant otherwise and (b) there is a pressing concern of safety with the continued occurrence of severe SIB. In addition, the appropriateness and acceptability of the punishment procedures should always be transparently addressed with caregivers before use.

Punishment procedures should be approached with caution and any stimuli and events selected to serve as punishers should meet rigorous criteria. First, punishers could be selected based on the outcomes of the functional analysis without the need of additional assessments (Lerman & Toole, 2011). This could be as simple as implementing the opposite of the reinforcement contingency when problem behavior occurs. The assumption being that stimuli that act as positive reinforcers when presented following appropriate behavior (contingent access to tangible items) will act as negative punishers when removed following problem behavior (contingent removal of tangible items). Similar reflexive properties are considered when negative reinforcers are removed following appropriate behavior (contingent removal of homework) and presented as positive punishers following problem behavior (contingent requirement of homework). In some cases, patterns in responding during the functional analysis could be indicative of a punishment effect. For example, if rates of SIB are found to be lowest in a condition where instructions and adult attention are contingently removed, then this may be indicative of timeout serving as a potential function-based punisher. On the other hand, adult interaction, such as reprimands, could also be deemed suitable as a punishment procedure when SIB is lowest in the functional analysis condition that includes contingent attention.

In a second set of criteria, aversive stimuli could be selected based on the results of an assessment conducted prior to evaluation in a treatment (Fisher et al., 1994; Verriden & Roscoe, 2018). Doing so could aid in the selection of the least aversive and most socially acceptable procedures while avoiding the use of arbitrary aversive events that may not serve to suppress problem behavior. Verriden and Roscoe (2018) briefly compared a selection of clinician-informed aversive stimuli and measured problem behavior, appropriate engagement with preferred items, and emotional responding as a comprehensive evaluation of potential punishers. In other words, if punishers are deemed necessary, they should reduce SIB without negatively impacting appropriate behavior or positive affect. In fact, a correctly implemented treatment package that includes rich reinforcement and punishment may even be preferred by the individual in some cases (Hanley et al., 2005).

Considerations for Automatically Reinforced SIB

Additional difficulties arise when SIB continues to occur in the absence of socially mediated consequences. This has often been referred to as automatic reinforcement because the behavior itself is said to produce some form of sensory stimulation that maintains SIB. Although SIB that is sensitive to automatic reinforcement is more likely to be resistant to treatment effects, there are potential procedural options. If the source of stimulation can be isolated, it would be possible to implement a function-based treatment using sensory extinction (Rincover et al., 1979). Sensory extinction involves eliminating the stimulation produced by the SIB using protective gear, response blocking, or medication. For example, protective wrist guards could be placed on the arms to reduce self-inflicted arm biting that is automatically reinforced (Luiselli, 1988). Attempts at identifying the specific type of stimulation could also be used to inform the selection of certain items that can compete with that source of reinforcement (Shore et al., 1997; Dowdy et al., 2020).

The competing stimulus assessment involves evaluating items that, when continuously available, reduce SIB by producing some form of substitutable reinforcement (Haddock & Hagopian, 2020). The assessment attempts to match stimulation produced by the SIB informing a treatment of NCR that will be more effective than including any arbitrarily selected preferred items. Therefore, the competing stimulus assessment is essentially an extension to preference assessments specifically designed to address automatically maintained SIB. For example, Piazza et al. (2000) conducted the competing stimulus assessment with a selection of items that appeared to match and not match sensory stimulation. Matched stimuli for hand mouthing included items that produced stimulation in the mouth (soft candy) or hand (hand massager) and unmatched stimuli included items that produced other sensory stimulation such as videos or musical toys. The authors obtained differentiated outcomes when implementing NCR, with the matched items producing more pronounced reductions in problem behavior across participants.

It may also be potentially beneficial to categorize SIB into multiple subtypes depending on the different patterns of responding that can be obtained during functional analyses the results of which indicate automatic reinforcement (Hagopian et al., 2015, 2017). The properties of automatic reinforcement may differ dependent on some biological underpinnings that influence how SIB responds to different contingencies. First, SIB could be sensitive to environmental stimulation and suppressed in a play condition when alternative forms of reinforcement are available. This has been identified as subtype I and suggests that reinforcement-based strategies are likely to be effective in reducing problem behavior. Second, SIB may be relatively insensitive to environmental stimulation and may occur across all conditions (i.e., subtype II). Subtype II is particularly resistant to reinforcement-based treatments and the behavior analyst may need to incorporate multiple treatment components including response blocking, punishment, and restraint. The presence of SIB that specifically includes some form of self-restraint across functional analysis conditions has been delineated as subtype III, which could inform the use of restraint procedures during treatment. Thus, delineating the different subtypes of SIB considers a pragmatic approach to assessment that helps to inform treatment selection and predict treatment efficacy even when SIB is historically influenced by automatic reinforcement.

Conclusion

Individuals who engage in intractable SIB run the risk of causing serious injury to themselves, to say nothing of the highly restrictive lifestyle that may be imposed by such behavior. Decades of research focused on the environmental determinants of SIB have fostered the development of an array of behavior analytic treatment approaches with strong evidence supporting their efficacy. A comprehensive approach to addressing socially-mediated SIB involves (a) conducting a functional analysis to identify the reinforcers of which SIB is a function; (b) teaching a simple FCR to empower an individual with a low-effort alternative response to produce said reinforcement, thereby rendering SIB unnecessary; (c) increasing the complexity of the FCR to a developmentally appropriate terminal topography; (d) teaching explicit responses to denials and disappointment; and (e) increasing the contextually appropriate behavior expected of the individual during periods of nonreinforcement. Special consideration should be given to SIB that is automatically reinforced, but reinforcement-based options such as providing competing stimulation should be considered prior to resorting to restraint or punishment-based procedures. A behavior analytic approach to treating SIB has the potential to yield socially meaningful improvements in behavior, minimizing an individual's risk and maximizing their opportunities to behave effectively in important environments.

Acknowledgement The authors wish to acknowledge Christine Warner and Gregory Hanley for their conceptualization and design of Fig. 61.1 included in this chapter.

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62 Assessment and Treatment of Toe Walking

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Idiopathic toe-walking (ITW) describes a condition in which children walk with a toe-to-toe gait pattern in the absence of any known cause (Sala et al., 1999). ITW is also less frequently referred to as habitual toe-walking and congenital short tendo calcaneus. ITW is not considered pathologic for individuals 2 years of age or younger (Matthew & Sean, 2012); however, after 2 years of age, treatment is recommended.

While ITW may be exhibited by typically developing individuals, there is a growing body of research suggesting that it may be more common among those with disabilities (Accardo et al., 1992; Barrow et al., 2011; Ming et al., 2007; Sala et al., 1999; Shulman et al., 1997). It may be particularly common among children with autism spectrum disorder (ASD). Barrow et al. (2011) examined ITW in 324 children with ASD. These researchers found that 65 (20.1%) exhibited persistent toe walking and 39 (9%) had tight heel cords. Tight heel cords were defined as heel cords that do not reduce past 90° in dorsiflexion (backward bend). When these results were compared to typically developing children, data showed that persistent toe walking and tight heel cords were more common in children with ASD than among children with developmental diagnoses other than ASD.

When it does occur, ITW may also persist longer in individuals with ASD (Barrow et al., 2011). Persistent ITW can lead to a number of medical problems. For example, one common result of persistent ITW is a secondary motor deformity in which the heel cord is shortened so much that the foot can longer be dorsiflexed beyond 90°. Sobel et al. (1997) reported that 80% of "high-toe walkers" had an ankle equinus deformity. Ankle equinus occurs when the ankle joint lacks the flexibility necessary to move upward, which is a result of tightness in the Achilles tendon or calf muscle. Sobel et al. also reported that ankle equinus was more common in older children who toe-walked, and that range of dorsiflexion tended to decrease with increasing age. Other complications that may arise as a side effect of ITW include falling, in-toe gait (walking with toes pointing inward), pain, fatigue, flatfoot (arches on the inside of the feet are flattened), limping, poor balance, and bunions (Sobel et al., 1997).

Interestingly, Sobel et al. (1997) described a variety of toe-walking patterns. Some children were found to walk high up on their toes (labeled "high toe-walker"), some exhibited a pattern of heel-to-toe steps followed by toe-walking steps, some toe-walked only after long periods of time,

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_62

some toe-walked when adults were not observing, some toe-walked barefoot but not in shoes, and some toe-walked barefoot and in shoes. Thus, it is important for clinicians to assess and describe the specific conditions under which toe walking may or may not occur.

Measurement of Toe Walking and Its Effects

The first step in assessing and treating ITW is to accurately measure its occurrence. Research on ITW exhibited by individuals with ASD can be found in the pediatric (Barrow et al., 2011), orthopedic (Matthew & Sean, 2012), and behavioral literature (Wilder et al., 2020). Orthopedic assessments of ITW typically include a neurological evaluation to rule out any underlying neuromuscular issues (Barrow et al., 2011; Shulman et al., 1997). The neurological evaluation may include measures of muscle bulk, tone, strength, deep tendon reflexes, sensation, head circumference, and leg length. The assessment may also include testing of motor nerves and superficial sensory nerves. A podiatric measurement of ITW also typically involves measurement of dorsiflexion. A lack of dorsiflexion range of motion (ROM) is often referred to as a tight heel cord. Barrow et al. (2011) classified a tight heel cord as a heel cord that did not extend beyond 90° in dorsiflexion while in a seated position.

In behaviorally based studies, measurement of toe walking typically requires direct observation and counting of inappropriate and appropriate steps. This can be difficult, because the child may walk at a quick pace or even jump when walking. Accurate measurement may require obtaining video footage of the child walking, then watching and scoring the videos later. Inappropriate steps are often defined as those with a toe-to-toe gait, and appropriate steps are defined as steps with a heel-to-toe gait (Hodges et al., 2018; Wilder et al., 2020). The percentage of toe-walking steps is obtained by dividing the total number of steps by the number of inappropriate steps, then multiplying by 100. To date in the behavioral literature, most studies have measured toe walking by providing a percentage of appropriate or inappropriate steps taken based on a predetermined amount of steps required. For example, recent studies have required participants to take 1000 steps and have calculated the percentage of these steps with toe walking (Hodges et al., 2018; Wilder et al., 2020).

Assessment of Toe Walking

Behavioral assessment involves identifying environmental variables responsible for challenging behavior. There are three primary assessment methods: informant, descriptive, and experimental. Informant methods involve a series of questions presented to the caregiver and/or client. The questions are designed to isolate the specific conditions under which the target behavior is likely to occur. For example, standard indirect assessment tools include, but are not limited to, the Motivation Assessment Scale (MAS; Durand & Crimmins, 1992), the Functional Analysis Screening Tool (FAST; Iwata et al., 2013), and the Questions about Behavioral Functioning (QABF; Paclawsky et al., 2000).

Descriptive assessment requires recording variables contributing to the occurrence or nonoccurrence of the target behavior as they occur in the natural environment via direct observation. Finally, experimental or functional analysis (FA) involves systematically exposing individuals to specific antecedent and consequence events, while carefully measuring the target behavior (Iwata et al., 1982/1994). The functional analysis (FA) is considered the gold standard assessment tool to identify the variables responsible for challenging behavior.

Given the complexity and etiology of ITW exhibited by individuals with intellectual disabilities (ID), it is important to assess ITW properly. This process includes obtaining medical and development information, consulting medical providers, and ruling out any underlining medical conditions. One study found that among patients with ITW referred to neurologists by orthopedic surgeons, 62% of the patients had an underlying neurological etiology (e.g., cerebral palsy, neuropathy, ASD; Hayes et al., 2018). Therefore, it is essential for pediatricians, parents, and behavior analysts to collaborate during assessments and intervention development and evaluation.

Informant-Based Assessment Informant-based assessments of ITW are typically conducted with caregivers. Caregivers serve as historians for their child's developmental milestones and concerns regarding ITW. Medical records that include gait analysis or baseline range of motion (ROM) data are also vital. The ROM data often indicate the severity of ITW and provide baseline information, which can later be used to evaluate treatment. During the structured interviews, basic questions should include the age of onset of ITW, specific activities that evoke ITW (e.g., walking, running), and family history of ITW. Pomarino et al. (2017) developed an interview checklist to determine the family history of ITW in specific family members, the onset of ITW (i.e., at the onset of walking, X number of months or years after walking), and current ITW status.

Other ITW assessment tools provide additional information. For example, Accardo and Barrow (2015) created a heel cord ROM questionnaire to obtain historical data on ITW and ROM. This tool includes a 3-point Likert scale, which scores ITW as 0 = absent, 1 = present (longer than 3 months), 2 = intermittently present, and 3 = persistent. Similarly, a 3-point Likert scale is used to evaluate ROM (p. 607). Other assessment or screening tools are more involved and require direct observation.

Most of the existing behavioral intervention studies on ITW have included informal parent interviews (Hobbs et al., 1980; Hodges et al., 2019; Persicke et al., 2014; Wilder et al., 2020). These interviews typically include questions about the environmental conditions under which toe walking is most and least likely to occur. Questions on the severity and frequency of ITW are also included.

Descriptive Assessment Direct observation is often the next step in evaluating ITW. Observations by an occupational or physical therapist or a physician typically focus on analyzing the individual's gait, both walking and running. It is often advantageous to observe individuals when they are unaware of the analysis, as reactivity in the form of altered gait or increased anxiety may occur (Bishop, 2016). In addition to gait analysis, medical providers conduct a physical exam and typically obtain ROM data on the hip, knee, and ankle. These measurements are necessary because individuals who engage in ITW are three times more likely to have dorsiflexion ROM limitations (Pomarino et al., 2017). It is essential to ensure the direct assessment conditions capture the conditions under which ITW is likely to occur. Most observations occur at the time of medical visits; however, some studies have used pre-recorded videos to evaluate ITW (McMulkin et al., 2006). Unfortunately, assessing ITW, either in vivo or via recording, can be cumbersome and time-consuming. ITW assessment technology ranges from basic questionnaires to sophisticated technology measures.

Questionnaires are the most simplistic form of assessment for physicians and allied clinicians. Williams et al. (2011) developed a 28-item ITW questionnaire to screen individuals for underlying medical issues, guiding primary care physicians on referring to other specialties. This tool requires physicians to observe the patient walking directly (both on normal gait and on heels), standing up from a seated position, testing reflexes, and muscle tightness (i.e., hamstrings, hip flexors, gastrocnemius, and soleus). In Williams et al., six clinicians used the tool to screen patients from a pre-recorded assessment; all videos contained all information needed to screen each patient. Results indicated that all clinicians correctly identified all individuals with underlying medical conditions; nevertheless, this tool is not commonly utilized by medical professionals or reported in research.

Other researchers have created assessment tools to quantify ITW severity. For example, Alvarez et al. (2007) created a severity screening tool to classify ITW into three distinct categories: mild, moderate, or severe. The authors examined the heel strike upon initial contact, followed by when the heel is lifting off the ground, and ankle movement, including power and positioning. The severe group demonstrated the most restrictive ankle ROM.

Some individuals do not present with severe ITW during brief medical exams. Therefore, Pomarino et al. (2017) created an assessment tool that was more likely to capture ITW. Their assessment included various movement conditions to evoke ITW, in addition to ROM measures; they tested the assessment tool across 836 individuals with ITW compared to 55 participants with a normal gait in a control group. The spin test requires the physician to quickly spin the individual around in one spot, starting with one spin and adding a spin until they reach a maximum of 10 spins. After the spin, physicians instruct the participants to walk 10 steps and record the spin number during which ITW occurred. The test is considered positive once the participant engages in ITW. The next condition examines performance during heel walking and the adjustment made to achieve heel walking (i.e., a forward inclination of the trunk, ankle dorsiflexion ability). Any compensation in the torso position, knee, or ankle produces a positive result. ROM is assessed in different positions and requires a goniometer for measurement.

Technology can alleviate some of the challenges in measuring, monitoring, and assessing ITW. For example, Kim et al. (2019) assessed wearable sensors attached to participants' lower back (L5-S1) to measure ITW. The device differentiated ITW from heel-to-toe gait with 82% accuracy across 3 days for five participants. Other researchers have successfully assessed ITW with kinesiological electromyography (EMG) (Thielemann et al., 2019) and three-dimensional gait analysis (Hicks et al., 1988; McMulkin et al., 2006; Westberry et al., 2008). Unfortunately, this technology can be cost-prohibitive.

Some of the behavioral intervention studies also included descriptive assessment (Hodges et al., 2018, 2019; Wilder et al., 2020). Hodges et al. (2018/ 2019) conducted direct observations of participants walking with and without shoes. Additional gait analysis was obtained via video recordings. Similarly, Wilder et al. (2020) observed participants walking and playing in a room via an observation window. Persicke et al. (2014) reported that direct observation data were obtained before the study, but did not mention how they conducted the observations. Other behavioral intervention studies either did not conduct descriptive assessments or neglected to report the data (Hirst et al., 2019; Hobbs et al., 1980; Marcus et al., 2010).

Experimental Analysis Assessment-based interventions that address the cause of challenging behavior are often most effective. During an FA, the clinician systematically manipulates specific antecedent and consequent events to identify the conditions under which the challenging behavior is likely to occur (Iwata et al., 1994). FA methods have evolved and become less intrusive and more efficient (Lang et al., 2011). Behavior that occurs during all FA conditions or during the alone or no interaction condition of a FA is said to be maintained by automatic reinforcement. That is, when a behavior occurs in the absence of social consequences, the behavior is described as producing its own reinforcement. Often, the specific source of reinforcement for the behavior is a condition of the body: a feeling or sensation that is either produced or removed when the behavior occurs. Querim et al. (2013) created a screening assessment for behaviors likely to be maintained by automatic reinforcement that accurately predicted the function of challenging behaviors that occur in the absence of social consequences.

Only a few behavioral intervention studies on ITW have included FA's, and these studies utilized the Querim et al. (2013) screening assessment. For example, Hodges et al. (2019) used the pre-treatment screening analysis (Querim et al., 2013) to verify that ITW occurred independent of social consequences. This assessment included a series of 100-step sessions, both with and without shoes, in which the participant was alone. Multiple video cameras recorded walking sessions conducted across several days. ITW occurred during a mean of 94% of steps. In a similar study, Hodges et al. (2018) again utilized the same pre-treatment screening analysis. Procedures were identical to the previous study, but the assessment occurred across 2 days. ITW occurred on 96% of steps with and without shoes. In both studies, the authors did not control for gait speed but reported that ITW occurred during both walking and running at similar rates. The screening assessment identified that ITW was maintained by automatic reinforcement for multiple participants. Wilder et al. (2020) also used the pre-screening assessment; however, participants in this study were instructed to walk around an empty room for 5 min. The experimenter observed and collected data through an observation window. The three participants engaged in ITW for means of 89%, 98%, and 98% of steps. Overall, when FAs have been used, they have verified that ITW was maintained by automatic reinforcement.

Medical studies have examined other variables that may contribute to ITW, such as various gait speeds, flooring types, and vibration sensitivity thresholds. For example, Valagussa et al. (2017) conducted two experiments to assess the conditions under which ITW was likely to occur. The first experiment examined ITW during standing, walking, and running in 69 individuals with ASD. In the standing condition, participants stood in front of a table with multiple preferred toys. To assess ITW during running and walking, the experimenter instructed the participants to either walk or run 10 m three times across 3 days. The second study assessed the cumulative number of seconds allocated to (1) tiptoes, (2) both full feet support, (3) one full foot support on a hard surface (i.e., linoleum floor), and a soft surface (i.e., foam mat). Participants included 14 individuals with ASD (7 with ITW and 7 non-ITW). Exclusionary criteria included any participant who exhibited an ankle dorsiflexion ROM of less than 90°. Results show 10 participants (14.49%) engaged in ITW across all three conditions, four during walking and running (5.57%), and eight in the running only (11.59%) condition. Surface assessment results showed a higher occurrence of ITW on hard surfaces (78.77%) versus soft surfaces (37.30%) for participants in the ITW group; the non-ITW group never engaged in ITW. These findings have implications for potential interventions, such as modifying shoe type.

Fanchiang et al. (2016) also evaluated the effects of different surfaces (i.e., vinyl tile, carpet, pea gravel) on barefoot gait patterns in 30 participants between 4 and 10 years of age. Fifteen participants served in the ITW group and 15 typically developing individuals served as age-matched peers without ITW. Exclusionary criterion included participants with neuromotor or musculoskeletal disorders. Motion system analysis recorded gait measures as the participants walked across each of the four surface types. Results showed similar gait patterns across different surfaces for both groups and no significant differences across age. However, vinyl and carpet produced significantly higher early heel rise effects for the ITW group. Alternatively, pea gravel produced no initial toe-contact, which resulted in decreased ITW.

In summary, FA is a process that demonstrates that particular events or conditions are responsible for the occurrence or non-occurrence of behavior. Thus far, researchers have verified that ITW often occurs in the absence of social contingencies (Hodges et al., 2018, 2019; Wilder et al., 2020) and have identified multiple surface types that may influence ITW (Fanchiang et al., 2016; Valagussa et al., 2017). Additional research is needed to replicate surface assessment results and expand assessment to include alternative surfaces and shoes.

Medical Interventions for Toe Walking

Both medical and behavioral interventions have been evaluated to treat ITW. Medical treatments for ITW include surgery (Eastwood et al., 2000; Hemo, 2006; Jahn, 2009), serial casting (Brouwer et al., 2000; Eastwood et al., 2000; Fox et al., 2006; Stott et al., 2004), Botulinum Toxin A (Engström et al., 2010; Engström et al., 2013; Sätilä et al., 2016), orthoses (Caselli, 2002; Herrin & Geil, 2016; Stricker and Angulo 1998), and watch and wait (Davies et al., 2018; Stricker

& Angulo, 1998). Unfortunately, there is a paucity of research with proper rigor on treatment efficacy (Leyden et al., 2019). Medical treatment can be influenced by clinician training, treatment funding source, and inconsistent treatment evidence (Williams et al., 2010).

Several recent reviews (Caserta et al., 2019; Leyden et al., 2019; Valagussa et al., 2017; van Bemmel et al., 2014) have described medical treatment for ITW. These reviews classified treatments into two main categories: surgical and non-surgical interventions (Caserta et al., 2019).

Surgical Interventions Surgery is the most invasive and expensive ITW treatment. Surgeons aim to achieve at least 10° ankle dorsiflexion by carefully lengthening the Achilles tendon, which tightens due to toe walking (Hall et al., 1967). This procedure is often effective for individuals who do not respond to other treatment modalities (van Bemmel et al., 2014). However, treatment outcomes for individuals with ASD are less promising than for those without an ASD diagnosis. In fact, Leyden et al. (2019) found that 75% of individuals with ASD resumed ITW within 2 years of surgery. Unfortunately, individuals with ITW and ASD receive surgical treatment nearly three times more often than those who exhibit ITW but do not have an ASD diagnosis (Leyden et al., 2019). Other interventions (e.g., serial casting, orthoses) may be dismissed due to concerns about tolerating less invasive treatments. Thus, it is essential to educate caregivers and medical professionals on the treatment outcomes within this population.

Most surgical studies omitted comprehensive pre-operative gait analysis and direct measurements and only reported post-operative gait or range of motion outcomes. Thus, these studies make it difficult to compare pre- and post-surgical outcomes. McMulkin et al. (2006) was one of the first authors to report quantitative outcomes for pre- and post-surgical intervention for 14 individuals who underwent a Vulpius-type procedure (gastrocnemius lengthening) bilaterally or Achilles lengthening surgery. Measurements from the ITW subjects were compared to normative data of their non-ITW peers. After surgery, participants showed significant improvements in peak dorsiflexion in stance and swing, increased stride length, improved ankle dorsiflexion with the knee extended and flexed, reduced hamstring tightness, and increased hip rotation.

Unfortunately, surgery imposes a sedation risk as well as a recovery risk. Van Bemmel et al. (2014) reviewed 10 studies that compared surgery to casting, and six of these studies ($N = 180$ patients) provided data on complications (61 casts, 119 surgery). Follow-up data were reported at 2.5 years for the casting group and 4.1 years for the surgical group. Only 3.3% of the casting studies reported complications, compared to 6.7% in the surgery studies. The predominant complication associated with casting was ulcerations. Six of the eight surgically treated individuals experienced Achilles tendinitis, and one individual had an ankle fracture due to manual pressure during the lengthening process.

Hemo et al. (2006) conducted parent interviews post-surgery (M = 2.9, range = 1.1–6.0 years). Twelve parents reported that their child consistently walked with a normal gait post-surgery, and three parents said their child still occasionally engaged in ITW. One participant experienced Achilles tendonitis 6 years post-surgery and required casting to correct ITW. Three additional studies reported high levels of parental satisfaction post-surgery (Stott et al., 2004; Stricker & Angulo, 1998; van Bemmel et al., 2014).

Serial Casting Serial casting involves placing a patient's lower legs and feet in a series of plaster or fiberglass casts to continually stretch the muscles surrounding the ankle, which may inhibit toe walking (Pistilli et al., 2014). The interior lining of the cast is waterproof, allowing individuals to bathe. Rubber sole walking shoes with Velcro™ straps are used to prevent slipping over the cast. Casting duration is typically 4–6 weeks (Ruzabarsky et al., 2016), although some studies report casting duration of up to 10 weeks (Fox et al., 2006). Casts are changed roughly every 2 weeks. Initial casts restrict ROM and require individuals to walk on their heels. This treatment sometimes precedes surgical interventions in typically developing individuals; however, individuals with ASD are more likely to undergo surgical interventions before attempting serial casting (Leyden et al., 2019). When implemented alone, serial casting is often the most effective non-surgical intervention (Bishop, 2016; Engström & Tedroff, 2012; Fox et al., 2006); however, long-term follow-up data are needed. In a review by van Bemmel et al. (2014), ITW returned in 52.1% of individuals at follow-up (M = 3.5 years) who received serial casting. Additional gait analysis by Van Kuijk et al. (2014) reported that gait patterns failed to normalize post-treatment. Thus, research on serial casting outcomes is inconclusive.

Fox et al. (2006) examined the effects of casting on 44 individuals between 2 and 14 years of age without intellectual disabilities. Professionals replaced casts twice with at least 1 week between changes; the pediatric physiotherapist conducted follow-up exams at 3 months post-cast removal and then every 6 months after that for approximately 14 months. Two thirds of participants decreased or stopped ITW. In a separate analysis, Katz and Mubarak (1984) reported that casting significantly improved gait in five out of six participants. Conversely, Eastwood et al. (2000) found that casting was not was as effective as described in Fox et al. and Katz and Muburak.

More recently, Davies et al. (2018) conducted a retrospective study that examined the long-term effects of casting (n = 23) versus stretching (n = 20) in 43 participants ranging in ages 13–28 years. Follow-up exams were conducted approximately 13.4 years post-intervention. In the casting group, all participants' casts were changed every 3 weeks. Following casting, 17 participants wore ankle foot orthoses for 1-year post-cast removal. Results showed a statistically significant difference from baseline to follow-up in the casting group but no significant difference in the stretching group. Seventy-four percent (12/23) showed improvements, 26% were unchanged (6/23), and 52% (12/23) of individuals self-reported that ITW still occurred at follow-up. In the stretching group, 35% (7/20) improved, 55% (12/23) remained the same, and 10% worsened (2/20). Self-report data indicated persistent ITW for 45% (9/20) of participants at the follow-up exam. Unfortunately, long-term outcome data were obtained by the parent's verbal report and not verified with ROM. Thus, outcomes should be interpreted with caution.

Finally, Thielemann et al. (2019) examined serial casting in 10 participants with ITW. These researchers excluded participants with underlying neuromuscular medical conditions or those who received previous ITW interventions. Treatment consisted of serial casting, and casts were changed every 14 days. Nine participants met the dorsiflexion requirement of 20° after 28 days, and one participant required an additional 14 days to meet the ROM aim. Electronic gait analysis data were obtained from the sensors in the insoles. Assessments were conducted after the cast was removed and at a 6-month follow-up visit. Results showed a significant reduction in gastrocnemius stiffness and heel force. Treatment effects persisted during the follow-up exam. This study was the first to report that casting resulted in complete gait normalization. The generality of treatment effects needs to be tested with other populations. Moreover, long-term maintenance of treatment effects is unknown beyond 6 months.

Botulinum Toxin A Medical professionals inject botulinum toxin A (BTX) in the muscles to treat a variety of medical conditions (e.g., migraines, muscle stiffness, eye problems) and cosmetic enhancements (e.g., wrinkles, severe sweating). BTX is also commonly prescribed for motor disorders, such as cerebral palsy. Botulinum toxins are potent proteins derived from the bacteria *Clostridium botulinum* and inhibit acetylcholine, a neurotransmitter, resulting in temporary paralysis (Anwar & Zafar, 2013). Treatment effects are dose-dependent, and last approximately 3 months (Anwar & Zafar, 2013; Jacks et al., 2004). Hastings-Ison et al. (2016) found that BTX injections administered once per year were equally effective to those administered three to four times per year and reported to have less adverse effects. Recently, BTX has been used to treat ITW (Multani et al., 2019).

Engström et al. (2010) evaluated the effects of BTX injections on ITW in 15 participants (5–13 years) without ID. Three-D video systems were used to obtain gait analysis data during three different 10-m barefoot walks. Participants received BTX injections, 6 units/kg of body weight with a maximum of 400 units, into both calves at four different sites. The physical therapist instructed parents and participants to stretch five times per day and walk on heels for at least 50 steps a day. Gait analysis data indicated significant improvements during initial contact, in the swing phase, and in ROM with ankle dorsiflexion. Three of the 15 participants stopped toe walking, and parents reported favorable treatment outcomes.

Engström et al. (2013) conducted another randomized controlled, parallel group trial in Sweden with 47 participants that compared the effects of casting to casting plus botulinum toxin. Sixty-eight percent of participants reported a family history of ITW, and participants had no prior intervention history. ITW improvements were defined as more than 50% of the time walking using an appropriate heel-to-toe gait. Gait measures were obtained using 3-D video analysis at the onset of the study, 3 weeks post-BTX injection, and with post-treatment follow-up analysis at 3, 6, and 12 months. The casting group included 26 participants with equal gender distribution ranging in age from 5.4 to 13.6 years. The casting plus botulinum toxin A group consisted of 21 participants (male = 16, female = 5) between the ages of 5 and 14. The experimenter applied analgesic cream 1 h before injections. A maximum of 400 BTX units were injected into the calf muscle in four areas. After BTX injections, participants were encouraged to stretch five times a week and walk on their heels 50 steps per day. A single BTX injection significantly decreased ITW and improved ROM for 11 of the 12 participants at the 12-month follow-up exam. The experimenters contacted the parents 3–5 years post-follow-up to track progress. Two parents reported ITW ceased, three parents indicated that ITW occurred during less than 50% of steps, two parents reported surgical interventions were later needed, and one parent stated ITW ceased after BTX plus casting. Only two parents reported ITW occurred during 75–100% of steps post-BTX. Three parents disclosed adverse outcomes that included moderate pain for 2–3 days post-injection.

In a similar study, Sätilä et al. (2016) conducted a 2-year evaluation of the effects of BTX ($N = 16$) relative to a more conservative intervention (i.e., stretching, foot orthoses, or firm shoes) group ($N = 14$). Thirty participants (2–9 years) presented with normal development and never received BTX, casting, or surgical interventions. The control group wore firm heel cups daily, night splints at least five nights per week, attended physical therapy once a week and stretched five times per week for at least 10 min per day. The BTX group received a 16 U/kg dose in three injection sites in both legs. Stretching occurred after the injections to activate the BTX. Participants were recorded walking and playing for 15 min. Experimenters evaluated ITW severity from the videotapes using a five-point scale. Follow-up assessments were conducted at 6, 12, and 18 months. Both groups showed significant improvements, and ITW was no longer present at the 24-month follow-up for 100% of the BTX group and 85% of the conservative treatment group. ROM outcomes varied across participants with no significant differences between groups.

Ankle Foot Orthoses (AFOs) An ankle foot orthosis is a plastic support sleeve used to train individuals on proper heel-to-toe gait (Herrin & Geil, 2016). Unfortunately, AFOs are not intended for long-term use, and ITW often re-emerges shortly after removal. AFOs restrict ROM and prevent ITW, whereas foot orthoses (FO) are less restrictive. Both AFOs and FOs are less invasive interventions, and at least one hospital (The Cincinnati Children's Hospital) recommends AFOs as the preferred non-surgical intervention for ITW (Herrin & Geil, 2016). Unfortunately, long-term outcomes are not promising.

Herrin and Geil (2016) conducted a randomized controlled trial to evaluate the effects of AFOs ($n = 10$) to FOs ($n = 9$) on ITW in individuals without neurological conditions. Participants ranged in age from 2 to 8 years. Experimenters obtained gait data using electronic motion analysis during five different 10 m walks. Participants in the AFOs group demonstrated significantly more treatment effects than the FO treatment group; however, treatment relapse occurred faster in the AFO group than in the FO group. That is, as soon as the AFOs were removed, ITW returned to baseline levels. Both parents and participants preferred the FO to the AFOs.

Researchers have also conducted a variation of FO treatment. Michalitsis et al. (2019) conducted a randomized controlled trial to determine the effects of orthoses with high-top boots on ITW in 10 males between 4 and 10 years of age. Participants walked on a GaitRite™ mat that measured heel strike and ankle dorsiflexion under three different conditions: barefoot, wearing everyday footwear, and wearing carbon orthoses inside high-top boots. The heel-to-toe strike occurred most often during the combined orthoses and high-top boots (89%) condition relative to the barefoot (64%) and normal footwear (68%) conditions.

In addition to manipulating the types of FO and shoes, researchers have also examined FO with feedback. For example, Pollind et al. (2020) used customized insoles with two pressure points to provide vibration feedback to five participants with ITW between 9 and 17 years of age. All participants temporally decreased ITW; however, absent vibration feedback, ITW resumed for all participants (median = 13 s). Participants reported that the feedback helped alert them to the target behavior; note, however, that participants' language development is unknown. Thus, it is unclear to what extent this treatment would be useful for individuals with ID.

Although AFOs are a more conservative treatment, empirical research supporting their efficacy is limited. In addition, parents and medical providers should consider the limitations of AFOs and FO before recommending them for treatment. Custom FO are expensive, and AFOs are bulky, uncomfortable, and require special shoes. Furthermore, AFOs are visually unappealing and can result in unpleasant social attention (e.g., bullying) (Ruzabarsky et al., 2016). Professionals should consider individual preference, given that research on AFO and FO has reported similar outcomes.

Watch and Wait The most conservative medical intervention requires caregivers and medical professionals to evaluate ITW over time, sometimes referred to as the watch and wait treatment. Taussig and Delouvee (2001) reported that some individuals self-corrected and no longer engaged in ITW between 3 and 8 years of age. Similarly, Engstrom and Tedroff (2018) surveyed 63 Swedish parents whose children met the criteria for ITW and did not have any other medical issues. Parents reported the approximate percentage of time (i.e., 25%, 50%, 75%, and 100%) their child was toe walking at various ages. Seventy-nine percent of parents reported that ITW stopped without treatment when their child was 10 years of age. Unfortunately, this study relied solely on the parents' report. In contrast, other studies have reported little change in ITW over time. For example, Eastwood et al. reported that 88% of participants met ITW criteria after 3 years of observation. Stricker and Angulo (1998) reported similar results; these results indicated that 48 individuals with ITW made no significant improvements without treatment at a 3-year follow-up. To date, no studies have compared an ITW watch and wait treatment group to an ITW non-treatment group with long-term follow-up data.

Overall, a variety of medical interventions have aided in the assessment and treatment of ITW. Surgical interventions and serial casting interventions have effectively reduced ITW; however, surgery is invasive, and a months-long recovery period is often necessary before the patient regains the ability to walk normally. Unfortunately, many individuals with ID who have undergone surgery reverted to ITW within 2 years (Leyden et al., 2019). While less invasive, serial casting prevents the patient from engaging in many everyday childhood activities, such as running and playing sports. In addition, as with surgical interventions, individuals with ID often revert to ITW in less than 3 years post-intervention

(Leyden et al., 2019). Thus, parents and medical professionals should examine ITW treatment relapse, especially for individuals with ID. Unfortunately, results from a healthcare survey (*N* = 908) reported a significant disconnect between medical professionals understanding of common ITW treatments and a treatment consensus (Williams et al., 2020). The paucity of evidence-based interventions imposes additional treatment challenges, and the non-evidence-based treatments need further examination. Recommending non-evidence-based treatments or treatments lacking long-term effects for specific populations (i.e., ID, ASD) can impose tremendous financial burdens on families and the healthcare system (Williams et al., 2020). Perhaps the most effective treatments may include behavioral interventions or a combination of behavioral and medical interventions.

Behavioral Interventions for Toe Walking

Behavioral interventions focus on the manipulation of environmental events to teach appropriate walking and/or increase the motivation for the individual to walk appropriately. Most behavioral interventions for challenging behavior such as ITW are preceded by a functional assessment, as described above. The purpose of the assessment is to determine the reinforcement contingency maintaining the challenging behavior. Social positive reinforcement involves the presentation of a social stimulus (e.g., attention) contingent upon the challenging behavior; this stimulus results in an increase in the occurrence of the behavior in the future. Social negative reinforcement involves the removal of a stimulus (e.g., an unpleasant task or activity) contingent upon the challenging behavior; this stimulus results in an increase in the occurrence of the behavior in the future. In contrast to social reinforcement, automatic reinforcement occurs when a behavior produces its own reinforcement "automatically"; another person is not involved. Automatic positive reinforcement occurs when a behavior produces some type of stimulation and this stimulation results in an increase in the occurrence of the behavior in the future (e.g., when a self-massage, which produces a pleasant condition of the body, is repeated). Automatic negative reinforcement occurs when a behavior alleviates or reduces some type of bodily sensation and this reduction in stimulation results in an increase in the occurrence of the behavior in the future (e.g., when scratching an insect bite alleviates itching, so it is repeated). Most cases of ITW are likely maintained by automatic positive or automatic negative reinforcement, although it is certainly possible that social reinforcement also plays a role in some cases. Walking with a toe-to-toe gait may produce pleasant sensations on the feet or toes, or may enable avoidance of unpleasant sensations produced by heel-to-floor contact.

Although ITW may often be maintained by automatic reinforcement, as described above, few studies have verified this. Future research should conduct functional analyses before intervening to reduce toe walking.

Behavior maintained by automatic reinforcement is among the most difficult to treat, in part because it is difficult to identify the exact source of reinforcement. For example, as described above, toe walking could be maintained by the muscle contractions it produces in the toes, the absence of stimulation on the heel, or both. Even when it is possible to identify the specific source of reinforcement, it is often impossible to manipulate this source of stimulation or stimuli relevant to the source. For example, some cases of toe walking may be maintained by the tactile stimulation the behavior produces. However, manipulating that stimulation may be impossible. Thus, behavior analysts have largely evaluated non-function-based interventions to decrease toe walking. Nevertheless, future research should explore function-based options.

Specifically, behavioral interventions for ITW have included punishment-based procedures (Charlop et al., 1988), differential reinforcement procedures (Marcus et al., 2010), stimulus control procedures (Hodges et al., 2018), and even the manipulation of response effort (Hobbs et al., 1980). Punishment-based procedures have included overcorrection and the application of light pressure to the participant's shoulder so that the feet are flat. Differential reinforcement procedures have been used with and without other procedures. Stimulus control procedures have included the use of a multiple schedule represented by a wristband. The use of heavy boots to increase the effort required to toe walk has also been examined.

Hobbs et al. (1980) were the first to implement a behavioral intervention for ITW. They combined a pair of heavy boots (to increase the weight of each foot and therefore increase toe-to-heel steps) with a differential reinforcement of other behavior (DRO) procedure to decrease ITW by a young child. The researchers conducted their treatment evaluation across two settings (hallways in a school and a playroom) using a combination multiple baseline and withdrawal design. The boots and DRO were each assessed alone and in combination. The results suggest that the combination of the two procedures was more effective than either procedure alone, although even in the combined condition, ITW still occurred during about 40% of intervals. Nevertheless, the researchers told the participant's mother to use the combined interventions. The researchers conducted a follow-up telephone call with the participant's mother over 3 years after the conclusion of the study and noted that the mother reported no toe walking at that time. However, no formal follow-up data were presented. In addition, design flaws prevent firm conclusions regarding the effectiveness of the interventions.

This study is interesting for a number of reasons. First, it was the initial foray into behavior analytic interventions for ITW. Second, the researchers employed a response effort-based intervention (a weighted boot) to decrease toe walking, which appeared to be at least somewhat effective. Finally, the researchers implemented a DRO procedure using food and tokens with the participant, which appeared to be less effective than the weighted boots, but again, concluding anything about the relative effects of the two procedures evaluated in this study is difficult due to design concerns.

A year later, Barrett and Lin (1981) implemented another behavioral intervention to reduce ITW. These researchers evaluated a combined physical therapy procedure with positive practice overcorrection. The physical therapy involved four specific techniques focused on decreasing tendon rigidity and increasing ankle range of motion. These techniques were practiced across all phases of the study, including baseline. The positive practice overcorrection procedure consisted of a verbal warning followed by required toe tapping on cloth footprints for 30 s. During this tapping, the therapist held the participant's heel against the floor. At least 10 taps were required during each 30-s procedure. The therapist physically guided the participant to perform the taps, if necessary. This procedure was implemented contingent upon each instance of ITW and was effective to decrease toe walking to low levels. Moreover, once ITW decreased, the researchers implemented the verbal warning by itself. If the participant ceased toe walking contingent upon the warning, they did not implement the toe tapping procedure. During this phase, levels of ITW remained low. Finally, the researchers also conducted a follow-up phase during which they discontinued both the toe tapping procedure and the verbal warning. ITW maintained at low levels during this follow-up phase.

This study is interesting for a number of reasons. First, it included a physical therapy procedure; unfortunately, the extent to which the physical therapy component was responsible for the treatment effects is unknown. Second, the researchers conducted an impressive follow-up evaluation, and the results were favorable. Finally, although the behavioral intervention was punishment-based (i.e., they referred to it as a positive practice overcorrection procedure), the researchers note that requiring the participant to repeatedly practice touching his toes to the ground while his heel was on the floor may have also contributed to learning the correct movements involved when walking appropriately.

Charlop et al. (1988) compared the effects of varied presentation of three punishers versus presentation of a single punisher to decrease problem behavior exhibited by three children with intellectual disabilities. One of the children, a 6-year-old girl, exhibited ITW. The punishers in the varied punishment condition included a verbal reprimand, overcorrection, and a time-out procedure. The single punisher condition consisted of either a reprimand, overcorrection, or a time-out procedure. The varied presentation of punishers was more effective than any of the single presentation punishers to reduce ITW. Unfortunately, the researchers reported data across dependent variables, so it is difficult to determine the specific effects of the procedures on toe walking. These data suggest that, when a punishment procedure is necessary to reduce ITW, varied presentation of punishers may be more effective than the delivery of only one type of punisher.

Marcus et al. (2010) were the first to use auditory feedback to treat ITW. These researchers attached Gaitspot Auditory Squeakers™ to the heels of participant's shoes. Every flat-footed step produced a squeak. They then paired the squeak sound with edible items so that the squeak became a conditioned reinforcer. Next, the researchers added components of simplified habit reversal (SHR). They then evaluated this multicomponent intervention to decrease ITW exhibited by three children with ASD. The procedure was effective; all participant's ITW decreased to some degree, although the amount of reduction varied. The researchers were even able to fade the squeakers and test for maintenance in the absence of the squeakers. Intervention effects largely maintained even after the squeakers were removed.

Lancioni et al. (2012) provide a technology-based example of an intervention designed to address ITW exhibited by 32-year-old woman with encephalopathy and blindness. The researchers used a microprocessor-based control device connected to an MP3 which was housed in a backpack worn by the participant. Sensors were placed on the two extremities of the participant's shoes to detect shoe-to-ground contact. Contingent upon contact of the heel of the shoe with the ground within 1.5 s, the device played the participant's preferred music for 5 s. The music continued if the next step (from the other shoe) was also appropriate. Contingent upon ITW, all music ceased. The results of the study suggest that the procedure was effective; the percentage of appropriate steps increased to between 80% and 100% when the intervention was in place. In a subsequent study, Lancioni et al. (2013) replicated this procedure.

Although effective, the technology used in these studies was expensive. The researchers estimated that it cost about $1000, which makes it out of reach for many families, agencies, and service providers. The price may decrease in the future, however, and this approach appears promising. The researchers also noted that the settings on the device might be adjusted for other participants. For example, a different schedule of reinforcement (e.g., FR 10) might be programmed during a maintenance phase.

Persicke et al. (2014) evaluated a modified TAGTeach™ procedure plus a correction procedure to decrease toe walking in a 4-year-old boy with ASD. Specifically, the researchers evaluated two conditions: correction alone and correction with an audible conditioned reinforcing stimulus. In the correction alone procedure, the researchers placed their hand on the participant's shoulder and added slight pressure until his heels touched the floor each time he engaged in ITW. In the correction plus audible conditioned stimulus (i.e., TagTeach™) procedure, the researchers used the same hand on shoulder procedure, but produced an auditory clicking sound contingent upon each appropriate step made by the participant. To establish the sound as a reinforcer, the researchers repeatedly paired it with a preferred edible item. The correction alone procedure produced little to no decreases in ITW. However, the correction plus an audible conditioned stimulus (i.e., TagTeach™) produced low levels of toe walking.

After verifying that toe walking persisted in the absence of social consequences, Hodges et al. (2018) evaluated the use of a multiple schedule to decrease ITW. The researchers placed a wristband on the participant's arm which signaled the availability of praise for appropriate walking and reprimands for toe walking. No programmed consequences were delivered in the absence of the wristband. Once ITW decreased to acceptable levels with the wristband on, the researchers systematically increased the number of steps during which the participant wore the wristband. They also evaluated the procedure in the community, in addition to a clinic. Finally, they had the participant's mother implement the procedure. Throughout all conditions and both settings, the procedure effectively reduced ITW to low levels.

Hodges et al. (2019) used a contingent acoustical feedback procedure to reduce ITW exhibited by a young boy with autism. The researchers paired a clicking sound with a preferred item to establish the sound as a conditioned reinforcer. They then used a clicker to deliver acoustical feedback contingent upon appropriate walking. After thinning the schedule of clicker delivery, they conducted generalization probes in another setting. The procedure was effective to reduce ITW and increase appropriate walking.

Jowett et al. (2019) used differential reinforcement of other behavior (DRO), rules, and feedback to decrease ITW exhibited by a 5-year-old girl. Although the participant had no known disability or psychiatric diagnosis, her language skills were well below those of her same age peers. The researchers first presented an instruction to walk with flat feet, which was ineffective. Next, they added a rule, a goal, feedback, and a DRO. The rule specified the contingencies, which involved access to preferred items via a token economy. That is, the participant earned a smiley face on a chart for each interval without ITW. The DRO interval was gradually increased until toe walking did not occur for an entire session. Finally, the researchers had the participant's teacher implement the procedure. The results suggested that the procedure was effective; intervals with toe walking decreased to low levels and remained low during all DRO sessions. ITW during the teacher implemented session was also well below baseline levels, suggesting the procedure can be successfully implemented by others.

Wilder et al. (2020) extended Marcus et al. (2010) by further evaluating the use of Gaitspot Squeakers™. Marcus et al. included additional treatment components (e.g., simplified habit reversal) in their intervention, which may have been unnecessary. In addition, Marcus et al. did not examine if the auditory feedback produced by the squeaker could decrease ITW. Wilder et al. (2020) conducted a pre-treatment screening analysis to identify the function of toe walking, eliminated other intervention components, and evaluated the squeaker-produced auditory feedback itself on toe walking. Three children with ASD and a multi-year history of toe walking participated. The researchers found that the squeaker-produced auditory feedback did decrease toe walking to some degree for all participants. For one participant, the auditory feedback alone produced clinically significant reductions. For the other two participants, the delivery of preferred edible items, which had been paired with the auditory feedback, was necessary to decrease ITW to acceptable levels. Finally, for one participant, the researchers had to add a procedure in which they placed a hand on the participant's shoulder contingent upon a step with toe walking, similar to Persicke et al. (2014). The researchers were also able to thin the schedule of edible item delivery while maintaining treatment effects. Generalization to another setting was also evaluated; ITW remained low across settings.

Future Research on ITW

Future research on medical interventions for ITW should focus on identification of a hierarchy of least intrusive and most effective interventions. For many children, orthoses might be the first line of intervention, followed by serial casting, and, if all else fails, surgery. Future research should also focus on identifying sub-populations of toe walkers for whom surgery and other intrusive interventions are needed immediately.

Future research on behavioral interventions for ITW should also focus on identification of a hierarchy of least intrusive and most effective interventions. In addition, function-based interventions should be evaluated and compared to non-function-based procedures, such as the manipulation of response effort and punishment-based interventions. Finally, stimulus control-based interventions should be refined and the delivery of more immediate and precise feedback should be included as intervention components.

Finally, future research on ITW should combine medical and behavioral interventions. For example, researchers should examine the use of FOs combined with behavioral procedures. In addition, researchers should develop a hierarchy of combined medical and behavioral interventions. Since they are less intrusive, behavioral interventions might be the first class of interventions implemented in a hierarchy. If possible, function-based interventions might be implemented initially. If necessary, stimulus-control-based, DRO, or response effort manipulations might be evaluated next. If ITW is not reduced, medical interventions (orthoses, casting, and surgery) might be appropriate.

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Using Reinforcement to Prevent Challenging Behaviors

63

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Challenging Behavior

What Is Challenging Behavior?

The term challenging behavior (CB) evokes varied imagery dependent on individual perceptions and experiences with behavior. According to Smith and Fox (2003), CB is a persistent behavioral pattern that impedes learning and social opportunities. These behaviors include tantrums, sleep disturbances, aggression, stereotypies, verbal outbursts, withdrawal, destructive behaviors, self-injury, noncompliance, and issues with eating. There are additional influences related to cultural beliefs and potential biases of the observer that factor into the identification of CB in children (Gilliam et al., 2016). CB ranges from mild to severe in nature, and when left untreated can cause long-lasting harm to the individual (Ogundele, 2018).

The prevalence of CB differs greatly across populations and age groups. Bowring et al. (2019) found that as many as one in five adults with intellectual disabilities (ID) receiving services engage in CB. In children with disabilities, ages 3–21, the prevalence ranges from 48% to 94%, with children with autism spectrum disorder (ASD) at the highest rate (Simó-Pinatella et al., 2019). The most commonly reported CB among individuals with disabilities are aggression (Newman et al., 2015), self-injury (Simó-Pinatella et al., 2013), and stereotypy (McTiernan et al., 2011). According to Alimovic (2013), the prevalence of CB among individuals with development disabilities (DD) is three to seven times higher than that of their typically developing peers. There has been a significant amount of research evaluating methods to address CB among various populations, including those diagnosed with intellectual and developmental disabilities.

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Treatment of Challenging Behavior

Functional behavior assessment (FBA) is an array of evidence-based methods used to identify the environmental contingencies that are functionally related to CB. The reinforcer that the CB produces is commonly referred to as the function of the CB. Traditionally, there are four families or types of functions: attention, escape, tangible, and automatic, or sensory stimulation (Iwata et al., 1994a).

FBAs can consist of both direct and indirect methods of assessment. Indirect methods may include interviews with the individual of interest or with stakeholders who regularly interact with

J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_63

the individual of interest. Direct methods include direct observation, descriptive analyses (such as correlational assessments), as well as experimental manipulation of reinforcement contingencies (i.e., functional analysis). A survey of practicing behavior analysts indicated that a majority of respondents primarily used interviews with stakeholders and descriptive analyses to identify the function of CB (Oliver et al., 2015).

Prevention of Challenging Behavior

The majority of CB interventions in the literature are reactive approaches (Fahmie et al., 2018). That is, the intervention is introduced following the development of clinically significant and severe levels of CB. Although effective in reducing CB, these intervention approaches can be resource intensive. For example, research has shown that the financial cost of caring for an individual with ID with comorbid CB is estimated to be $3 billion annually (Waddell et al., 2018). Moreover, there are several practical constraints in implementing a functional analysis methodology (Hanley, 2012; Iwata & Dozier, 2008). Implementing a functional analysis requires considerable time and expertise. Research has shown that a traditional functional analysis can take up to 3–4 days to implement, making it impractical to implement in most outpatient or educational settings (Iwata et al., 1994b; Tincani et al., 1999). These findings highlight the importance of identifying preventive or proactive strategies to decrease the likelihood of CB emerging in the first place.

Some ways to prevent severe CB are (a) reinforcing appropriate responses noncontingently, (b) placing less severe CB on extinction, and (c) teaching an appropriate response in situations that evoke the severe CB (Fahmie et al., 2016). Hanley et al. (2007) implemented some of these preventive strategies with typically developing preschoolers, who were at risk for developing severe CB due to the time spent in nonmaternal care. Appropriate social behavior (referred to as preschool life skills [PLS]), such as responding to name, tolerating a delay in reinforcement, and friendship skills (e.g., saying, "thank you"), were taught using a classwide approach, independent of the presence of CB.

Similarly, Luczynski and Hanley (2013) evaluated the acquisition and maintenance of self-control and functional communication skills in preschool children, who warranted more intensive CB and self-control interventions than their peers. However, instead of a classwide approach to teaching PLS as was used by Hanley et al. (2007), the authors implemented a small-group PLS program (Luczynski & Hanley, 2013). The authors also included a control group of participants who did not receive the PLS intervention. The study results demonstrated that all participants who received the PLS intervention successfully engaged in the target skills. Five of six participants continued to engage in the target skill during maintenance. Moreover, CB worsened for all participants who did not receive the small-group PLS intervention.

To further this research line, Fahmie et al. (2016) conducted a two-part study with an adult with developmental disabilities. As per the teacher report, the participant engaged in a minor but emerging CB when the teacher restricted access to tangible items. The purpose of Study 1 was to implement sensitivity tests, and the purpose of Study 2 was the evaluate the efficacy of a prevention strategy. The sensitivity tests, a variation in the trial-based functional analysis, were conducted to identify the establishing operations (EOs) that may create the occasion for the emergence of CB. During the control trials, the implementer provided noncontingent access to tangible items. During the test trials, the implementer conducted five test conditions, which might evoke CB maintained by access to tangible items (e.g., removed access condition). If the participant engaged in an appropriate response or severe CB (e.g., aggression or self-injury) during the test trials, the implementer removed the potential EO by delivering the tangible items. If the participant engaged in minor CB (e.g., body rocking), the implementer placed the CB on extinction. The sensitivity test results demonstrated that the participant engaged in only minor CB and no appropriate requests during test trials. These results allowed the researchers to analyze the preventive effects of the intervention in Study 2. In this study, the participant was taught a functional communication response (i.e., card exchange) in the presence of the EO. Subsequently, the implementer taught the participant to tolerate delayed reinforcement by waiting to access tangible items following appropriate communication. Finally, the implementer also taught the participant to tolerate denied reinforcement, in which the participant was told "no" following appropriate communication.

Although a research-based prevention model to address CB is relatively new compared to more prevalent reactive approaches, there are several evidence-based reinforcement strategies that have been shown to be effective in a variety of settings that could potentially reduce the likelihood of CB occurring. The remainder of the chapter will focus on strategies that can be used as preventative strategies for CB.

Reinforcement Strategies to Prevent Challenging Behavior

Differential Reinforcement

Differential reinforcement (DR) is a schedule arrangement in which reinforcement is provided for a specific response (or class of responses) and withheld when other responses are emitted. DR can be applied to various dimensions of a behavior including the frequency or rate of a behavior, the inter-response time (IRT) (i.e., the time that passes between two instances of a response), and the magnitude, or intensity of a response. Reinforcement can also be delivered noncontingently. One variation of DR that is not discussed here is differential reinforcement of other behaviors, which is discussed in another chapter.

Differential Reinforcement of Alternative Behaviors

Differential reinforcement of alternative behaviors (DRA) is a procedure in which interventions minimize or withhold reinforcement for undesirable behaviors and provide greater reinforcement for desirable behaviors relative to that offered for undesirable behaviors (Vollmer et al., 2020). Conceptually, DRA is a concurrent-operants schedule, where two independent reinforcement schedules are simultaneously in place for two different responses (Kunnavatana et al., 2018).

DRA can be considered a proactive strategy for addressing CB because its manipulation of reinforcement should alter future frequencies of CB. Further, developing the strength of the alternative response increases the future frequency of that alternative, socially valid response in the natural environment, where it can be met with reinforcement. In DRA intervention sessions, the establishing operation for the CB is in place. By manipulating reinforcement contingencies after the establishing operation is introduced, DRA theoretically increases the future frequency of alternative, more desirable behaviors in the environmental arrangements that tend to evoke CB and decreases the future frequency of CB.

DRA has been shown to be effective in decreasing a variety of undesirable behaviors in a wide variety of populations (MacNaul & Neely, 2018; Petscher et al., 2009). Although most commonly used for individuals with developmental disabilities (including ASD), DRA has also been successfully used for individuals with other disorders, such as schizophrenia, cerebral palsy, and feeding disorders, as well with those with typical development. DRA has been used to successfully reduce CB such as aggression (Athens & Vollmer, 2010), pica (Hagopian et al., 2011), property destruction (Durand & Carr, 1992), disruptive behavior (LeGray et al., 2013), elopement (Davis et al., 2012), food rejection/packing (Piazza et al., 2003), self-injury (Worsdell et al., 2000), inappropriate vocalizations (Kunnavatana et al., 2018), inappropriate sexual behavior (Fyffe et al., 2004), and tantrums (Carr & Durand, 1985). DRA has also been used to increase other desirable behaviors, such as appropriate vocalizations (LeGray et al., 2013), task completion and/or compliance (Athens & Vollmer, 2010), and food acceptance (Piazza et al., 2003).

When implementing DRA, practitioners should carefully consider what an appropriate alternative behavior might be. The behavior should be functionally equivalent to the CB targeted for reduction. While traditional thinking suggests the alternative behavior should be in the child's repertoire or should be easy to quickly prompt, pre-teaching the alternative behavior may improve therapeutic outcomes (LeGray et al., 2013). For learners who can understand verbal instructions, describing the behavioral contingencies can support learning (Schlichenmeyer et al., 2015).

Differential Reinforcement of Incompatible Behavior

One slight variation of the DRA procedure is differential reinforcement of incompatible behaviors (DRI). Procedurally, DRI is identical to DRA. The distinction is that the replacement behavior selected when implementing a DRI schedule is incompatible with, or cannot occur at the same time as, a target CB. To select an incompatible behavior, you must ensure that the replacement behavior cannot occur simultaneously with the target CB. Research evaluating the effects of DRI procedures oftentimes categorize the independent variable as a DRA procedure with the distinction that the alternative replacement behavior is also incompatible with the target CB (Schlichenmeyer et al., 2015). DRI has been shown to be effective to address pica and maladaptive behaviors displayed by adults with ID (Donnelly & Olczak, 1990; Datlow-Smith, 1987; Spira et al., 2004), idiopathic toe-walking and elopement in individuals diagnosed with ASD (Marcus et al., 2010), and appropriate mealtime behaviors in an elementary school lunchroom (Wheatley et al., 2009). DRI can be beneficial as it provides a competing schedule of reinforcement between a desired and undesirable behavior given that the two behaviors cannot occur at the same time.

Differential Reinforcement of Low or High Rates of Behaviors

One element of the behavior that a practitioner might want to alter using DR procedures is the rate or frequency of the behavior. Differential reinforcement of low rates of responding (DRL) and differential reinforcement of high rates of responding (DRH) are two DR procedures that might be selected when you are interested in changing the rate at which behavior occurs.

Select a DRL procedure when you are interested in reinforcing a lower rate of the target behavior compared to baseline rates, but it is not necessary for the behavior to stop occurring altogether. In addition to reducing the rate or frequency of a response you can also use DRL to decrease the intensity or magnitude of a response (Schmidt & Ulrich, 1969; Wilson & Hopkins, 1973).

On a DRL schedule, reinforcement is delivered if a predetermined number of responses is not exceeded within a set period of time, or when a minimum amount of time has passed between one instance of a response and the next response. Deitz (1977) described three distinct methods of programming DRL schedules: (a) spaced-responding DRL, (b) full-session DRL, and (c) interval DRL. In spaced-responding DRL, reinforcement follows a response when a predetermined inter-response time is met. In other words, a response is only reinforced if a minimum amount of time has passed between the current response and the previous response. A full-session DRL requires that the number of responses are at or below a pre-determined criterion in order for reinforcement to occur across an entire session of time. Essentially, the learner earns reinforcement when they do not exceed the maximum number of responses allowed across the entire period.

An interval DRL schedule requires a certain response rate to be met within a pre-determined interval; if the response rate is exceeded within the interval, the interval is reset, and reinforcement is delayed. This might sound similar to a full-session DRL; however, the intervals used in this schedule require that the entire session is divided into a series of equal intervals of time. Consider a 2-h treatment session; for full-session DRL, the practitioner would record whether a certain number of responses was met (and not exceeded) across the entire 2-h period. Using an interval DRL, the same 2-h period might be divided into eight, 15-min intervals and a certain response requirement must be met (and not exceeded) in each interval.

To select the initial interval prior to implementing a DRL procedure, it is recommended that practitioners review baseline response rates. To determine the inter-response time (IRT) for space responding DRL, the practitioner should determine how often the target response occurs within a set period of time in baseline. For example, if a behavior occurs, on average, six times within a 30-min interval, an IRT of 5 min between responses would be appropriate. In other words, reinforcement would only be delivered if 5 min elapsed between one instance of the target response and the next response. Similarly, the average response rate within a set period of time can be used to determine the interval for an interval DRL procedure. For the behavior that occurs six times per 30-min interval, a response requirement of no more than one response per 5-min interval would be appropriate.

When using full-session DRL, the practitioner should identify the average number of responses emitted within a time period and set the response requirement slightly lower than that number. For example, if a student were to engage in 15 instances of talking out per hour for teaching attention, you would want to set the criterion for reinforcement at 15 responses per hour or lower.

Using baseline data to select the target response rate, IRT, or interval will help to ensure that the learner is capable of meeting the target rate of responding is more likely to access reinforcement for doing so. DRL has been used to reduce the frequency of question-asking and inappropriate social behaviors by adults with ID (Otalvaro et al., 2020; Singh et al., 1981), children's requests for teach attention (Austin & Bevan, 2011; Becraft et al., 2017), the rate of off-task or disruptive behavior in a classroom (Deitz & Repp, 1973, 1974), as well as to increase pro-social behaviors related to employment during transition to adulthood for individuals with ASD (Taylor & Seltzer, 2011).

A variation of the DRL schedule is DRH. This schedule can be used when you are interested in increasing the rate at which a target behavior occurs. Girolami et al. (2009) used a DRH procedure to increase the pace of self-feeding in a 9-year-old boy who was gastrostomy tube dependent. Not only did the DRH procedure increase the number of bites consumed during mealtime, but the average duration of each meal decreased during treatment from 35.5 min on average in baseline to 25.3 min on average in treatment. DRH can be an effective strategy to employ when you are interested in increasing the rate of a target behavior.

Some questions that have been presented in the literature regarding the effects of DRL/DRH schedules include whether the schedule affects non-targeted behaviors during the intervention. For example, Otalvaro et al. (2020) observed a decrease in the number of questions asked by adults with intellectual and developmental disabilities at an adult day treatment workplace when a full-session DRL was implemented. They also measured the duration of task engagement to determine whether a reduction in the number of questions asked by participants resulted in an increase in the duration of task engagement. Their findings were difficult to translate directly into an increase of work productivity and the authors suggested that future researchers might measure the rate or number of tasks completed rather than duration of task engagement to evaluate the effects more clearly.

Additionally, it is not clear how a DRL/DRH procedure affects the target behavior in non-intervention environments. When utilizing interval-based schedules of reinforcement, the length of the interval could decrease the effects of the intervention if a delay to reinforcement is an issue. In such cases, it is important to examine whether an intervention is successful using a shorter interval or appropriate schedule thinning procedures are used.

Given the nature and expected outcomes of a DRL schedule, this procedure should not be used to target self-injurious or dangerous behaviors. Additionally, DRL should not be used when you are interested in rapid behavior reduction. When it might be appropriate for the target behavior to be reduced to zero, you could select a full-session or interval DRL, as reinforcement can be delivered even if there are no instances of the behavior.

However, when it is important that the behavior remain in the learner's repertoire to some extent, it might be more appropriate to select a spaced-responding DRL, as reinforcement is delivered following an occurrence of the behavior.

Noncontingent Reinforcement

Noncontingent reinforcement (NCR) is an empirically supported treatment that has been used to increase a large number of appropriate, pro-social behaviors while simultaneously preventing the occurrence of CB (Richman et al., 2015). Vollmer et al. (1993, p. 10) described NCR as a "response-independent or time-based delivery of stimuli with known reinforcing properties." NCR consists of the delivery of reinforcement on a fixed interval or fixed time schedule of reinforcement. In other words, to implement NCR, a practitioner should provide learners access to stimuli that have known reinforcing properties on a fixed time schedule, noncontingent on the occurrence of target behavior. There are three primary assumptions as to why NCR is effective in changing behavior. The first assumption is that NCR results in a manipulation of the establishing operation of the target behavior (Vollmer et al., 1993). Rescorla and Skucy (1969) discuss the possibility that it could be a result of a disruption of the response-reinforcer relation or extinction. Finally, NCR may result in behavior changes because reinforcement occurs following responses other than CBs (Carr, 1996).

There are some characteristics of NCR that should be considered prior to implementing an NCR schedule. First, you must consider the interval by which you will deliver reinforcement. NCR has been implemented using many variations of basic schedules of reinforcement (i.e., fixed time, variable time), with or without schedule thinning, and with or without extinction (Carr et al., 2009). Second, you must consider the reinforcer presented. Richman et al. (2015) coined procedures that included functional reinforcers as NCR whereas procedures that included nonfunctional reinforcers as NCN. Although there was a small difference between outcomes when using functional and nonfunctional reinforcers, the results of the metanalysis conducted by Richman et al. (2015) do suggest functional reinforcers (or utilizing the maintaining variables for CB) are preferable over nonfunctional reinforcers.

Considerations of Differential Reinforcement Procedures

With Extinction For practitioners who determine that quick elimination of a dangerous behavior is needed, a DR procedure with extinction may be the most prudent choice (MacNaul & Neely, 2018; Petscher et al., 2009). Indeed, Petscher et al. (2009) noted several instances of learners who did not demonstrate acceptable levels of CB until a DRA with extinction procedure was introduced.

An additional consideration when choosing to use extinction is if the behavior can be safely placed on extinction. For example, behaviors that are attention-maintained, but result in serious injury to the learner or others, may not be placed on extinction. Additionally, in some environments, such as schools, extinction of CB may not be permissible, or even achievable (e.g., behavior that is maintained by peer attention).

A second consideration is the degree to which resources afford near-perfect procedural fidelity, as extinction by definition requires zero rates of reinforcement. Errors of commission (accidentally reinforcing CB) have been shown to be counter-therapeutic (Pipkin et al., 2010; Vollmer et al., 2020). In a study explicitly manipulating treatment integrity errors in DRA with extinction procedures, Pipkin et al. (2010) documented decreased rates of alternative behaviors and increased rates of CB when errors of commission were committed.

Without Extinction Practitioners might consider implementing a DR procedure without extinction for several reasons. First, certain settings and behaviors do not allow for extinction to be used. Legal constraints, safety of peers and adults in the environment, or size of the client relative to the size of the therapist all are variables that may prohibit extinction from being achievable (Vollmer et al., 2020). Additionally, behaviors that are dangerous to the learner or others and are attention-maintained may not be blocked without providing reinforcement (i.e., attention; Vollmer et al., 2020). In these instances, DRA without extinction is an acceptable alternative.

Interventionist factors also might make DRA without extinction most practical. If the therapist is physically weaker than a learner, response blocking may not be possible (Vollmer et al., 2020). Further, if the interventionist is an indigenous implementer, such as a parent or teacher, it may not be reasonable to expect them to perform with complete procedural fidelity. DRA without extinction may not be as sensitive to the counter-therapeutic effects of errors of commission in a DRA with extinction intervention. This is an additional way DRA without extinction may serve as a preventative measure for future CB.

Finally, practitioners who wish to use DR without extinction should consider if reinforcement can be consistently manipulated in some dimension, and if the learner is sensitive to changes in reinforcement along that dimension. Because sensitivity to manipulations of reinforcement dimension varies across learners, practitioners should consider testing learner sensitivities to those dimensions first (Kunnavatana et al., 2018). Further, practitioners should carefully document the variation in the selected reinforcement dimension and monitor the procedural fidelity of how those manipulations are delivered.

The most common dimensions of reinforcement that can be easily manipulated are quality, magnitude, and immediacy. When manipulating quality, practitioners can offer a highly preferred reinforcer for the alternative behavior and a lower-preferred reinforcer for the CB. For example, Kunnavatana et al. (2018) provided access to a highly preferred item after mands but provided access to a low preferred item in response to CB. Magnitude (in other words, intensity or duration) of reinforcement may be altered across the two schedule components. For example, Kunnavatana et al. (2018) offered 90 s of access to a preferred tangible contingent on undesirable behavior, and 15 s of access to the same tangible contingent on desired behavior. Immediacy of the delivery of reinforcement may also be altered such that the delivery of the reinforcer for the desirable behavior is more immediate than it is for the CB. For example, Horner and Day (1991) provided immediate escape contingent on alternative behaviors and delayed access to escape contingent on CB for an individual with escape-maintained self-injurious behavior and aggression.

Schedule Thinning An additional consideration when implementing a DR procedure is the gradual thinning of the schedule of reinforcement for the desired behavior. Reinforcement is often not delivered as consistently or immediately in the natural environment as it is in a tightly controlled intervention environment (Drifke et al., 2020) and it may not be reasonable to reinforce requests for desired stimuli on a FR1 schedule. Thus, in order to prevent future re-emergence of CB when these delays occur, schedule thinning should be included in a DR intervention plan.

Schedule thinning may be introduced once the target CB has been decreased to acceptable levels and an alternative response has been acquired under the original, denser reinforcement schedule for the appropriate response. Then, learners are taught to tolerate a delay between the appropriate response and delivery of reinforcement. "Tolerance" can be most simply defined as the absence of CB. The number of tasks required for completion before reinforcement is delivered can then be gradually increased, thus also gradually increasing the delay to reinforcement. Teaching learners to engage in an alternative response during delays to reinforcement has been shown to produce more desirable treatment outcomes (i.e., low levels of CB and repeated mands for reinforcement during delays, but maintained levels of mands when appropriate) than simply teaching learners to wait during the delay (Drifke et al., 2020).

Reinforcement-Based Intervention Packages

The following intervention packages are based on the assumption that all behaviors are responding to the environment in which it occurs. As such, by providing reinforcement for appropriate and desirable behaviors, the requirement to engage in CB to access reinforcement is minimized.

Functional Communication Training

In a review of the research on DRA, Petscher et al. (2009) found that 70% of the included studies used procedures that could be categorized as Functional Communication Training (FCT) interventions. FCT is a function-based DRA behavior intervention in which a CB is replaced with an appropriate verbal response. For example, individuals who engage in severe aggression reinforced by access to attention might be trained to say the phrase “play with me please” as a replacement. This intervention reduces CB by providing a socially acceptable replacement behavior (verbal response) that is reinforced instead of the CB. FCT was first codified by Carr and Durand (1985), who drew from prior research that suggested that CB occur when reinforced by attention or escape from difficult tasks. By training an appropriate verbal replacement response (i.e., a functional communication response, or FCR), CB is reduced. As FCT provides a more appropriate, functionally equivalent behavior to the CB, effective FCT requires that the verbal response functionally replaces the target response. Therefore, to implement FCT, it is essential to first determine the function of behavior (Durand & Moskowitz, 2015). Once the function of the target behavior is identified, a verbal replacement behavior can be identified. When selecting an appropriate verbal behavior, it is important to ensure that the verbal behavior is appropriate for the individual. Therefore, if the client is verbal and capable of speech, it is possible to select a socially valid mand (e.g.., “I would like to play, please”). However, if the client is nonverbal, minimally verbal, or otherwise presents with a verbal deficit such as a stutter or speech impediment, it is important to select an alternative response that is appropriate for the client’s verbal repertoire. Some alternatives to lengthy mands include brief mands of one or two words (e.g., “play please”), or a visual communication system such as picture exchange or communication board. The verbal response selected must be at strength within the participant’s repertoire as the greater the difficulty of response, the more likely the client is to default to the initial CB. Repeated pairings between the verbal response and access to the functional reinforcer serve to reduce CB by providing alternative access to reinforcement. This is most effective if extinction between the CB and reinforcement is implemented, allowing access to the reinforcer only contingent on the FCR.

FCT has wide ranging use and is appropriate for most clients at different ages and functioning levels. FCT should always be considered when the target CB is clearly functionally related to a specific reinforcer or reinforcement class, or even when a behavior might be multiply maintained (Falcomata et al., 2013). FCT is not appropriate to use in situations where clients are unable to independently emit a verbal response of any kind (including picture exchange systems). FCT is also not appropriate in the treatment of behavior that is automatically maintained, as these responses cannot be functionally replaced by an FCR (Gerow et al., 2018). FCRs should be selected with an eye towards social acceptability, as well as feasibility. Training an FCR that will be acceptable in a wide variety of situations (e.g., “help me please”) will allow the response to contact reinforcement under a wide variety of potential conditions, as well as receiving reinforcement from novel populations without the need for training. Further, choosing a socially valid FCR provides the learner access to the verbal community, where the response will likely be reinforced regardless of context. However, overly general FCRs (such as the above example, “help me please”) do not functionally replace behavior, and thus might not serve to replace behavior in all instances. Consider that a behavior such as aggression maintained by access to a tangible object (striking another child in order to access a favorite toy) is not functionally equivalent to asking the child, or a teacher, for access to that same toy. In this example, the likely outcome of the FCR is not access to the tangible item, but rather attention from the peer or teacher. Access to the tangible is thus necessarily more delayed (and potentially denied) as it requires mediation by a third party. In cases where the behavior is maintained by a consequence other than attention, the use of an FCR such as "help me please" provides reinforcement for that behavior only incidentally, and at far less consistency than an FR1. Thus, when access to the functional reinforcer after the FCR is unreliable, resurgence of CB is likely to occur.

Considerations When Implementing FCT

Establishing Operations Prior research in FCT implementation suggests that the presence of the establishing operation (EO) during training can have a large effect on the occurrence of CB. DeRosa et al. (2015) and later Fischer et al. (2018) demonstrated that longer periods of exposure to the EO resulted in greater rates of CB. Their research suggested that restricting the presence of the EO during FCT can reduce overall CB. Thus, if rates of CB are a concern, they recommend restricting the presence of the EO when conducting FCT.

One concern in regard to EOs and FCT, however, is that the presence of an EO is necessary for FCT to be possible. FCRs will only occur when they provide access to functional reinforcers, and thus require the presence of deprivation in order to be valuable. Shillingsburg et al. (2013) demonstrated that FCRs only occurred when an EO (in this case, physical blocking of access to a reinforcer) was present. Without the presence of the EO, no FCRs occurred. In addition, McGill (1999) noted that FCRs are not functionally related to the EO. They modify only the response that occurs in the presence of the EO, but do not change the EO itself. Manding for "help," for example, does not provide access to the functional reinforcer, it merely provides the opportunity for another person to provide the reinforcer.

Resurgence and Schedule Thinning One special concern for implementation of FCT is resurgence of CB. When implementing FCT, a sudden decrease in CB occurs as the FCR comes to provide alternative access to the functional reinforcer. However, resurgence of CB will always occur as CB retains its strength due to prior history of reinforcement. Resurgence is least likely to occur when FCT provides access to the functional reinforcer on an FR1 schedule. However, for long-term maintenance of behavior, it is not feasible to provide certain consequences at such a dense schedule of reinforcement. For example, an individual reinforced by escape from work tasks might have a functional replacement behavior for aggression in the FCR "I need a break please." While implementation of this FCR will likely reduce CB and serve as an appropriate functional replacement, such a dense schedule of escape from work tasks is not appropriate in school or work settings as it disrupts the individual's ability to engage in necessary activity.

Therefore, it is essential to train schedule thinning in order to allow for the FCR to retain strength even when it is reinforced at a less dense schedule of reinforcement (Durand & Moskowitz, 2015). However, this leads to fairly obvious problems. As parents, teachers, and other non-behavior analyst individuals are ultimately responsible for delivering consequences after clinical intervention concludes, the FCR is likely to be overtaken by CB in cases where it provides faster or more reliable access to reinforcement. Thus, it is necessary to effectively train for tolerance of delays and/or denial of reinforcement in response to the delivery of an FCR.

Prior research has been conducted on methods that increase the speed of schedule thinning and reduce the occurrence of CBs during the transition from dense, FR1 schedules of reinforcement to schedules that include delays and/or denial of reinforcement in response to FCR (Austin & Tiger, 2015; Falcomata et al., 2013; Hagopian et al., 2005). In general, schedule thinning resulted in an overall reduction of CB during the extinction condition, as well as increased responding. These may be considered when concerns arise that CB will prevent effective schedule thinning.

Positive Behavior Supports

Positive Behavior Supports (PBS) is a widely used, evidence-based technology that is conceptually and scientifically grounded in applied behavior analysis, with additional contributions from developmental and social psychology (Sailor et al., 2008). The key features of PBS include FBA (Dunlap et al., 1991), the rearrangement of environmental variables to prevent CB (Carr & Sidener, 2002), focus on teaching functionally equivalent replacement behaviors (Carr & Durand, 1985), and providing appropriate consequences for both desirable and undesirable behaviors (Koegel et al., 1996). PBS aims to improve the quality of life of recipients by addressing academic and social-emotional challenges of individuals and systems through thoughtful arrangement of the environment and the addition of other variables, such as reinforcement to increase appropriate behavior, coupled with the removal of environmental factors that promote CB (Carr & Sidener, 2002). Data collection is a defining element of PBS, and the importance of tracking both treatment fidelity and individual outcomes is emphasized (Horner & Sugai, 2015).

Positive behavioral interventions and supports (PBIS) is the most widely recognized application of PBS. PBIS was adopted by schools to improve student behavioral and academic outcomes, and school culture, by reducing or eliminating the use of often ineffective punitive practices (Horner & Sugai, 2015). PBIS is federally mandated for use with individuals with disabilities according the Individuals with Disabilities Act (IDEA), with specific emphasis on function-based assessment and intervention, and the use of positive approaches to behavior management (IDEA, 2004).

PBIS offers an alternative to reactive, punitive practices that were historically implemented in schools and other social systems. It requires a commitment to systems change and encourages scaling-up evidence-based behavioral interventions (Tincani, 2007). The interventions take place in the natural environment and are designed to produce long-lasting behavior change (Sugai & Horner, 2008). PBIS is a proactive approach that uses a tiered framework, as symbolized by Fig. 63.1, which was originally derived from the field of public health (Sugai et al., 2000).

Teams are established in order to develop specific plans for tiered supports, track and review data, and make decisions regarding effectiveness of intervention. These teams have varying focus dependent on the level of support provided to the individual. At the tier 1 level, teams meet regularly for planning and tracking effectiveness of the program. They monitor system-wide data to ensure that individual access to supports is equitable, strive to build foundational relationships with families, and attempt to gain cultural knowledge for individually relevant supports (Horner & Sugai, 2015). At tier 2, the teams increase training and professional development opportunities for staff, improve communication efforts with families, and continue to gather and analyze student data. Teams at the tertiary level are developed to conduct assessments, design intervention, more closely monitor student outcomes, and provide training and feedback to interventionists (Horner et al., 2010a).

Tier 1 is focused on universal prevention of CB. Creating supports at this level involves establishing behavioral expectations, providing operational definitions of behaviors and intervention procedure components, specifically training skills using modeling and feedback, delivering reinforcement contingent on the engagement of appropriate behaviors, utilizing interruption and redirection contingent upon the occurrence of CB, and systematic data collection to inform decision making (Horner et al., 2010b, 2014; Sugai & Horner, 2002). Tier 1 supports are designed for all members of the population, therefore, these components are embedded naturally into the environment and become part of the daily routine. The types of supports presented in Tier 1 include offering choice, providing prompts, the good behavior game (Barrish et al., 1969), utilizing visuals, social skills instruction, frequent contact with families, differentiation of

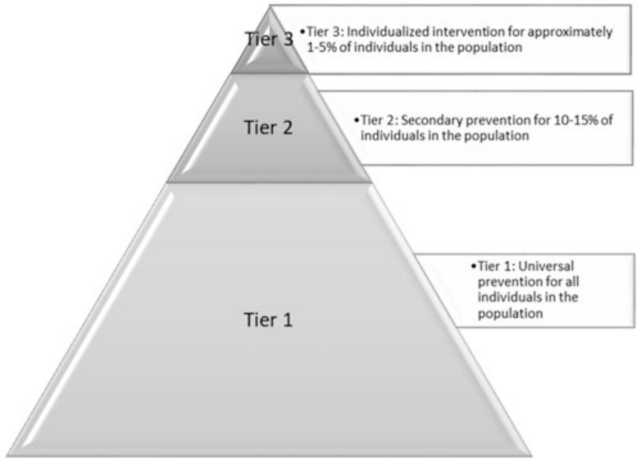

Fig. 63.1 PBIS tiered prevention model

instruction based on interest and readiness, flexible seating, and goal setting.

Approximately 10–15% of individuals do not respond to Tier 1 supports and require Tier 2 intervention. Tier 2 supports are supplemental to those of tier 1 and seek to prevent the need for more intensive intervention. Tier 2 interventions are often planned in advance and ready to be utilized quickly upon recognition of need, making them efficient and minimally time restrictive for interventionists. They are implemented in similar fashion across students, or in small groups where individuals have related behavioral, social-emotional, or academic needs. Supports at this level can include parent training, conflict resolution training, social-emotional skill groups, mentoring programs, check in check out (CICO; e.g. Todd et al., 2008), time management training, mentoring programs, self-regulation training (Horner et al., 2014), organization and study management training, visual supports, task analyses, self-monitoring, small group instruction, individual or group counseling, increased opportunities for access to reinforcement, and multicomponent intervention programs (Sugai & Horner, 2008).

Tertiary supports are reserved for the approximately 1–5% of individuals who do not respond to tier 1 and 2 supports, and whose behavior necessitates intensive, individualized intervention. Individualized support teams are developed to conduct FBAs, develop function-based behavior intervention plans (BIP), closely monitor fidelity and outcome data, make changes to interventions when data indicate, and evaluate for potential individualized education programs (IEP).

Since its inception PBS has evolved from a practice for specific use with individuals with disabilities (Carr & Durand, 1985), to a well-established system that has many applications. The technology has documented success in K-12 schools (Horner & Sugai, 2015), early intervention programs (Fox et al., 2003), Head Start and other early childhood programs (Voohrees et al., 2013), juvenile facilities (Kumm et al., 2020), and foster care systems (Crosland et al., 2008).

Considerations of PBS

While PBS has a history of well-documented success, there are several areas that still need to be explored. Future research could look toward the long-term impact of PBIS on youth outcomes in secure juvenile facilities and developing more honed tools for measurement (Kumm et al., 2020). In child welfare, more research is needed on the use of behavioral intervention across all child welfare services, the application of Behavior Analysis Service Program (BASP) type programs outside of the state of Florida, and in the area of prevention of abuse and neglect, as suggested by Stoutimore (2008).

Summary

The reinforcement strategies and treatment packages just discussed can contribute to a prevention-focused model of CB. Establishing an environment where desirable behaviors are intentionally reinforced, potential risk factors for CB are monitored via continuous data collection, and specialized interventions are implemented to address these behaviors before they become significant can contribute to more effective outcomes for learners in all environments.

DR and NCR procedures have been well-documented as effective strategies for increasing appropriate alternatives to CB in a variety of populations. In order to achieve the most desirable therapeutic outcomes, characteristics of the setting, implementer, and behavior should be considered to determine which specific reinforcement strategy would be most appropriate. DRL or DRH schedules can be selected when the frequency, duration, or magnitude of a behavior should be changed, but not necessarily completely eliminated. While FCT is extremely effective at reducing CB and has a great degree of acceptability within participating populations, the strength of FCT relies on its ability to be implemented universally in novel contexts. This relies on FCRs being effectively reinforced and maintained in generalized settings. Doing so will help the individual learner be more resistant to delay and disruption in reinforcement, as reinforcement of FCRs might be delayed or ignored during normal daily activities.

Interventions based on reinforcement succeed best when reinforcement for the preferred alternative is availably continuously. However, when reinforcement is inevitably withheld (intentionally or otherwise), problem behavior will almost certainly resurge. Just as no plan survives contact with the enemy, no reinforcement-based intervention survives exposure to real-world environments that often prefer extinction and punishment-based alternatives to behavior control. Programming for failure becomes necessary if interventions are ever to maintain outside of carefully controlled laboratory settings. Interventions that seek to utilize these methods should plan for schedule thinning, as well as programming resistance to extinction and punishment of target behaviors.

From its emergence almost four decades ago, PBS has grown and evolved into a comprehensive approach for addressing social-emotional and behavioral needs across a number of disciplines. PBS promotes a positive and safe environment where individuals are encouraged to meet their full potential. With its broad growth and expansion over time, it is reasonable to assume that the application of PBS will be extended even further to reach new individuals in areas that do not yet have access to this powerful technology.

Reinforcement-based strategies and interventions packages for problem behavior work by providing alternative ways of obtaining reinforcement. When approaching treatment of a CB, it is important to remember the axiom that learners naturally respond to the contingencies of their environment. To approach the treatment of problem behavior from a purely reinforcement-based experience is to acknowledge that the environment has selected for such behaviors. Consequentially, it is important to re-arrange the environment to promote a more desirable repertiore.

Creating an environment that uses supportive structures to promote desired behaviors often requires helping parents, teachers, and staff rethink and reprogram their environments. Interventions such as PBS strive to help create a more enriching environment in which to support reinforcement-based strategies of behavior modification. However, interventions such as DR, and especially FCT, help our clients to bridge this gap by providing novel skills that allow for access to reinforcement in their environments. Giving our clients access to appropriate replacement behaviors and/or access to the verbal community sets them up for success in environments that previously shaped and maintained CBs. Thus, the best outcomes stem from being able to both create an environment that supports the kinds of behaviors we want to see, and to promote behaviors in our clients that provide access to better outcomes.

Currently, the majority of CB treatments are initiated following the occurrence of severe levels of CB. However, there is a growing body of research on preventive treatment strategies. These research studies have implemented effective strategies that have prevented the emergence of CB or have prevented its development into severe topographies, such as aggression and self-injury (e.g., Fahmie et al., 2016; Hanley et al., 2007; Luczynski & Hanley, 2013). These strategies include: (a) teaching appropriate skills in situations CB is most likely to occur; (b) providing reinforcement for appropriate skills noncontingently, and (c) placing less severe topographies of CB on extinction. Although still in its early stages, the existing literature provides a promising start to this line of research.

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Part X

Special Populations

Autism

64

Ana Luiza Roncati and Andresa A. De Souza

Autism spectrum disorder (ASD) is a developmental disorder characterized by (a) deficits in social communication skills and social interactions across different contexts; and (b) restricted interest and repetitive behaviors (DSM-5, 2013). According to the Center for Disease Control (CDC, 2020), 1 in every 54 children in the United States of America has an ASD diagnosis. Furthermore, data show that ASD affects four times more boys than girls.

The term *autism* was used for the first time in the literature by Eugene Bleuler in 1911 (Evans, 2013). Bleuler employed the term to refer to some characteristics commonly observed in individuals diagnosed with schizophrenia such as loss of connection with reality and impaired communication (Stotz-Ingenlath, 2000). Later, Leo Kanner (1943) used the word when referring to 11 children with behavior manifestation, differentiating their condition from that of individuals with a diagnosis of schizophrenia. These children described by Kanner were socially isolated from others and presented repetitive behaviors and speech. One year later, Hans Asperger (1944/1991) also used the term autism in his descriptive study involving children with similar characteristics as those identified by Kanner.

Although references to autism were observed early in the previous century, it was only around the 80s that the condition was characterized in the way we currently understand it (Kamp-Becker et al., 2010). The DSM-5 characterizes autism as a neurodevelopmental disorder and distinct from other personality disorders. The new classification elucidates the presence of different manifestations of the disorder and the need for recognizing the different levels of support that individuals with this diagnosis might need across their life.

Interventions Based on Applied Behavior Analysis

ASD is a disorder that will be present in the entire life of the individual. Fortunately, there has been substantial evidence showing that effective and timely interventions can mitigate the deficits and negative behavior manifestation characteristic of ASD (Roane et al., 2016). However, to guarantee that an individual with a diagnosis of ASD can benefit from specialized interventions, it is very important these interventions are evidence-based.

The term *evidence-based practice* was first used in the medical field (Sur & Dahm, 2011), but it has been adopted by different fields in

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_64

human care including mental health (Frank et al., 2020), and education (e.g., Hempenstall, 2006). According to the American Psychological Association (APA, 2008), evidence-based practice involves the combination of practice with strong empirical support of evidence, implemented by a trained professional, taking into consideration the client's characteristics, values, and cultural background. In response to the need for evaluating and informing service providers, educators, and parents of evidence-based practice for the intervention of individuals with ASD, the National Autism Center (NAC, 2009) conducted and published the National Standard Report with the objective of providing information about the levels of scientific evidence of several behavioral and educational interventions implemented with individuals with ASD.

The NAC (2009) was a systematic literature review of studies published from 1957 to 2007 involving intervention for individuals with ASD. The report was conducted in consultation with subject-matter experts and a panel of reviewers who collaboratively developed criteria for evaluating the scientific rigor of published studies (i.e., *Scientific Merit Rating Scale* [SMRS]), the effect of the intervention, and the level of confidence about the effectiveness of a specific intervention (i.e., *Strength of Evidence*). Out of the 38 interventions identified in the report, 11 were classified as established interventions (i.e., intervention which had enough empirical support to be considered as evidence-based). In 2015, the Phase 2 of the NAC was published with similar results from 2009. The NAC (2015) concluded that the overwhelming majority of the interventions identified as "established" were developed in the behavioral intervention literature including applied behavior analysis (ABA). In fact, ABA research involving interventions for individuals with ASD has been robust for the last decades (Roane et al., 2016; Smith, 2013). Several studies have evaluated procedures to address specific behavior deficits as well as the enhancement of already established intervention technologies for children with ASD.

ABA-based interventions focus on addressing behavior concerns that might otherwise interfere with the quality of life of individuals with ASD. ABA interventions rely on observable behaviors and clinical decisions based on reliable data and can be implemented at home, clinic, school, or community to address a variety of behaviors. The goals and objectives of the intervention are guided by the outcomes of behavior assessments evaluating the individual's skills deficits and behavior excesses (Fovel, 2002). These assessments provide information that will guide not only the selection of behaviors that will be addressed during the intervention but also the selection of the optimum service model. ABA-intervention for individuals with ASD and other developmental disabilities can be classified into two broad models: Comprehensive interventions and focused interventions (Smith, 2013; Steinbrenner et al., 2020).

Comprehensive Interventions

Comprehensive intervention models involve a service approach aimed to address a broad aspect of behaviors and conditions associated with ASD (Odom et al., 2014). In these models, the focus is not only on the individual's behavior deficits across a range of domains but also on the improvement in the family's quality of life. According to Odom et al. (2014), interventions following into this model are characterized by the following criteria: (a) the intervention model has been described and the description has been published; (b) a written guide of procedures or a manual is available; (c) the model follows a distinct conceptual or theoretical framework (e.g., behavior analysis, developmental); (d) it promotes changes in several developmental domains (e.g., language, communication, social); and (e) it is delivered for more than 25 h/week for a minimum of 1 year. There have been several comprehensive interventions documented in the literature (Odom et al., 2014). Two ABA-based models are early intensive behavioral intervention (EIBI; Lang et al., 2016) and the Early Start Denver Model (ESDM; Dawson et al., 2010).

Early Intensive Behavioral Intervention

The goal of early intensive behavioral intervention (EIBI) is to promote, early in life, changes in several domains of a child's development and daily-living aspect. Intervention procedures within this model are designed based on the principles of ABA and are delivered for several hours per week (Lang et al., 2016). Typically, the intervention would focus first on the development of the child's early communication (e.g., making requests, labeling items, and responding to simple questions), learning skills (e.g., attending to adults, following commands, scanning objects, imitation), and pre-academic skills (e.g., matching pictures and selecting items on command; Sundberg & Partington, 1999). Goals related to basic social skills such as joint attention and looking at and following peers might be addressed at this time (Sundberg, 2014). As these foundational skills are acquired, the intervention might involve complex skills building on existing repertoire and setting the basis for early academic skills (e.g., recognizing letters and numbers; writing). It is common for age-related, daily-living objectives to be incorporated throughout the intervention such as toilet training, dressing and grooming, and independent feeding (Partington, 2006). Behaviors that can hinder learning (e.g., escape-maintained challenging behavior, stereotypes) or that are harmful for the child and individuals around (e.g., self-injurious behavior, aggression) should also be addressed in EIBI (Sundberg, 2014).

According to Green et al. (2002), studies implementing EIBI as an intervention for children with ASD typically have the following features in common: (a) These interventions were comprehensive, with individualized goals addressing most if not all of skill domains; (b) several procedures based on principles of behavior analysis were employed to promote acquisition of functional skills and reduction in maladaptive behaviors; (c) there was at least one service provider who had advanced training in ABA and experience working with children with ASD; (d) intervention goals and objectives were defined based on typical child development; (e) parents had an active role in the delivery of intervention; (f) intervention was initially delivered in a one-to-one format and then transitioned to learning occurring in small groups and, finally, in large groups when appropriate; (g) intervention was initially implemented at home and then transferred to other environments and settings including school classrooms; (h) intervention involved structured activities which were programmed for 20–30 h per week plus unstructured opportunities for learning and practice of skill throughout the child's waking hours; (i) it was common for children to receive intervention for a minimum of 2 years; and (j) children started intervention at age of three or 4 years old (Green et al., 2002).

EIBI was first developed by Ivar Loovas for the intervention of children with ASD (Roane et al., 2016). In 1987, a seminal study conducted by Lovaas brought attention to its applications for children with ASD. Lovaas (1987) compared the effects of different dosage of intervention based on ABA intervention in children with an ASD. Participants were assigned to one of two groups: Experimental group received 40 h of ABA intervention per week and the control group received 10 h of ABA intervention per week. Participants were children younger than 46 months of age with a diagnosis of ASD. Both groups received intervention at a clinic-based setting for two or more years. The first year of intervention focuses on decreasing challenging behavior, the establishment of compliance, and the development of imitation and basic play skills. During this year, families became heavily involved in their child's intervention. During the second year, the intervention emphasized the acquisition of expressive and advanced language, and social skills. Finally, in the third year of the intervention, teaching involved the development of complex language such as the expression of emotions, basic academic skills (i.e., reading, writing, and arithmetics), and higher-order behaviors such as observational learning. The outcomes of behavioral (i.e., direct observation of participant's behavior) and cognitive (e.g., Stanford-Binet Intelligence Scales) assessments were compared pre- and post-intervention across both groups. Results showed that 47% of participants from the experimental group demonstrated pre-academic and academic skills similar to same-age, typically-developing peers versus 2% of participants from the control group. Although Lovaas (1987) study has received much criticism in particular to the weakness of his experimental methodology (Gresham & MacMillan, 1997), it continues to be the hallmark of the development of EIBI for children with ASD.

Since then, there have been several studies demonstrating the effectiveness of EIBI to address the core and co-occurring conditions of children and adults with ASD. Eldevik et al. (2009) conducted a meta-analysis of studies employing EIBI for children with ASD. The authors reviewed 34 studies including nine controlled designs involving a comparison or a control group. A test of homogeneity and publication bias was conducted to assess if the populations of the selected studies had the same distribution and the presence of bias in publications. Furthermore, the authors measured differences in effect size for any or both of two parameters conducted pre- and post-intervention: a full-scale measure of intelligence (e.g., Wechsler Intelligence Scale for Children–Revised) or a standardized assessment of adaptive behavior (e.g., Vineland Adaptive Behavior Composite). Eldevik et al. results demonstrated that the population sample of the selected studies was reasonably homogeneous and no publication bias was identified. Mostly important, the results showed a large effect size for measures of IQ and a moderate effect size for measures of adaptive behavior assessments before and after the EIBI. Eikeseth (2009) conducted a literature review of comprehensive psycho-educational interventions for children with ASD. His review included 25 studies published in peer-review journals, involving comprehensive intervention in children less than 6 years old at intake with reported outcome data. Selected studies were evaluated by their scientific merit and the magnitude of reported results. Children who underwent ABA-based comprehensive interventions were more likely to demonstrate significant gains in standardized measures when compared to children receiving other interventions. Finally, the NAC (2015) has included and classified EIBI as an established intervention for children with ASD between the ages of 0–9 years old.

Whereas Loovas' EIBI model relied heavily on discrete trial teaching (DTT) as the main teaching strategy with many presentations of the target skill and strong control of antecedent stimulus (Roane et al., 2016), contemporary ABA-based comprehensive interventions favor a combination of DTT and natural environment teaching (NET) to promote acquisition of skills, in particular language skills (Sundberg & Partington, 1999).

Early Start Denver Model

The Early Start Denver Model (ESDM; Rogers & Dawson, 2010) is a multidisciplinary, developmental approach for the intervention of young children with ASD recently incorporated as a type of ABA-based intervention (Roane et al., 2016; Vivanti & Stahmer, 2020). The ESDM was created from the early work of Sally Rogers out of the University of Colorado Medical Center in Denver and Geraldine Dawson (Rogers, 2016). The conceptual basis of the ESDM and its intervention approach follows a developmental framework taking into account the concept of normal child development and their "readiness" for the acquisition of skills (Rogers & Dawson, 2010). Moreover, the model takes into consideration the characteristics of learning and the importance of a conducive environment for infants and toddlers to develop their early milestones, in particular, communication skills. The model favors a naturalistic approach where the adult follows the child's interest during the intervention procedures (Rogers, 2016).

According to Rogers (2016), the ESDM integrates three areas of science: developmental including communication development, relationship-based, and applied behavior analysis while focusing on individualized intervention and the adult-child relationship. The child intervention plan is developed by a multidisciplinary team containing experts in different aspects of child development. Direct services are delivered by a trained therapist and overseen by a team leader. The child's progress is assessed every

12 weeks and the intervention plan is updated based on the outcomes of the assessment. Furthermore, parents are coached in promoting learning opportunities for their child during everyday activities and routines (Rogers, 2016). Services can be delivered in a variety of settings including clinical, at home, pre-school or day-care, or via parent coaching. The major areas of intervention involve skills related to imitation, joint attention, play including pretend play, and language and social communication. According to Rogers (2016), these skills can set the foundation that will allow the child to learn within her natural environment and in the interaction with others.

Dawson et al. (2010) conducted the first randomized, controlled-trial study evaluating the effects of ESDM intervention for young children with ASD. Participants were 48 children between ages of 18 and 30 months with a diagnosis of ASD and related developmental disorders. Participants were randomly assigned to the ESDM group or the assess-and-monitor group. Children in the ESDM group received (a) 20 h/week of ESDM intervention delivered by trained therapists in the University of Washington autism clinic; (b) 5 or more hours/week of ESDM intervention delivered by parents; and (c) any other community services parents chose. Children in the assess-and-monitor group received intervention from community providers in the greater Seattle region. Children were evaluated before the start of the intervention, after 1 year, and either after 2 years or at 48-month-old by experienced examiners who were naive to the study phase at the time of the evaluation. Several standardized measurements were utilized to evaluate intervention outcomes (e.g., Mullen Scales of Early Learning; Vineland Adaptive Behavior Scales; Repetitive Behavior Scale). Results demonstrated more robust intervention effects for children in the ESDM groups as compared to children in the assess-and-monitor group. According to Dawson et al. (2010), the gains demonstrated with the ESDM model in terms of IQ scores, language development, and adaptive behavior were greater than it had been shown before by any other developmental behavioral approach. The authors suggested the ESDM offers an effective model for young children with ASD with an intervention approach that focuses on a rich and engaging relationship between the child and the implementer.

In the last 10 years, several empirical studies have demonstrated the effectiveness of the ESDM for young children with ASD (e.g., Contaldo et al., 2019; Vivanti et al., 2014). Most recently, Fuller et al. (2020) conducted a meta-analysis to evaluate the effectiveness of ESDM for young children with ASD. The meta-analysis included 12 published studies that met the following criteria: (a) participants were children younger than 6 years old with a diagnosis of ASD; (b) the main intervention evaluated was the ESDM; (c) the intervention group was compared with a group who did not receive ESDM (e.g., treatment as usual, waitlist control); (d) included participant's outcome; and (e) the study had a group design including randomized control trial and quasi experimental design. The authors extracted the data from included studies and calculated the standardized mean difference effect size of participants' outcome measurements. Overall, results of the meta-analysis suggested a moderate but statistically significant effect size favoring children who received ESDM intervention as compared to control groups.

ESDM is a promising intervention (Waddington et al., 2016); however, more research is still needed to consolidate the intervention as an evidence-based practice for children with ASD. Baril and Humphrey (2017) conducted a broad systematic review to evaluate the evidence of ESDM for children with ASD. The authors examined the quality of 14 published studies using a method for evaluating and determining the level of evidence in intervention approaches (Reichow et al., 2008). Results demonstrated high levels of variability across studies in terms of methodology, characteristics of participants and the intervention implemented, and research rigor. Baril and Humphrey concluded that although there have been compelling demonstrations of the effectiveness of ESDM for addressing behavior concerns in children with ASD, additional research is still needed including replications of previous studies by independent researchers.

Focused Interventions for Core Skills

In contrast to the comprehensive model, focused interventions are individually designed practices to teach a specific skill or address a specific behavioral concern of individuals with ASD (Steinbrenner et al., 2020). These practices are typically carried over for a shorter period of time as compared to comprehensive interventions or until the goal of the intervention is reached. They are typically evaluated using single-subject research designs and data collection of specific target skills or behaviors (NAC, 2015). Evidence-based focused intervention are those behavioral and educational practices that have enough empirical support of being effective in addressing the different core and comorbid conditions of individuals with ASD (Steinbrenner et al., 2020).

Several focused practices have been identified as evidence-based interventions by previous literature reviews, scientific reports, and intervention manuals (ONTABA, 2017). Whereas comprehensive interventions take into consideration specific age groups (Odom et al., 2014), focused interventions will be determined by the behavior domain addressed. The National Clearinghouse on Autism Evidence and Practice extended a systematic literature review of studies published between 1990 and 2017 evaluating interventions for individuals with ASD (Steinbrenner et al., 2020). The results were summarized in terms of type of intervention, behavior domain addressed, and age for which it has been shown to be effective. Out of 28 focused practices identified in the review, 23 had a behavioral framework and are regularly included in ABA-based studies and ABA-based interventions (e.g., antecedent-based interventions, differential reinforcement, discrete trial training, extinction, functional behavior assessment and functional communication training, reinforcement). Based on the existing literature, each of those intervention practices should be implemented to address specific behavior issues for individuals in specific age groups as prescribed by literature reviews and intervention manuals.

Language and Communication

Goals related to language and social communication skills in individuals with ASD are a very important part of the intervention as they provide the basis for complex repertoire such as social and academic skills (Sundberg & Partington, 1999). Furthermore, deficits in functional communication skills can lead to the development of challenging behavior ranging from mild to severe (Sundberg & Michael, 2001). When addressing language and communication skills in individuals with ASD, behavior analysts approach it from a functional rather than a topographical perspective (Carr et al., 2000). Skinner (1957) established the behavior analytical approach to language and focused on identifying the function of the communicative response rather than its form or shape. In other words, behavior analysts are interested in the environmental conditions that foster language development, and specifically, the environmental antecedents, consequences, and setting events that are functionally related to language development (Sundberg & Michael, 2001). Skinner called this communication repertoire *verbal behavior* referring to responses which are reinforced by the mediation of another person's behavior. This assumption implies the presence of a speaker (the one who emits the behavior) and a listener who mediates the consequences for these behaviors. Skinner (1957) developed a taxonomy of verbal behavior and referred to the different functional responses as *verbal operants*. Sundberg and Michael (2001) suggested that researchers and clinicians should employ Skinner's taxonomy of verbal behavior when teaching language to children with ASD to ensure that learning opportunities are designed taking into consideration the appropriate antecedents and consequences for each of the verbal operants.

Focused ABA interventions for children with ASD typically target each verbal operant individually and build up on complexity as the child expands his verbal repertoire (Sundberg & Partington, 1999). The goals of the intervention are commonly informed by behavior skills assessments such as the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2014) or the Assessment of Basic Language and Learning Skills-Revised (ABLLS-R; Partington, 2006). These assessments provide information about the child's verbal strengths and deficits and will guide the selection of intervention goals. The verbal operants commonly addressed in focused interventions are the mand, the tact, the echoic, and the intraverbal. The mand and the tact have received the most attention from the scientific community, followed by the intraverbal and the echoic (DeSouza et al., 2017).

The mand is potentially one of the first verbal operants to be addressed in language interventions for children with very limited verbal repertoire. Mands are essentially requests for items, attention, information, and removal of unwanted stimulus. It provides the child with some control of the environment and access to social and nonsocial reinforcement while promoting the foundations for the speaker and listener roles which are essential for the development of more complex verbal skills (Sundberg & Michael, 2001). One essential aspect of mand training is the manipulation of motivating operations (MOs) to ensure that the verbal response is under the control of relevant antecedent stimulus (Sundberg, 2004). Sweeney-Kerwin (2007) manipulated the presence of the preferred edibles to transfer the control of mands from the discriminative visual stimulus (i.e., edible item) to the establishing operation (i.e., item deprivation). Two children with ASD who would mand in the presence of the item but not in its absence participated in the study. The therapist would give a small portion of the item to the child, put the rest of the item away from the child's view, and wait for 2 min for a mand. If the child emitted a mand, the therapist delivered the time. If the child did not mand for the item, the therapist presented the item again and restarted the procedure. Both children were able to request the item under the control of the EO when items were absent.

Others strategies have been developed to ensure that the mand being taught is in fact under the control of relevant EOs. One strategy commonly used during mand training is behavior chain interruption (Carnett et al., 2017). The behavior chain interruption strategy consists of identifying a chain of behavior and interrupting it to create an EO for the emission of a mand that would result in continuation of the chain. Albert et al. (2012) used the behavior chain interruption strategy to teach mands to three children with ASD. Children were first taught to complete a behavior chain for access to a preferred item (e.g., sandwich). Then, while making a sandwich, the experimenter removed an essential item (e.g., toaster) and prompted the child to request for the item after a 10-s delay. The behavior chain interruption strategy has also been used to teach mands for information using “where?” (Carnett et al., 2020), “who?” and “which?” (Shillingsburg et al., 2014), and “how?” (Lechago et al., 2013).

A large number of studies have evaluated procedures to teach tact to children with ASD (DeSouza et al., 2017). Skinner (1957) called tacts those behaviors of labeling and describing stimuli in one's environment. Most studies have examined tacts of visual stimulus (e.g., pictures or items; Bak et al., 2021), although there has been a growing body of study which has evaluated procedures to teach tact of stimuli in other modalities. For example, Hanney et al. (2019) taught two children with ASD to tact auditory stimuli; Dass et al. (2018) taught three children with ASD to tact olfactory stimuli; and Rajagopal et al. (2021) taught three children with ASD to tact private events of tactile stimulation in different parts of their bodies. Interventions involving tact training typically employ vocal prompt, prompt delay, and differential reinforcement to teach the tact of target responses (DeSouza et al., 2017).

There have been only a few studies evaluating procedures to establish echoic repertoire (vocal imitation) in children with ASD (DeSouza et al., 2017). A few studies have used the stimulus-stimulus pairing procedure which consists of presenting a reinforcing item along with therapist vocalizations to increase the child's vocalizations (Miguel et al., 2002), and then bringing these vocalizations under the control of a vocal stimulus (Carroll & Klatt, 2008). Chaining is another procedure that has been used to increase echoic responses by breaking down target words into smaller units and then teaching each unit in a chain until the child could echo the whole word (Tarbox et al., 2009). When deficits in echoic responses present as a compliance issue rather than a repertoire issue (i.e., the child demonstrates high levels of vocalization but would not respond to a request to engage in vocal imitation), the intervention should focus on bringing these responses under instructional control. For example, Hansen et al. (2019) used the high-probability (high-p) instruction by presenting a sequence of several motor imitation requests followed by a vocal imitation request to increase echoic responses in a child with ASD.

The intraverbal has been receiving increasing attention from researchers for the intervention of children and adolescents with ASD (DeSouza et al., 2017). Some behaviors classified as intraverbals are responding to questions, making comments, telling stories or past events, singing along, and engaging in back-and-forth conversation. According to Sundberg and Sundberg (2011), most of a person's verbal interaction involves intraverbal responses and the acquisition of complex intraverbal fosters the development of cognitive, academic, and social skills in children. Several studies have demonstrated the effectiveness of different prompt procedures such as textual prompts (e.g., Vedora et al., 2009), echoic prompts (e.g., Ingvarsson & Hollobaugh, 2011), and tact prompts (e.g., Kodak et al., 2012) to teach intraverbals to children with ASD. Recently, Roncati et al. (2019) showed that the effectiveness of prompts used to teach intraverbals depends mostly on the child's history of reinforcement with the specific prompt.

Considering the extent of an intraverbal repertoire, it is unrealistic to assume that a child could be taught every possible intraverbal relation through direct teaching. Therefore, understanding the prerequisites necessary for facilitating the emergence of novel verbal responses without direct teaching is critical to the development of complex language repertoire. In the last two decades, a number of studies have demonstrated that instructional conditions can be arranged to facilitate the emergence of untrained skills in children with ASD (Gibbs & Tullis, 2021) and, therefore, reduce the amount of direct teaching needed for a child to acquire language skills. In other words, emergent responding approaches seek to identify the set of skills that once taught will promote the acquisition of novel intraverbal responses. DeSouza et al. (2019) demonstrated that teaching the sequence of skill determined by Sundberg and Sundberg (2011) to be the prerequisite skills for complex intraverbal responses facilitated the emergence of intraverbal under divergent control in four children with ASD.

For those individuals whose vocal language has not emerged to a functional level, one option is the use of augmentative and alternative communication (AAC; Shane et al., 2012). AACs are intervention strategies used to compensate for the lack of speech and replace or augment the individuals' social communication skills (Ganz et al., 2012). Two types of AAC strategies commonly used with individuals with ASD are picture-based such as the Picture Exchange Communication System (PECS; Bondy & Frost, 1994) and speech generating devices (SGDs; Tincani et al., 2020). With the PECS, individuals communicate by exchanging with a communication partner a laminated picture representing their communicative responses. SGDs are typically implemented with the aid of tablets and smartphones (Tincani et al., 2020) and require a specific device application. With SGD, individuals would select pictures of their communicative response by touching the screen in the device. Rather than exchanging a picture card as one does while using PECS, with SGD the device generates an automated speech that matches the communicative response selected by the individual. A meta-analysis conducted by Ganz et al. (2012) demonstrated that AAC interventions had a large effect on target behavior outcomes such as making requests, spontaneous social initiations, and spelling. Furthermore, results demonstrated that SGDs had larger positive effects when compared to the effects of PECS. Although these are promising results, further research is still needed to evaluate the effectiveness of these intervention technologies to supplement the communication across different domains of individuals with ASD as well as guidelines for the selection of the most appropriate AAC modality given the need to the individual learner (Ganz, 2015).

Social Skills

A defining feature of ASD is impairment in social interaction skills. According to Mendelson et al. (2016), individuals with ASD are more likely to experience social isolation and peer rejection than their typically-developing peers. Moreover, social skills deficits do not resolve with age and development (White et al., 2007); the summative effects of social skills deficits across the years hinder the acquisition of other skills that, for typically-developing children, are shaped and reinforced through interactions with peers (Bellini, 2006). Social skills deficits in individuals with ASD can be perceived at young ages as lack or inappropriate eye contact, failure to attend to others, and reciprocal and shared enjoyment. As the child ages and acquires language, these deficits can be observed as failure to initiate and engage in reciprocal conversations with others. Older children or adults might experience difficulties in identifying and adapting to others' emotions, making and maintaining friendships, and demonstrating communication skills needed for securing and maintaining employment (Klaiman et al., 2015).

ABA interventions have employed a variety of procedures to teach social skills to individuals with ASD (Flynn & Healy, 2012). Early social skills have been taught using differential reinforcement, shaping, and prompting. Fonger and Malott (2019) used a shaping procedure to teach sustained eye contact (minimum 3-s duration) to three children with ASD. In the first part of the intervention, the therapist reinforced any eye-orientation to any part of the therapist's body and later only to the therapist's face. Next, reinforcement was delivered only for eye contact with the therapist for specific durations (1-s, 2-s, 3-s). Finally, the therapist incorporated instructions into the procedure and reinforcement was delivered only if participants made eye contact in between high-probability instructions. Taylor and Hock (2008) used differential social reinforcement and least-to-most prompt to teach three children with ASD to respond to bids for joint attention by looking at the direction of an item, making a comment, and looking back to the adult. The researchers taught the same children to initiate bids for attention using differential social reinforcement and most-to-least prompt.

Social play skills are also typically impaired in children with ASD. Several studies have used an activity-schedule to teach and increase social play between children with ASD (e.g., Betz et al., 2008) and between children with ASD and typically developing peers (e.g., Akers et al., 2018). An activity-schedule involves a sequence of words or pictures that can serve to prompt someone to engage in specific behaviors (McClannahan & Krantz, 2010). Another strategy to teach social play involves video-modeling in which the participant watches a video-recording of the desired skill as it is demonstrated by other people. Jung and Sainato (2015) incorporated participants' toy preference into a video-modeling procedure to increase peer-play in three children with ASD. Jung and Sainato used least-to-most prompt along with video-modeling to increase participants' engagement in play activities with a peer of typical development. Video-modeling has also been used to teach conversation skills. Charlop et al. (2010) used video-modeling to increase appropriate verbal (comments and intonation) and non-verbal (gestures and facial expression) communication skills in three children with ASD. Children in the study watched two adults engage in appropriate conversation interexchanges, and then practiced the skills with the therapist. Generalization probes, including conversations with peers, were conducted after mastery of the skill in the intervention setting.

Behavioral skills training (BST) is another strategy that has been used for social skills training for individuals with ASD (Leaf et al., 2015). BST is an evidence-based intervention package used to teach and train individuals on specific behaviors or skills (Parsons et al., 2012). BST involves the following components:

(a) Vocal instructions with or without written instructions of how to perform the skill; (b) demonstration of the skill by the trainer; (c) practice of the skill by the trainee; and (d) praise and corrective feedback during practice. An important feature of BST is that it involves direct observation of the trainee's performance and it is only concluded once the trainee reaches an acceptable level of competency demonstrated by data of directly-observed behaviors (Miltenberger, 2004). Ryan et al. (2019) used BST to teach and increase appropriate conversation skills to six adults with intellectual disability and ASD. In another application of BST, Roberts et al. (2020) implemented BST to improve the interview skills to three young adults of 19 and 20 years old with ASD. Participants practiced and learned how to properly respond to possible questions during interviews, appropriate questions to ask to a potential employer, and appropriate body language expected during an interview. Two of the participants had an interview (with accommodation for the candidate's disability) for a real position and at least one of the participants was offered a position.

Several authors have discussed the importance of diversity and inclusion in not only services delivered but also in research (Fong et al., 2017). Davenport et al. (2018) conducted a literature review of studies evaluating social skills interventions in individuals with ASD. The purpose of the review was to examine cultural considerations and adaptation during social skills training. Out of the 329 articles included for analysis, 124 or 38% did not include information on participants race, ethnicity, or nationality. The remaining articles (n = 205) were further analyzed for the presence of cultural adaptation in their intervention. Only five articles meet this criterion and were included in the review. The authors discussed the importance of reporting race, ethnicity, and nationality of participants and the need for additional research evaluating the implementation of evidence-based social skills training with adaptation to meet the needs of diverse populations with ASD.

Focus Interventions for Challenging Behaviors

The presence of challenging behavior can affect individuals with ASD at any age and interfere with learning and quality social interactions (Issarraras & Matson, 2018). Research has shown that children with ASD demonstrate greater levels of challenging behavior as compared to typically-developing children and children with other developmental disabilities (Matson et al., 2009). The most common challenging behaviors observed in individuals with ASD are self-injurious behavior, aggression, and stereotypy (Fodstad et al., 2012). Furthermore, the levels and intensity of these challenging behaviors seem to be highly correlated with the severity of ASD symptoms (Matson et al., 2009).

The literature for the intervention of challenging behavior has been robust and made great progress in the last 30 years. Evidence-based interventions for challenging behavior involve first a functional assessment and selection of function-based interventions (Beavers et al., 2013). The functional analysis is today considered the gold standard for the assessment of challenging behavior (Hanley, 2012). The assessment involves manipulating antecedents and consequences that could potentially evoke and maintain the challenging behavior and evaluating the effects these changes have on the levels of challenging behavior. The idea behind functional analysis is that every behavior, including challenging behavior, serves a function for the individual. The functions of challenging behavior can be attention or tangible (social-positive reinforcement), escape (social-positive reinforcement), and automatic (positive and negative reinforcement). By manipulating the variables in the environment (antecedents and consequences), one can identify what variables are controlling the behavior and therefore arrive at the function of the challenging behavior (Beavers et al., 2013). Once the function is identified, the practitioner can select an intervention that has shown to be effective for challenging behavior maintained by the identified function. There has been strong evidence that function-based interventions for challenging behavior are more likely to be effective and have long-lasting effects (Horner et al., 2002).

Self-Injurious Behavior

Self-injurious behavior (SIB) is a type of challenging behavior commonly observed in individuals with ASD (Barrera et al., 2007). According to Dominick et al. (2007), about one-third of children with ASD present with some form of SIB. The topography of the challenging behavior varies across individuals and can take the form of body and head hitting, head banging, self-biting, skin picking among others (Chezan et al., 2017; Dominick et al., 2007). The severity of these behaviors can also range from mild with the appearance of rashes or bruises, to severe with the occurrence of concussions or open-skin wounds requiring medical care (Rojahn et al., 2007). Depending on the severity of the SIB, protective equipment (e.g., helmet) might be required until an effective intervention is implemented to preserve the physical integrity of the individual (Moore et al., 2013).

Chezan et al. (2017) conducted a literature review of studies focusing on the intervention of SIB for children with ASD. The review included 24 single-subject-design studies published from 2000 to 2016 with a total combined of 38 participants. Functional communication training (FCT) was the intervention implemented with the majority of participants in the review (24 out of 30). FCT is an evidence-based intervention that involves teaching as a replacement behavior to a challenging behavior, a communicative response that will serve the same function as the challenging behavior (Carr & Durand, 1985; Ghaemmaghami et al., 2020). By engaging in the new, appropriate replacement behavior, the individual will still get access to the same consequence obtained with the challenging behavior. Typically, FCT is implemented along with extinction for the challenging behavior (i.e., SIB no longer produces the consequence that maintains it; Hagopian et al., 1998). As a result, the levels of challenging behavior tend to decrease as the levels of the communicative response increase. For children whose SIB is maintained by escape from demands, the communicative response would be requesting a break from tasks (Lalli et al., 1995). For children whose SIB is maintained by access to attention from adults or tangible items, the communicative response would involve requesting for attention or for a specific tangible item (Hagopian et al., 2001). The effectiveness of FCT relies on the fact that the individual's SIB is maintained by social reinforcement (i.e., attention, tangible, and escape). When the function of the SIB is automatic, other interventions might be required.

Chezan et al. (2017) reported that 27% of studies implemented antecedent interventions. Antecedent interventions involve the manipulation of antecedent variables in an attempt to prevent or decrease the motivation of the individual to engage in the challenging behavior (Smith, 2011). Antecedent interventions can be implemented in a form of environmental arrangements. DeLeon et al. (2004) implemented an antecedent modification to decrease the levels of SIB in a 4-year-old boy with ASD. The experimenters identified through direct observation, that the levels of the boy's SIB were higher during his first waking hours than at any other time. The intervention involved a faded bedtime strategy to adjust the boy's sleeping schedule. This intervention changed the boy's sleep patterns resulting in less night-wakings and lower levels of SIB at his waking-time. Noncontingent reinforcement (NCR) is another antecedent strategy used as an intervention for SIB. During NCR, reinforcement (preferably the one maintaining the challenging behavior) is delivered on a time-based schedule regardless of the levels of challenging behavior (Phillips et al., 2017). Falcomata and Gainey (2014) compared the effects of different forms of NCR on the levels of multiply-controlled SIB in a 4-year-old girl with ASD. The experimenters compared the delivery of NCR with attention versus NCR with attention plus preferred activities both in the presence and absence of work. NCR with attention plus preferred activities was more effective in decreasing the levels of challenging behavior regardless of the presence or absence of work. When the reinforcer delivered during NCR is not the one maintaining the SIB (e.g., reinforcer is attention but SIB is maintained by automatic reinforcement), it is important to select the reinforcer via a competing stimulus assessment to increase the likelihood that the intervention would be successful (Rooker et al., 2018). Other antecedent interventions that have been implemented to address escape-maintained SIB are choice, task modification, and visual schedule (Chezan et al., 2017).

Results from previous research have suggested that about 27% of SIB are maintained by automatic reinforcement (Chezan et al., 2017; Iwata et al., 1994). One of the difficulties of identifying the exact source of reinforcement of automatically-maintained SIBs is that the consequence of SIB is only perceived by the individual himself. Rooker et al. (2018) suggested that with automatic-positive reinforcement, the SIB produces sensory stimulation reinforcing for the individual; whereas with automatic-negative reinforcement, the SIB produces the elimination or reduction in aversive stimulation (e.g., pain) which removal is reinforcing for the individual. Iwata et al. (1994) demonstrated that reinforcement-based interventions were effective to decrease the levels of SIB of 90% of individuals whose SIB was maintained by social reinforcement in contrast with only 65% of individuals whose SIB was maintained by automatic reinforcement. Rooker et al. argued that these data suggested that automatically-maintained SIB seems to be, in general, more resistant to interventions. According to Rooker et al., (2018), the most common intervention used for SIB maintained by automatic reinforcement was reinforcement-based procedures alone. Toussaint and Tiger (2013) implemented a differential reinforcement of other behavior (DRO) procedure to decrease the levels of covert SIB (skin picking when none was looking) in a 12-year-old boy with ASD. During the intervention, the boy was left by himself in a room without access to leisure items. If the boy was not picking at his skin the moment the therapist entered the room, he would receive a token that could later be exchanged for his preferred items or activities.

There has been a relatively small number of studies that examined interventions involving punishment procedures (Rooker et al., 2018). Manente and LaRue (2017) evaluated the effects of differential punishment of high rates of behavior on the levels of severe SIB in the form of head hitting and head banging in a 28-year-old man with ASD. During the intervention, the therapist delivered a vocal reprimand if the man engaged in rates of SIB that was above an established criterion within a specified time interval. The intervention resulted in a decrease of levels of SIB and long-term maintenance of these outcomes. Punishment-based interventions or procedures using any type of physical restraint should be implemented when other less intrusive and reinforcement-based procedures have been tried without success. It is important as well to analyze if the benefits of the reduction in a specific behavior surpass the possible side effects of punishment procedures (Horner et al., 1990; Lerman & Vorndran, 2002). Moreover, punishment-based interventions should always be accompanied by reinforcement procedures contingent on appropriate behaviors.

Aggression

Kanne and Mazurek (2011) indicated that 56% of individuals with ASD engage in some type of aggression, either physical (e.g., hitting, biting, hair pulling) or verbal (e.g., cursing, insulting) against others (Issarraras & Matson, 2018). According to Matson and Jang (2014), adults who engage in aggression are likely to do so in a higher intensity and severity when compared to children due to their superior strength and longer history of reinforcement for these behaviors. The presence of aggression might put the individual at risk of social isolation and being placed in a restrictive environment under intrusive procedures (Brosnan & Healy, 2011). This alone makes the need for the design and planning of early and effective interventions even more urgent so to guarantee the quality of life of these individuals and the physical integrity of caregivers and other individuals around them. As such, the first step towards the intervention is to conduct a functional behavior assessment (Hanley, 2012) of the aggressive behavior.

As discussed earlier, functional analysis is the gold-standard procedure for the assessment of challenging behavior. Because the functional analysis involves the intentional manipulation of the antecedents that can potentially evoke the behavior and the consequences that might maintain it, it is possible that aggression will be emitted at high levels during the assessment. For the past 30 years, several variations in functional analysis have been developed to prevent situations where therapists and direct care staff might be placed at serious risk of injury because of the behavior-evocative nature of this assessment (Hanley, 2012). These technologies of assessment have provided practitioners with different options to complete a functional analysis. Horner et al. (2002) showed that function-based behavioral interventions can decrease by 80–90% the levels of challenging behaviors in individuals with ASD and other developmental disabilities.

According to Brosnan and Healy (2011), if not addressed, aggression will most likely persist and aggravate throughout the individual's lifespan limiting his access to social and community activities. Research on the assessment and intervention of severe challenging behavior has repeatedly demonstrated that the lack of communication skills leads to the occurrence of challenging behavior that, many times, have a communicative function. Beavers et al. (2013) conducted a literature review of 435 studies in functional analysis of problem behavior with a sample of 981 functional analysis. Aggression was the most reported target behavior representing 47.5% of reported challenging behaviors. Furthermore, results showed that aggression was mostly maintained by social reinforcement, although there have been a few examples in the literature that showed that aggression was maintained by automatic reinforcement (Beavers et al., 2013).

FCT is one of the most recommended and implemented interventions for socially-controlled challenging behavior, including aggression (Brosnan & Healy, 2011). Wacker et al. (2013) demonstrated the effectiveness of FCT to decrease aggression along with other topographies of challenging behavior in 17 young children with ASD. The intervention was implemented by parents who were coached via tele-health in how to teach the appropriate communicative response to their child, provide reinforcement for appropriate requests, and block and ignore challenging behavior. During FCT for aggression maintained by tangible and attention (social positive reinforcement), the child was taught to wait for a brief moment (1–2 min) and request for a preferred item or the parent's attention. Contingent on appropriate waiting and requesting, the parent delivered the item to the child or provided 1–2 min of positive attention. During FCT for escape (social negative reinforcement), the child was taught to request for a break after complimenting simple tasks. The parent showed the child a picture indicating that it was time to work; contingent on compliance with work, the parent praised the child and switched to a card signaling that it was time to play. At this moment, the child was allowed to request and receive a break from task and access to play activities. Most children (15 out 17) demonstrated over 80% reduction in problem behavior relative to baseline.

Other reinforcement-based procedures have also been used to decrease aggression in individuals with ASD and other developmental disabilities (Brosnan & Healy, 2011). Typically, differential reinforcement procedures (e.g., DRA, DRO, and FCT) have an extinction component embedded to them as the replacement target response is followed by reinforcement while the challenging target behavior receives no programmed consequence (Brosnan & Healy, 2011). Although extinction can be effective in decreasing the rate of challenging behavior, there might be situations when extinction cannot be implemented, compromising the integrity of the intervention. Furthermore, the side effects associated with extinction (e.g., extinction burst, emotional reactions) can be challenging in particular when it will be carried over by parents or other caregivers (Athens & Vollmer, 2010). There have been several studies that evaluated the effect of differential reinforcement procedures without extinction on the level of challenging behavior in individuals with developmental disabilities. Athens and Vollmer (2010) implemented a differential reinforcement of alternative behavior (DRA) without extinction to decrease the levels of aggression of seven children from 4 to 12 years old with a diagnosis of ASD. All children showed a decrease in the levels of aggression and increase in the levels of compliance after manipulation of different parameters of reinforcement for appropriate behavior such as the duration, the quality, and the immediacy of delivery of reinforcement.

When designing interventions for challenging behavior, it is important that the practitioner evaluates not only the effectiveness of the intervention but also its feasibility (Fisher & Bouxsein, 2011). Interventions that have many components (e.g., environmental manipulation, prompts, different types of reinforcement) or require constant monitoring of the individual will very likely not be practical for parents and caregivers or possible to be carried over. Fisher and Bouxsein (2011) described several procedures that have been developed and empirically tested to make intervention more practical for parents, caregivers, teachers, and staff. Some of these procedures that can be implemented alongside FCT are (a) *Schedule thinning* can be implemented to lean the rate of reinforcement delivery thus decreasing the need to provide excessive edibles or time away from tasks; (b) *response restriction* is a strategy used to decreased the rates of requests (only for responses that involve the exchange of a picture-card) by making the request response unavailable; (c) when the communicative response is vocal, compound schedules of reinforcement (multiple or chained) haves been implemented to signal when requests will and will not be honored. For NCR, the authors suggested gradually changing the schedule of reinforcement from lean to dense; also, it would be helpful to identify alternative reinforcers when it's impractical or impossible to deliver the item that previously served as reinforcement for challenging behavior. Finally, one strategy for challenging behavior maintained by escape from demands is *demand fading* which involves gradually incorporating tasks before break from demands is available as a reinforcer (Fisher & Bouxsein, 2011).

Stereotypy

Restricted interest and repetitive behaviors (e.g., focused interest in specific toys, objects, or topic; repetitive body movements and vocalizations) are core characteristics of ASD (Lanovaz et al., 2013a) and are in fact what differentiates a diagnosis of ASD from other developmental disabilities. According to Lanovaz et al. (2013a), most children present with some type of repetitive behavior; however, these behaviors decrease around the age of 2 years old for typically-developing children, while it will persist past that age for children with ASD. Repetitive behaviors are persistent and might interfere with the individual's effective functioning and social interactions (Matson et al., 2006). Another issue related to the presence of stereotypy is that the individual might spend most of her time engaging in these behaviors and might miss the opportunity to engage in appropriate social interactions, functional leisure activities, learning opportunities, and academic tasks (Lanovaz et al., 2013a). In these cases and when the repetitive behavior might cause physical harm (e.g., hand-mouthing), they are considered a challenging behavior and should be a target for intervention. Differently from other types of challenging behavior such as SIB and aggression, stereotypies are most often maintained by automatic reinforcement (Akers et al., 2020). As such, interventions, which rely on communicative responses such as FCT, might not be effective due to the fact that reinforcement for the repetitive behavior might not be mediated by the behavior of others.

In a systematic review, Akers et al. (2020) analyzed 109 research articles investigating interventions for motor stereotypy in individuals with ASD. Results showed that 59% of participants received some sort of antecedent intervention for motor stereotypy. The most common antecedent intervention employed was environmental enrichment which involves making highly-preferred reinforcers, identified via a preference assessment, non-contingently available to the individual (Rapp, 2004). Hansen and Wadsworth

(2015) used environment enrichment to decrease the levels of motor stereotypies in a 10-year-old boy with ASD. The authors compared the effects of environmental enrichment with access to a therapist-selected matching-simulation toy and environmental enrichment with a choice of matching toys selected by the participant. Both conditions were effective in decreasing levels of stereotypies, but the environmental enrichment with the choice condition resulted in zero levels of stereotyped behaviors. A review of literature conducted by Gover et al. (2019) showed that environmental enrichment as a sole intervention for automatically-controlled challenging behavior was effective in only 41% of studies. As a result, supplemental procedures might be necessary to increase the effectiveness of environmental enrichment (Gover et al., 2019).

Consequence-based interventions, such as DRA, have focused on increasing the rates of appropriate behaviors competing with the stereotypy (Akers et al., 2020). Hedquist and Roscoe (2020) compared the effects of DRA and DRO without response blocking or interruption on the levels of motor stereotypy and task engagement and completion in three adolescents with ASD. During the DRA condition, the experimenter delivered a preferred item contingent on task completion and provided no consequences for motor stereotypy. During the DRO condition, the experimenter delivered a preferred item after a specific time interval if motor stereotpy had not happened during the entire interval, and provided no consequence for task engagement or completion. The results demonstrated that DRA was more effective than DRO in decreasing the levels of stereotypy and increasing levels of task engagement and completion for all participants.

Two interventions that have been successfully used for vocal stereotypy in individuals with ASD are DRO and response interruption and redirection (RIRD; Lanovaz et al., 2013b). DRO DRO consists of having a preferred item (preferably one that matches the same stimulation input produced by the stereotypy) delivered after a specific interval of time if the target stereotypy has not occurred within the interval (Lanovaz et al., 2013b). Lanovaz et al. (2014) used a DRO procedure with two children with ASD after noncontingent music and DRA failed to decrease levels of vocal stereotypy. The results for both participants showed that levels of vocal stereotypy decreased below baseline levels during the DRO procedure. Although DRO can be effective in decreasing the levels of stereotypy, one of the limitations is the fact that the procedure alone does not teach the individual any functional skills (Lanovaz et al., 2013b). RIRB is a consequence-based procedure consisting of interrupting the stereotypy and redirecting the individual to a functional vocal response. Contingent on the emission of a vocal stereotypy, the therapist interrupts the vocalization by asking for an attending behavior (e.g., "Look at me!") or by saying the individual's name. Next, the therapist presents a series of tasks known to the individual requiring a vocal response (Ahearn et al., 2007). In addition to being effective in decreasing the levels of vocal stereotypy, there have been a few cases in which RIRD has resulted in the increase in appropriate vocalizations (Miguel et al., 2009).

When the stereotypy does not cause physical harm to the individual or property damage to the environment, one potential solution is to bring the behavior under the control of an environmental stimulus that signals when is appropriate and when is not appropriate to engage in the behavior (Akers et al., 2020). Slaton and Hanley (2016) compared the effects of two different compound schedules of reinforcement with a discriminative stimulus (multiple and chained) to bring motor stereotypy under the control of a colored card signaling when motor stereotypy was and was not allowed to happen. During the multiple-schedule condition, the availability and non-availability for engaging in motor stereotypy alternated based on the passage of time regardless of participants engagement in tasks as directed by the experimenter. During the chained-schedule condition, engaging in motor stereotypy was made available contingent on engaging in a specific number of leisure or vocational tasks after being directed by the experimenter. The experimenter blocked motor stereotypy during both conditions. The chained schedule was more effective than the multiple-schedule in decreasing the levels of motor stereotypy and increasing the levels of task engagement. Furthermore, the results of a concurrent-chain assessment demonstrated that participants preferred being exposed to the chained-schedule condition over the multiple-schedule condition.

Final Considerations

The prevalence of children diagnosed with ASD has greatly increased in the last 10 years (Zablotsky et al., 2019) so have the options for interventions including behavioral, nutritional, and medical. As such, it became imperative that potential interventions have the level of evidence to be considered as effective practices. Interventions recognized as evidence-based (APA, 2008) are the most effective options and the ones that provide the best potential for positive outcomes. Hundreds of researches have demonstrated that interventions based on applied behavior analysis are effective for addressing the core symptoms of individuals with ASD (NAC, 2015; Steinbrenner et al., 2020). Furthermore, ABA has been shown to also have a positive impact on the life of families and in society as a whole (Dillenburger et al., 2014).

Young children who present with developmental delays and who are at risk of receiving a diagnosis of ASD should start intervention as early as possible; the earlier the child starts intensive intervention, the bigger are her chances to acquire functional skills (Ramey & Ramey, 1998). The general recommendation is that early intensive comprehensive interventions should be delivered for 10–20 h per week for young children between the ages of 0–36 months and 30–40 for older children with a diagnosis of ASD (ONTABA, 2017). To accomplish these hours, intervention should be implemented in different aspects of the child's life including the school setting and other typical daily routines (e.g., meals, play time).

According to CDC (2020), the average age for receiving a diagnosis of ASD is 4 years and 4 months. Some children have received a diagnosis as young as 18 months while others might not receive one until the age of 8 years old. For the later, comprehensive intervention models might no longer be a viable or recommended option. At this point, focused interventions targeting areas of priority might be the most appropriate model of service. Targeted and effective interventions for older children and adolescents with ASD can promote autonomy once they reach adulthood increasing their chances of becoming active members of their communities.

The NAC (2015) pointed to two major limitations of the behavior literature for individuals with ASD. One limitation relates to the level of evidence of ABA interventions for individuals with ASD across their lifespan. There is a big gap in the empirical demonstration of intervention effectiveness for adults with ASD. Specifically, research targeting training programs for vocational skills, social skills, and sexuality education for adults with ASD is much needed (NAC, 2015) and critical for increasing their likelihood of entering the workplace, developing meaningful relationships, and participating in their peer groups.

Another limitation refers to the lack of demographic information including race or ethnicity, cultural background, and socioeconomic status in ABA research (NAC, 2015). A recent review conducted by Jones et al. (2020) examined the demographic variables reported in studies published in the *Journal of Applied Behavior Analysis* from 2013 to 2019. Jones et al. showed that only 7% of studies reported on race or ethnicity of participants, 4% of studies reported on their language, and 2% reported on participant's socioeconomic status. Of the studies which reported the race or ethnicity of participants, 69% were Caucasian, followed by 20% African American. Less than 5% of participants were of any other race. These results exposed not only the disparity in the availability of intervention across groups of people but also the importance of ensuring that practices yielded from the empirical literature are adapted and acceptable for a particular group of individuals, in particular minorities who are poorly represented in research (Jones et al., 2020).

ABA interventions focus on using the knowledge gained from the science of behavior analysis to address socially-significant behaviors (Baer et al., 1968) including the behavior concerns typically observed in children, adolescents, and adults with ASD. Even though ABA interventions have already been consolidated as evidence-based, there is a general sense in the field of constant reevaluation of well-known procedures and development of new ones to ensure practices that are as effective and as efficient as possible in order to guarantee a better quality of life for individuals with ASD and their families.

Conflict of Interest We have no known conflict of interest to disclose.

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65 Substance Abuse

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Introduction

Addiction to drugs, alcohol, and cigarettes costs the United States about $740 billion annually in crime, lost work productivity, and health care (National Institute on Drug Abuse, 2020). Although some pharmacological treatments produce beneficial effects, their effects are drug specific, they do not completely eliminate the targeted drug use in all participants, and their effects do not persist after the pharmacological treatment ends (Mattick et al., 2014; Sees et al., 2000). Furthermore, pharmacological interventions are not available for some drugs, like cocaine (Chan et al., 2019). Psychosocial treatments may have limited or no effect (Amato et al., 2011; De Crescenzo et al., 2018). We clearly need treatments that are more effective.

Operant conditioning treatments for drug addiction, frequently called contingency management interventions, hold great promise. Extensive research in the laboratory and the clinic shows that contingency management interventions have a strong empirical foundation and may be one of the most effective types of treatments for drug addiction (Dutra et al., 2008). This chapter will review the scientific foundation of contingency management interventions, provide an overview of both the strengths and limitations of contingency management interventions, and suggest broad areas for future directions. Because this chapter will address a large body of research, we will primarily reference reviews where readers can learn more about specific areas. We will use examples from our own research in adults with opioid use disorder to illustrate the main points of the chapter. Although these examples focus on a specific population (i.e., adults with opioid use disorder) and particular drugs (i.e., opiates and cocaine), the methods and outcomes apply to other populations and drugs of abuse.

A Laboratory Model of Drug Addiction

Contingency management interventions are rooted in a robust laboratory model of drug addiction as operant behavior (Bigelow et al., 1981; Deneau et al., 1969; Schuster & Thompson, 1969). Central to that model, laboratory research has shown that most commonly abused drugs can serve as reinforcers to maintain their self-administration. Virtually all drugs abused by humans can serve as reinforcers in the laboratory (Griffiths et al., 1980); most notably, cocaine (Johanson & Fischman, 1989), opiates (Schuster & Johanson, 1981), barbiturates (Ator &

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_65

Griffiths, 1987), benzodiazepines (Ator & Griffiths, 1987), marijuana (Justinova et al., 2005), and nicotine (Le Foll & Goldberg, 2005). The findings that drugs can serve as reinforcers generalize across a wide range of species, including humans (Griffiths et al., 1980). Importantly, this research showed that drugs could serve as reinforcers in naïve nonhuman organisms who were not exposed to special environmental circumstances or particular behavioral histories. In addition to suggesting that drug addiction can be operant behavior, this research suggests that drug reinforcement is biologically normal (Bigelow et al., 1981). That is, the reinforcing efficacy of drugs is not limited to certain individuals or specific environmental factors. Like clinical observations, drug reinforcement in the laboratory can maintain drug self-administration despite severe adverse consequences. For example—and most remarkably—animals given unlimited access to cocaine will self-administer the drug at levels that ultimately lead to death (Aigner & Balster, 1978; Deneau et al., 1969). Although drug addiction has frequently been described as a disease (Barnett et al., 2018; Leshner, 1997; Volkow et al., 2016), we can view drug addiction as operant behavior under the control of powerful and biologically normal drug reinforcement (Bigelow et al., 1981).

Environmental Modulation of Drug Reinforcement

Despite the powerful effects of drug reinforcement, laboratory researchers have shown that the same range of environmental variables that affect other operant behaviors can modulate behaviors maintained by drug reinforcement (Griffiths et al., 1980; Johanson & Fischman, 1989; Schuster & Johanson, 1981; Schuster & Thompson, 1969; Woolverton, 1992). Most relevant to the operant treatment of drug addiction, we can decrease drug-reinforced responding and drug consumption by arranging reinforcement with non-drug reinforcers for an alternative response. The effect on drug-reinforced responding and drug consumption is most substantial when laboratory subjects are required to make mutually exclusive choices between drug and non-drug reinforcers. The reduction in drug-reinforced responding and drug consumption is positively related to the magnitude of the non-drug reinforcer and the response requirement for drug reinforcements. Likewise, the reduction in drug-reinforced responding and drug consumption is negatively related to the dose of the drug and the delay to the non-drug reinforcer. Finally, we can decrease drug-reinforced responding and drug consumption by punishing drug-reinforced responding.

Nowhere is the potential of the environment to modulate drug use more evident than in a series of residential laboratory studies with so-called "skid-row alcoholics" (Bigelow et al., 1975). In these studies, participants living in a residential unit accessed alcohol drinks while under different contingencies. The studies showed that environmental consequences of alcohol use could reduce alcohol consumption. For example, access to enriched environments contingent on limited drinking (Cohen et al., 1971) or brief time outs for alcohol use (Bigelow et al., 1974) reduced alcohol use. Whereas many thought that the drinking of these skid-row alcoholics was "out of control," these studies showed that alcohol drinking in these individuals could be modulated by the consequences of drinking (Cohen et al., 1971).

Models of Relapse

Researchers and clinicians frequently describe drug addiction as a chronic relapsing disorder (McLellan et al., 2000). This conception comes from observations that many people alternate between periods of drug use and abstinence, but frequently continue drug use for many years and sometimes throughout life (Hser et al., 2001; McLellan et al., 2000; Vaillant, 1973). From an operant perspective, relapse is an orderly and predictable event. Laboratory models of relapse show that organisms whose responses (e.g., lever pressing) are acquired and maintained by drug reinforcement will stop responding when the reinforced response no longer produces drug administrations, but that those organisms will resume responding when a discriminative stimulus that previously set the occasion for drug reinforced responding is re-introduced. Laboratory researchers have demonstrated this so-called reinstatement model of relapse across a wide range of organisms and conditions (Katz & Higgins, 2003).

Physical Dependence

Some drugs when taken regularly produce physical dependence, and their discontinuation can produce an uncomfortable and potentially dangerous withdrawal syndrome. Although physical dependence and withdrawal are not necessary for drug reinforcement, they can increase drug reinforcement (Schuster & Johanson, 1981). For example, an individual who becomes physically dependent on opioids may take them in part because opioid self-administration avoids or alleviates opioid withdrawal symptoms. To the extent possible, any treatment for drug addiction, including operant treatments, should manage and diminish drug physical dependence and withdrawal.

Addiction Treatment Medications

Medications are available to treat addiction to some drugs and can provide great benefit in treatment (Volkow, 2020). Laboratory research shows that effective medications for the treatment of drug addiction diminish the withdrawal syndrome associated with abrupt termination of drug use and/or reduce the reinforcing effects of the abused drugs (Mello & Negus, 1996). When available, treatment medications can be enormously helpful in the operant treatment of drug addiction.

Application of Operant Conditioning to Treat Drug Addiction

Researchers have applied contingency management interventions to treat drug addiction in two ways: through the direct reinforcement of drug abstinence and through the reinforcement of behaviors that might increase drug abstinence.

Abstinence Reinforcement

Drug use is operant behavior that we can reduce by arranging reinforcement for drug abstinence. However, arranging abstinence reinforcement poses special challenges. People addicted to drugs use drugs at home or in other areas in the community, under a wide range of conditions, and at all hours of the day and night. Therapists cannot be present to continuously observe behavior and provide programmed consequences to reinforce abstinence or alternative behaviors. To circumvent this practical limitation, therapists can provide reinforcement when biological samples (i.e., permanent products) show that a patient has been abstinent from drugs. Researchers have used biologically based abstinence reinforcement interventions to promote abstinence from most commonly abused drugs across diverse populations (Bigelow et al., 1981; Silverman et al., 2011).

Biological Measures of Drug Use

People take drugs into the body through various routes (e.g., oral, intravenous, intranasal) and eliminate those drugs from the body—as the original drug or as converted or metabolized versions of the drug—through biological products. We can determine whether an individual used a particular drug by analyzing those biological products. We can reinforce abstinence from a drug by providing reinforcement when those biological products confirm abstinence from that drug. Abstinence reinforcement interventions are best when analyses of collected biological products identify relatively recent instances of drug use and when we can detect all or most instances of drug use in those products for a given period.

The value of tests of biological products The value of tests of biological products for abstinence reinforcement interventions can vary considerably. Tests of biological products that only reveal recent drug use (e.g., drug use that occurred in the past few hours) can be useful because they allow relatively immediate reinforcement of abstinence; however, they pose special challenges for abstinence reinforcement interventions because we must conduct those tests frequently or on a random schedule to avoid missing some instances of drug use. Tests of biological products that reveal less recent drug use (e.g., drug use that has occurred in the past few days) can be useful because they reduce the chance of missing any instances of drug use; however, those tests limit the potential to reinforce recent abstinence. For example, interventions designed to reinforce abstinence from heroin and cocaine typically rely on qualitative analyses of drug metabolites (morphine and benzoylecgonine, respectively) in urine samples (Phan et al., 2012; Tenore, 2010). Abstinence reinforcement interventions to promote smoking cessation can use breath Carbon Monoxide samples, which can confirm very recent smoking cessation, or urine cotinine (a metabolite of nicotine), which can confirm smoking cessation over several days (SRNT Subcommittee on Biochemical Verification, 2002).

Valid sample collection In conducting an abstinence reinforcement intervention, we must confirm that the sample is valid so that we can be sure that we are reinforcing the behavior that our intervention targets. Specifically, we must confirm that the participant provided the biological sample and that the sample is not adulterated. We can do this in different ways, depending on the type of sample provided and the location of the collection. For example, treatment providers typically collect urine samples under direct observation by a same-sex staff person and breath samples under direct observation or through remote video recordings. We require that a urine sample be close to body temperature to confirm that the sample came directly from the participant's body. We can test the urine for creatinine to confirm that the participant did not dilute the sample and test for other adulterants to confirm that the participant did not add other chemicals to the urine sample that could obscure the test results (Phan et al., 2012).

Effectiveness of Abstinence Reinforcement

Abstinence reinforcement interventions are among the most effective psychosocial treatments for drug addiction. One meta-analytic review showed that abstinence reinforcement interventions were the most effective of all psychosocial interventions examined in controlled studies (Dutra et al., 2008). Similarly, the National Institute for Health and Care Excellence in the United Kingdom reviewed psychosocial treatments for drug addiction and concluded that abstinence reinforcement interventions are among the most effective of available treatments (Pilling et al., 2007). Cochrane reviews have shown that abstinence reinforcement interventions are effective in the treatment of cocaine addiction (Knapp et al., 2007) and cigarette smoking (Notley et al., 2019).

Early studies Researchers like Maxine L Stitzer, George E. Bigelow, Peter M. Miller, and Thomas J. Crowley started investigating the effectiveness of abstinence reinforcement interventions over 40 years ago. Early studies (Silverman et al., 2011; Stitzer & Kirby, 1991) showed that abstinence reinforcement interventions could promote abstinence from alcohol, they could promote abstinence from opiates and benzodiazepines in adults enrolled in methadone treatment, they appeared useful to promoting drug abstinence in "impaired" health professionals, and they proved effective in promoting smoking cessation in diverse populations of cigarette smokers.

Voucher-based reinforcement In the early 1990s, Stephen T. Higgins and his colleagues at the University of Vermont developed what proved to be one of the most effective and versatile abstinence reinforcement interventions (Higgins et al., 1991). Under that intervention, participants received monetary vouchers exchangeable for goods and services for providing thrice-weekly urine samples that were negative for cocaine. The intervention was in effect for 12 weeks, and the value of the vouchers increased as the number of consecutive cocaine-negative urine samples increased. In addition, participants received bonus vouchers for every three consecutive cocaine-negative urine samples. Since its original development, this voucher intervention has proved effective in promoting abstinence from most commonly abused drugs and in diverse populations (Davis et al., 2016; Lussier et al., 2006).

Prize reinforcement In 2000, Nancy M. Petry developed a variation in the voucher intervention that proved effective and attractive to clinicians and others (Petry et al., 2000). Under that intervention, participants earned the opportunity to draw "prizes" from a bowl contingent on providing alcohol-negative breath samples. The bowl contained a number of slips of paper with a message. Seventy-five percent of the slips indicated that the participant won a small, medium, or large prize; the remaining slips did not produce a prize and said, "Sorry, try again." The prizes were onsite in a locked file cabinet. Similar to the schedule of escalating reinforcement for sustained abstinence that Higgins and colleagues had developed, participants earned progressively more draws as the number of their consecutive alcohol-negative breath samples increased. They also earned bonus draws when they maintained abstinence from alcohol for a full week. Many investigators have used this prize reinforcement intervention to promote abstinence from a range of drugs and in diverse populations, including studies conducted by NIDA's Clinical Trials Network, a national network of drug-abuse treatment programs in the United States (Benishek et al., 2014).

An illustrative example One study of injection drug users who used cocaine during methadone treatment provides a good example of the benefits and limitations of abstinence reinforcement interventions (Silverman et al., 1996). In that study, after a five-week baseline period, participants were randomly assigned to a voucher-based abstinence reinforcement condition or a yoked control condition. The voucher-based abstinence reinforcement condition was similar to the intervention developed by Higgins and colleagues (Higgins et al., 1991). Participants in the yoked control condition received the same vouchers independent of their cocaine abstinence. Over the 12-week intervention period, participants in the voucher-based abstinence reinforcement condition achieved significantly more cocaine abstinence than participants in the yoked control condition. This study illustrates both the benefits and limitations of abstinence reinforcement interventions. First, the abstinence reinforcement intervention was highly effective in promoting cocaine abstinence in this population. Second, although effective, not all participants achieved sustained cocaine abstinence when exposed to this intervention. Finally, many participants relapsed to cocaine use when the voucher-based abstinence reinforcement intervention ended.

Critical Parameters of Abstinence Reinforcement Interventions

Although abstinence reinforcement interventions have been highly effective, as described above, not all participants have responded to these interventions. In virtually all applications of abstinence reinforcement interventions, some proportion of participants do not respond to the intervention (Silverman et al., 2011). In many applications, half or more of participants appear unresponsive. A range of key parameters probably influences the effectiveness of abstinence reinforcement interventions. Researchers have not studied most parameters directly, but employing optimal parameters known to affect other instances of operant conditioning is probably appropriate.

Reinforcement magnitude Researchers have studied the effects of reinforcement magnitude in abstinence reinforcement interventions more than other parameters. Early research showed that increasing reinforcement magnitude in an abstinence reinforcement intervention could increase smoking cessation (Stitzer & Bigelow, 1984). Two studies showed that increasing abstinence reinforcement magnitude could promote abstinence in refractory participants who did not initiate abstinence at lower reinforcement magnitudes (Dallery et al., 2001; Silverman et al., 1999). In one of those studies (Silverman et al., 1999), researchers offered adults who had evidence of injection drug use and continued to use cocaine during methadone treatment $1155 over 13 weeks for providing cocaine-negative urine samples three times per week. Participants who did not initiate cocaine abstinence in that "treatment failure screening" condition, were then exposed to a zero, low-magnitude, and high-magnitude condition in counterbalanced order in which they could earn $0, $380, or $3400, respectively, for providing cocaine-negative urine samples three times per week for nine weeks. Figure 65.1 shows the longest duration of sustained cocaine abstinence that participants achieved in the three nine-week conditions. Participants achieved significantly longer periods of sustained cocaine abstinence in the high-magnitude condition than in the other two conditions (i.e., zero and low-magnitude conditions). Although the percentage of participants who provided cocaine-negative urine samples never exceeded 25% during the 13-week treatment failure condition or during the nine-week zero or low-magnitude conditions, the percentage of participants who provided cocaine-negative urine samples exceeded 50% during five of the weeks of the nine-week high-magnitude condition.

Other studies showed that abstinence reinforcement magnitude affects abstinence outcomes (Higgins et al., 2007; Petry et al., 2004). For example, Petry and colleagues (Petry et al., 2004) randomly assigned cocaine users to one of three conditions: a standard treatment, standard-magnitude abstinence reinforcement, and low-magnitude abstinence reinforcement. In the standard-magnitude condition, partici-

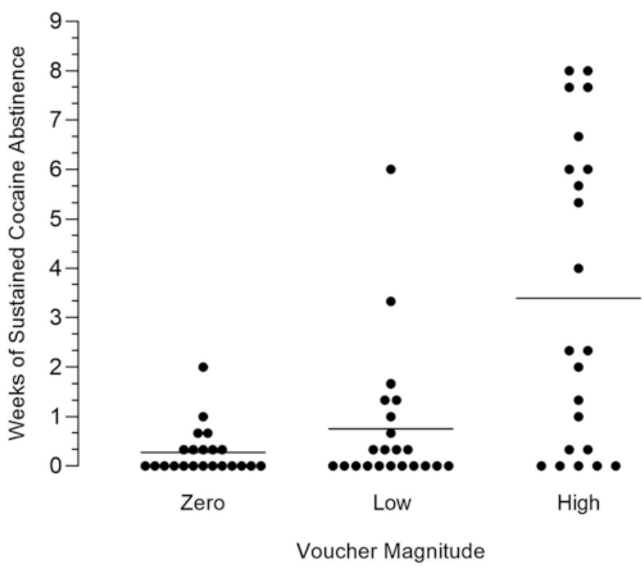

Fig. 65.1 Longest duration of sustained cocaine abstinence achieved during the zero (*left column*), low (*middle column*), and high (*right column*) magnitude voucher conditions. Each *point* represents data for an individual participant ($n = 22$) and the *lines* represent condition means. Each participant was exposed to each of the three voucher conditions in counterbalanced order. The maximum possible duration of sustained abstinence was nine weeks for each condition. (Adapted from Silverman et al. (1999), Fig. 2, with permission)

pants received a reinforcer that was a similar magnitude as those found effective in prior studies; whereas, in the low-magnitude condition, participants received a reinforcer one third the size of that in the standard-magnitude condition. The study found that, although the standard-magnitude condition was effective in increasing cocaine abstinence, the low-magnitude condition had no effect on cocaine abstinence.

Unpredictable reinforcement (lottery-like reinforcement) Some researchers have suggested that offering unpredictable and varying reinforcement magnitudes, like a lottery, can increase effectiveness over a predictable reinforcement magnitude, like the voucher-based abstinence reinforcement intervention developed by Higgins and colleagues. Prize reinforcement is a common intervention that uses this unpredictable-magnitude approach. Prize reinforcement researchers have proposed that one could use variable or unpredictable reinforcement to reduce the magnitude of reinforcement (and cost) without sacrificing effectiveness. One study that directly compared prize reinforcement to standard voucher-based abstinence reinforcement (i.e., predictable magnitude) showed that the two approaches produced similar results when overall reinforcement magnitude was similar (Petry et al., 2005).

Other reinforcement parameters Other parameters of abstinence reinforcement (e.g., immediacy) appear to alter the effectiveness of abstinence reinforcement interventions, but the evidence comes mostly from basic laboratory research or by comparison across clinical studies. For example, one meta-analysis used data from different studies that arranged various delays to reinforcement and found that effectiveness decreased as the delay to reinforcement increased (Lussier et al., 2006).

Relapse Prevention

Researchers and clinicians have called drug addiction a chronic relapsing condition (McLellan et al., 2000). Although occasionally interrupted, drug addiction frequently lasts for many years and often throughout a person's lifetime (Hser et al., 2001; Vaillant, 1973). Despite their success in the short-term, addiction treatments have generally failed to produce long-term drug abstinence. For example, Methadone maintenance treatment is one of the most effective treatments for opioid addiction; however, when the methadone dose decreases, participants return to opioid use (Sees et al., 2000). Similarly, from the earliest applications, abstinence reinforcement interventions have failed to promote abstinence that reliably lasts after the abstinence reinforcement ends (Silverman et al., 2011). Some studies show that the effects of abstinence reinforcement interventions are detectable after the abstinence reinforcement ends, but even those studies show that progressively more participants relapse to drug use as the time after discontinuation of the abstinence reinforcement intervention increases.

Combining abstinence reinforcement with relapse-prevention counseling Some observers and researchers have suggested that abstinence reinforcement interventions might produce lasting effects when combined with cognitive-behavior relapse prevention counseling. However, several studies that evaluated this possibility failed to show any benefit of this combination, during or after the interventions were applied (Silverman et al., 2011).

Abstinence reinforcement as a maintenance intervention Abstinence interventions may need to be continued on a long-term basis to maintain their effectiveness over time—similar to various medical interventions that need to be continued over time (e.g., antiretroviral medications for HIV, methadone for opioid use disorder). Silverman and colleagues have proposed using abstinence reinforcement as a maintenance intervention to prevent relapse (Silverman et al., 2002, 2004). Two studies showed that long-term exposure to abstinence reinforcement could maintain cocaine abstinence (Silverman et al., 2004) and cocaine and opiate abstinence (Silverman et al., 2002) for one and three years, respectively. One study randomly assigned participants to a short-term or longer-term reinforcement of cocaine abstinence and showed that longer-term exposure to voucher-based abstinence reinforcement maintained higher rates of cocaine abstinence, at least as long as the abstinence reinforcement was maintained (Kirby et al., 2013).

Another study in methadone patients who continued to use cocaine during methadone treatment demonstrated the effectiveness and limitation of using abstinence reinforcement as a maintenance intervention (DeFulio et al., 2009; DeFulio & Silverman, 2011). In that study, all participants attended a model "therapeutic" workplace for 18 months, where they could work every weekday and earn about $10 per hour. During a six-month training phase, the therapeutic workplace staff trained participants to become data entry operators and exposed them to employment-based abstinence reinforcement in which they could maintain maximum pay as long as they continued to provide urine samples negative for drugs (opiates and cocaine). If a participant ever failed to provide a urine sample or provided a drug-positive sample, the staff temporarily reduced the participant's hourly pay for working in the workplace. After the first six months, participants who continued attending the therapeutic workplace and initiated drug abstinence were hired as data entry operators in a simulated therapeutic workplace business for one year and randomly assigned to an Employment Only group or to an Abstinence-Contingent Employment group. Employment Only participants could work and earn pay independent of their urinalysis results. Participants in the Abstinence-Contingent Employment group had to provide drug-negative urine samples to access the workplace and to maintain maximum pay.

Figure 65.2 (DeFulio & Silverman, 2011) shows the percentage of participants that provided cocaine-negative urine samples every six months before, during and after exposure to the Employment Only and Abstinence-Contingent Employment conditions in the therapeutic workplace business. As designed, almost no participants from both groups provided cocaine-negative urine samples at Intake to the study, but almost all participants provided cocaine-negative urines samples at the end of the six-month training phase when all participants experienced employment-based abstinence reinforcement. During the year of employment after random assignment, Abstinence-Contingent Employment participants maintained significantly higher rates of cocaine abstinence than Employment Only participants, demonstrating that employment-based abstinence

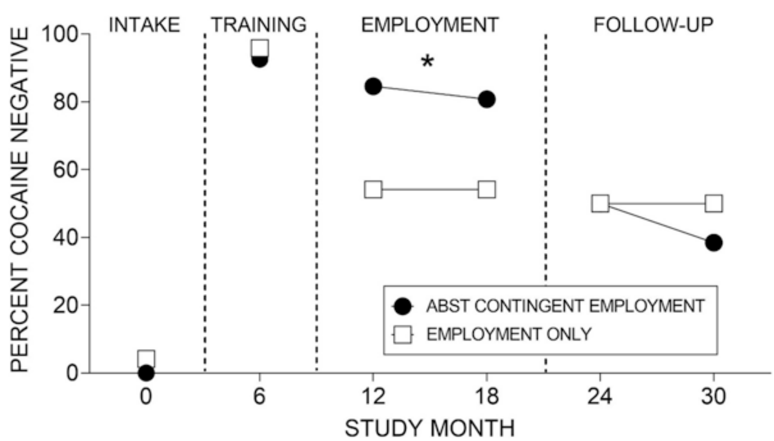

Fig. 65.2 Percentage of cocaine-negative samples collected at intake (study month 0), the end of the abstinence initiation and training phase (study month 6), during employment (study months 12 and 18), and at post-treatment follow-up (study months 24 and 30). Missing samples were counted as positive. The asterisk indicates that the groups are significantly different ($P < 0.05$) based on generalized estimating equation (GEE) analysis. (Adapted from DeFulio and Silverman et al. (2011), *Addiction*, Fig. 1, with permission)

reinforcement can serve as an effective maintenance intervention. Despite experiencing 18 months of employment-based reinforcement, many Abstinence-Contingent Employment participants relapsed to cocaine use in the follow-up year and provided similar rates of cocaine-negative urine samples as the Employment Only participants. This study showed that abstinence reinforcement could serve as an effective maintenance intervention and could maintain abstinence over extended periods. However, as many other studies have shown, many people relapse to drug use after the abstinence reinforcement contingencies end

Reinforcement of Behaviors that Might Reduce Drug Use

Researchers have also used operant conditioning or contingency management to increase other behaviors that might increase drug abstinence. These applications have sought to increase attendance in counseling, to increase alternative behaviors that might be incompatible with drug use, to increase the use of addiction medications, and to reduce risk factors that might increase vulnerability to drug addiction.

Attendance in Counseling or Alternative Behaviors

Some investigators have used operant conditioning to promote attendance in substance abuse treatment (Kidorf et al., 1994; Schacht et al., 2017) or alternative behaviors that are incompatible with drug use (Petry et al., 2006). These types of interventions can increase the target behaviors, but they do not appear to increase drug abstinence.

Medication Adherence

Some addiction treatment medications, like methadone or buprenorphine, can serve as reinforcers and can help retain participants in treatment and promote adherence to the medication regimen. However, some treatment medications are not reinforcers and treatment retention and adherence are serious problems. In those cases, reinforcement can promote adherence to medication regimens (DeFulio & Silverman, 2012; Petry et al., 2012). Naltrexone is a good example. Naltrexone has no effects on its own, but blocks the effects of opioids. Although it has features that could make it a good medication for the treatment of opioid addiction, many patients refuse to take it. Several randomized controlled trials have shown that financial incentives can reinforce naltrexone adherence, but failed to show that reinforcement of naltrexone adherence increases opioid abstinence. One secondary analysis that combined data from three studies did provide some evidence that reinforcement of naltrexone adherence can increase opiate abstinence (Jarvis et al., 2017).

Risk Factors

Researchers have also used operant conditioning or contingency management to modify risk factors that might affect drug use (Silverman et al., 2019), although relatively little research has addressed risk factors. As discussed above, drug reinforcement is biologically normal, as evidenced by the fact that it is common in laboratory animals independent of any special history. Yet drug addiction is more common in some populations than in others. Some vulnerabilities appear rooted in environmental circumstances that operant conditioning could modify. For example, people with limited education, who are unemployed, and who live in poverty appear particularly vulnerable to drug addiction.

The Institute of Medicine identified poverty and high-school graduation as two of the "most powerful determinants of health for which meaningful action can be taken (p. 3) (National Center for Health Statistics, 2012)." A large-scale and rigorous analysis showed that "poverty, smoking, and high-school dropouts impose the greatest burden of disease in the United States" of major known risk factors (Muennig et al., 2010). A number of studies have shown that poverty is associated with reduced lifespan and a variety of health problems, including drug addiction (Armstrong, 2007; Chetty et al., 2016; Muennig et al., 2010; Silverman et al., 2019; Williams & Latkin, 2007).

Education Importantly, scientific evidence suggests that "schooling is causally related to improvements in health outcomes" as is "raising the incomes of the poor (Kawachi et al., 2010)." Improving education could be an ideal means to improve the lives of poorly educated and low-income populations because increasing education appears to increase income. Data from the U.S. Census Bureau shows that lifetime income increases progressively as adults achieve higher levels of education (Bauman & Ryan, 2001; Day & Newburger, 2002). Health policy experts writing for the New York Academy of Sciences concluded that "if socioeconomic disparities in U.S. population health are to be substantially improved by the next generation, investing in all manner of education is broadly speaking one of the most promising approaches (Dow et al., 2010)."

Despite the need and potential benefits of education, very few adults who do not have a high-school diploma or equivalent participate in adult education. The Institutes of Education Sciences, National Center for Education Statistics estimated that among adults over the age of 16 who did not have a high-school diploma or equivalent, only 1.0% participated in degree or diploma programs, and only 4.2% participated in work-related courses (Planty et al., 2007).

In their efforts to combat poverty, governments and private foundations have attempted to promote the education of low-income adults, but these efforts have generally failed because of low rates of participation in the available educational opportunities (Courtin et al., 2020; Holtyn et al., 2017). A large-scale randomized controlled study evaluated "education-focused" programs for adult welfare-recipients, but failed to show definitive benefit of the education-focused approach because most participants did not attend the education and training programs long enough to reap their potential benefits (Bos et al., 2002). Importantly, secondary analyses showed that increased retention and participation in educational programs were associated with improvements in basic literacy and math skills, increased attainment of GEDs, and increased employment earnings. In reviewing these results, Bos and colleagues (Bos et al., 2002) concluded that "All this suggests that [education-focused] programs could have more substantial effects on economic outcomes of welfare recipients if these programs managed to improve their effects on mediating education outcomes. Our analyses suggest that increased retention might be one way to achieve this (p. 14)." Similar results were obtained in adult literacy programs (Porter et al., 2005).

A series of studies conducted in the therapeutic workplace showed that reinforcement could increase attendance in education and progress through training programs (Silverman et al., 2018). One study by Koffarnus and colleagues illustrates the need for and potential of reinforcement to promote education in low-income drug users (Koffarnus et al., 2013). In that study, unemployed injection drug users could work on typing and keypad training programs. In both of the programs, participants practiced the skills in 1-minute timings. The investigators randomly assigned participants to two groups: Group A and Group B. Group A participants earned base and productivity pay while working on the typing program and base pay only while working on the keypad program. Group B participants earned base and productivity pay while working on the keypad program and base pay only while working on the typing program. Participants always earned about $10 per hour. Participants completed significantly more training program steps (Fig. 65.3, top panel) and significantly more timings per hour (Fig. 65.3, bottom panel) when they earned productivity and base pay (filled circles) than when they only earned base pay (open circles). That study showed that the unemployed injection drug users who participated in this study will work on training programs significantly more when offered pay for performance on training programs than when they do not earn incentives for performance on training programs (Koffarnus et al., 2013). Similar reinforcement contingencies could promote academic and job skills that might promote employment and reduce poverty.

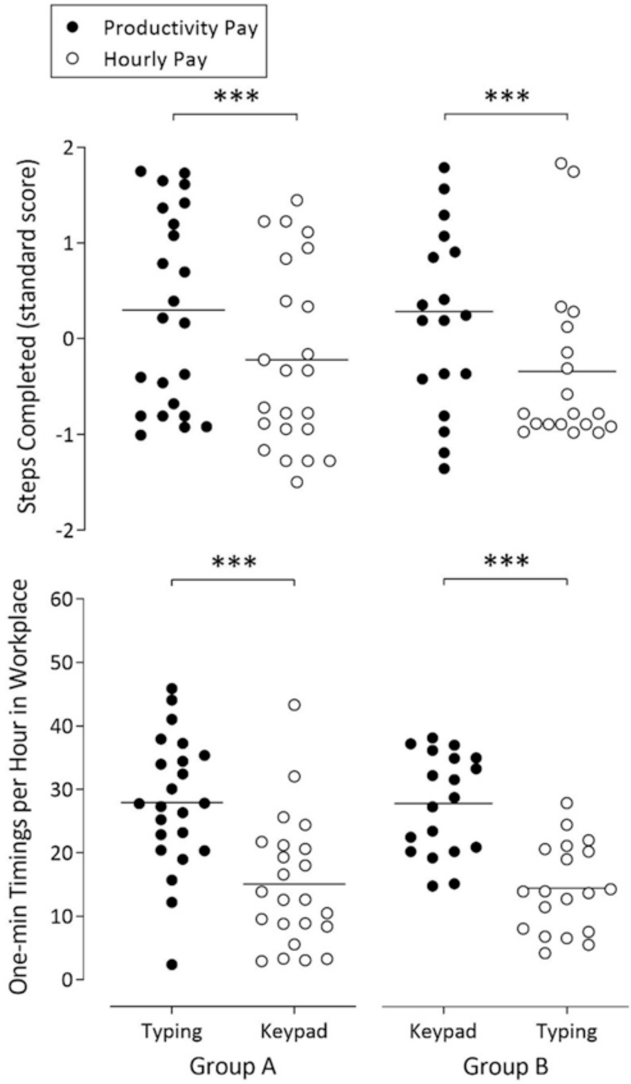

Fig. 65.3 Steps completed (top) represented as a standard score and timings initiated per hour (bottom) as a function of group and payment condition. Each point represents an individual participant, and the horizontal lines represent the group means. Asterisks indicate a significant effect of planned comparisons between payment conditions for each group (***$p < 0.001$). (Adapted from Koffarnus et al. (2013), Fig. 1 with permission)

Unemployment and poverty Governments in Minnesota, Connecticut, Milwaukee, New York, and Canada have used wage supplements to increase employment in welfare recipients (Holtyn et al., 2017). One study showed that reinforcement contingencies, specifically abstinence-contingent wage supplements, could directly increase employment and reduce poverty in a group of unemployed drug users (Holtyn et al., 2020). Under wage supplement programs, participants earned wage supplements for working in community jobs. Abstinence-contingent wage supplements use wage supplements (e.g., supplemental hourly pay) to promote employment, while simultaneously harnessing the power of the wage supplements to reinforce drug abstinence. In this study, after a three-month abstinence initiation and training period, unemployed adults in medication-assisted treatment (methadone or buprenorphine) for opioid use disorder ($N = 91$) were randomly assigned to a Usual Care Control group or to an Abstinence-Contingent Wage Supplement group. All participants could work with an employment specialist to seek employment in a community job for 12 months. Abstinence-Contingent Wage

Supplement participants could earn employment-based incentives in the form of stipends for working with the employment specialist and wage supplements for working in a community job, but had to provide opiate- and cocaine-negative urine samples to maximize pay. Abstinence-Contingent Wage Supplement participants provided significantly more opiate- and cocaine-negative urine samples than Usual Care Control participants during the 12-month intervention. In addition, Abstinence-Contingent Wage Supplement participants were significantly more likely to obtain employment (59% versus 28%; Fig. 65.4, top panel) and live out of poverty (61% versus 30%; Fig. 65.4, bottom panel) by the end of the 12-month intervention than Usual Care Control participants. That study showed that abstinence-contingent wage supplements can promote drug abstinence, increase employment, and reduce poverty (Holtyn et al., 2020).

Applications for Widespread Use

Despite the strong empirical evidence of effectiveness, our society has not applied contingency management interventions widely. Several researchers have made efforts to develop applications that we could use widely in society. This section provides important examples of these interventions.

Remote Technology

One barrier to adoption of contingency management interventions is transportation to and from the clinic. Transportation is particularly problematic when frequent participant visits are required. To address this logistical problem, several researchers have developed contingency management interventions that utilize remote internet and computer technology (Dallery et al., 2019; Getty et al., 2019). Under these interventions, participants can video record themselves emitting

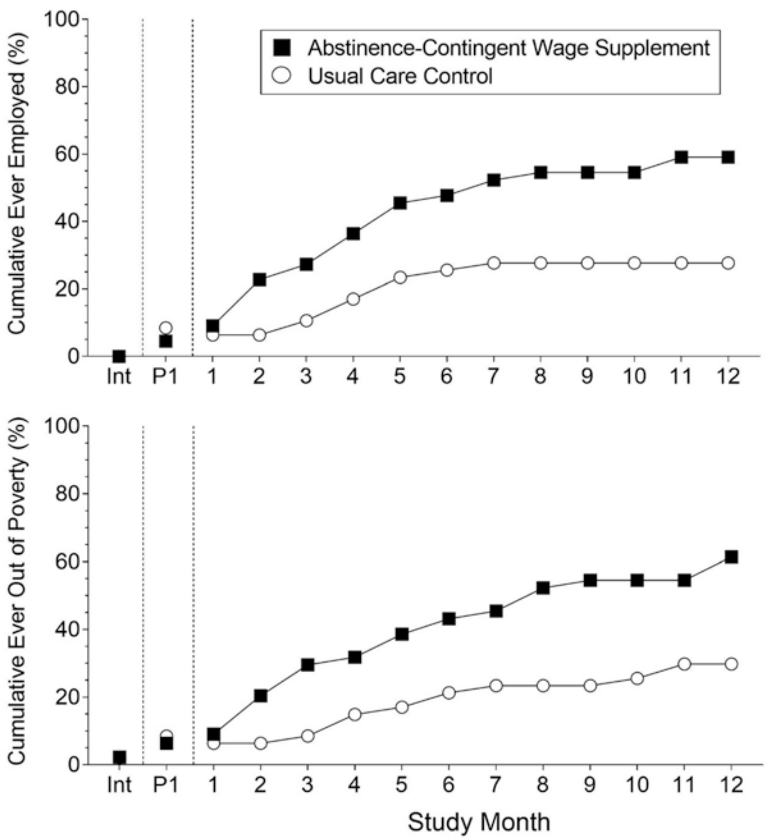

Fig. 65.4 Percentage of participants who were ever employed (top) and ever lived out of poverty (bottom) in the usual care control group (circles) and the abstinence-contingent wage supplement group (squares) at intake (Int), during phase 1 (P1), and across consecutive months during the intervention (phase 2). The difference between groups at the end of phase 2 was statistically significant for "ever employed" (OR = 3.88, 95% CI 1.60 to 9.41, $p = 0.004$) and "ever lived out of poverty" (OR = 3.77, 95% CI 1.57 to 9.04, $p = 0.004$). (Adapted from Holtyn et al. (2020), Figs. 3 and 4, with permission)

the required behaviors and transmit the videos through the internet. In addition, some devices allow for direct transmission of the results of biological testing. Using these technologies, treatment providers can evaluate participant behavior and arrange reinforcement remotely. Researchers have used these remote technology interventions to promote smoking cessation, medication adherence, and abstinence from alcohol and marijuana. These remote internet technologies can extend the reach and reduce the cost of contingency management interventions.

Dallery and colleagues pioneered this type of intervention to promote smoking cessation. Under their intervention, participants recorded videos of themselves providing Carbon Monoxide (CO) breath samples, which provided evidence of recent smoking or smoking cessation, and sent the time-stamped videos to researchers through the internet. Researchers reviewed the videos and provided incentives through the internet if the video was valid and if the CO level met the criterion for reinforcement. Results across multiple studies have demonstrated the effectiveness of this intervention in reducing smoking. In one study, Dallery and colleagues demonstrated the remarkable reach of this intervention (Dallery et al., 2017). They randomly assigned 94 smokers from 26 states across the United States to an Abstinence-Contingent group or to a Submission Contingent group. Both groups provided a $50 deposit. Abstinence-Contingent participants received the internet-based contingency management smoking cessation intervention. Abstinence-Contingent participants provided significantly more negative CO samples during the intervention.

Short-Term Benefits

As discussed previously, one of the greatest limitations of contingency management interventions is that their effects do not reliably persist after the intervention ends. However, a contingency management intervention can be extremely beneficial in situations in which only a short-term effect is required.

Abstinence reinforcement interventions have promoted smoking cessation in pregnant cigarette smokers, and short-term exposure to these interventions has produced important beneficial effects on the fetus and newborn child (Higgins et al., 2010). For example, an analysis of three randomized controlled trials in pregnant cigarette smokers showed that voucher-based reinforcement for smoking cessation promoted smoking cessation in the women, increased birth weight of the babies, and reduced the percentage of low-birth-weight babies (Higgins et al., 2010). The effects of the voucher-based abstinence reinforcement intervention on smoking cessation in the women was still evident and statistically significant after the intervention ended, although the rates of smoking cessation decreased progressively over the weeks after delivery and after the abstinence reinforcement ended. The voucher-based abstinence reinforcement produced short-term beneficial effects on the newborn babies, despite the fact than many of the mothers relapsed to cigarette smoking after the abstinence reinforcement ended.

Businesses and Government Organizations

Contingency management interventions might be applied by organizations that see benefit in promoting therapeutic behavior change in its members. Businesses might be one such organization. Halpern and colleagues conducted studies of smoking cessation interventions of employees in large businesses (Halpern et al., 2015, 2018). One study included 2538 employees (and their relatives and friends) of CVS Caremark and the other included 6006 employees of 54 different companies. Both studies showed that reinforcement of smoking cessation could significantly increase the percentage of people who stopped smoking—although both studies used very small magnitude incentives and affected the behavior of relatively small percentages of participants. In addition, the U.S. Department of Veterans Affairs implemented prize-based abstinence reinforcement in over 70 substance abuse treatment clinics in the United States (Petry et al., 2014).

Harnessing Existing Reinforcement

Some researchers have harnessed the power of high-magnitude reinforcers dispensed for non-therapeutic reasons and arranged abstinence reinforcement contingencies using those reinforcers (Silverman et al., 2011). Social businesses, which exist to address the problems of poverty (Yunus & Weber, 2010), could address the problems of drug addiction in the poor and unemployed by using the social business to arrange employment-based abstinence reinforcement (Silverman et al., 2016). A therapeutic-workplace social business (Hopkins Data Services) employed and paid drug users to serve as data entry operators (Aklin et al., 2014). To promote abstinence, the data entry operators were required to provide routine drug-negative urine samples to maintain access to the workplace and to maintain maximum pay. Participants randomly assigned to a therapeutic workplace group that received the employment-based abstinence reinforcement described above achieved significantly higher rates of drug (opiates and cocaine) abstinence than participants randomly assigned to a usual care control group (see Fig. 65.5). This study suggests that we could use social businesses to address the problems of drug addiction in the poor and unemployed by using the social business to arrange employment-based abstinence reinforcement.

Conclusions

Contingency management interventions are rooted in a robust laboratory model of drug addiction, and many controlled studies show that these interventions can be highly effective in the treatment of drug addiction. Indeed, contingency management interventions may be some of the most effective and versatile interventions available for the treatment of drug addiction. Abstinence reinforcement interventions are arguably the most useful of these interventions. However, contingency management interventions in general and abstinence reinforcement interventions in particular have at least three limitations that we should recognize and address. (1) Contingency management interventions are not effective in all participants. (2) Their effects do not reliably last after the interventions end. (3) Despite the strong empirical evidence of effectiveness, our society has not applied these interventions widely.

Promoting widespread use of these interventions is a great challenge. We do not know why people have not used these interventions widely, although we have some suspicions. As those suspicions have limited factual foundation, we have not offered them. Some researchers have sought to identify barriers to widespread dissemination of contingency management interventions and we refer the interested reader to those resources (Oluwoye et al., 2020). We might see reason for optimism in the fact that various clinicians, governments, and other organizations have used abstinence reinforcement in the treatment of drug addiction, although without experimental evaluation and without clear reference to the empirical support reviewed in this chapter. For example, governments have applied taxes for cigarettes to decrease cigarette smoking (Chaloupka et al., 2012). Physicians addicted to drugs have undergone random urine testing for extended periods that can last as long as five years with severe consequences (loss of ability to continue to work, including loss of license) for detected drug use (DuPont et al., 2009; McLellan et al., 2008). Similarly, drug addicted workers, particularly those in safety sensitive jobs, may be required to undergo a long-term regimen of random urine testing and risk losing employment for detected drug use (Cashman et al., 2009).

Contingency management interventions are unique in that they have a strong empirical foundation, both in the laboratory research that underlies them and in the large number of controlled trials that demonstrate their effectiveness. Widespread application of contingency management interventions could improve treatment outcomes for many drug-addicted individuals. One of our greatest challenges is to ensure that clinicians, governments, and other organizations embrace and adopt effective contingency management interventions for the treatment of drug addiction. This goal will be particularly difficult to achieve if the contingency management

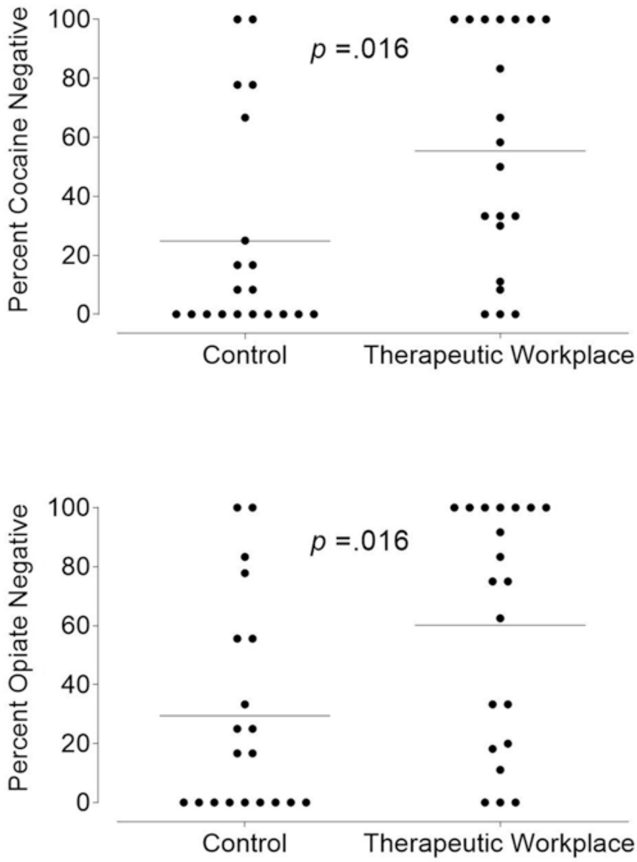

Fig. 65.5 Percentage of negative urine samples for cocaine (top panel) and opiates (bottom panel) during the period while the data entry business, Hopkins Data Services, was opened. Dots represent data for individual participants and horizontal represent group means. Missing samples were considered positive. (Adapted from Aklin et al. (2014), Fig. 2, with permission)

interventions employ high-magnitude reinforcement to promote behavior change in the largest proportion of participants possible and if the contingency management interventions maintain reinforcement over time to sustain the desired behavior change. Promoting adoption of important innovations is not simple (Rogers, 2003), but the extensive body of research conducted to date should serve as a strong foundation for the adoption and diffusion of this important innovation.

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People with Intellectual and Developmental Disabilities

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The history of people with intellectual and developmental disabilities (IDD; note some people prefer identity-first language and to be referred to as intellectually-disabled people) is generally one of shunning and mistreatment (Trent, 2016). In the 1950s and 1960s when other areas of psychology were calling people with IDD unteachable, behavior analysts were evaluating how the principles of behavior could be used to teach new skills and remediate behavioral excesses. This interplay between intellectual disabilities and behavior analysis is still present today both in research and in practice. According the Behavior Analyst Certification Board (BACB) statistics, the number of Board Certified Behavior Analysts (BCBAs) who work with people with IDD is third only to the number who work with people with autism spectrum disorder (ASD) and in education (Behavior Analyst Certification Board, 2020). It is likely that these two most common practice areas include people with IDD. Similarly, Jones et al. (2020) found that the largest population to participate in research in the *Journal of Applied Behavior Analysis* was those with IDD (36%). In this chapter, we will discuss the influence people with IDD have had on behavior analysis in the early years. It will also provide a review of the role that applied behavior analysis (ABA), both as a science and as a profession, has had in upholding the rights of people with IDD and discuss areas in which we need to provide further support.

What Is IDD?

People with IDD make up approximately 1.04% of the world's population (Maulik et al., 2011). including genetic syndromes (e.g., Down syndrome), perinatal causes (including birth injury and birth asphyxia), and postnatal causes (e.g., infections). Intellectual disability is defined in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2022) as deficits in both intellectual and adaptive functioning. This deficit is confirmed by both clinical assessment and standardized intelligence testing (i.e., IQ testing). The onset of the IDD must occur during the developmental period, and limit the individual's functioning in cognitive, conceptual, academic, social, communication, and practical domains (American Psychiatric Association, 2013; Jacobson et al., 2007).

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Behavior Analysis and Early Applications with People with IDD

Throughout the 1930s and 1940s, Skinner began collecting and publishing data on operant conditioning, and this research evolved into the science of behavior analysis (Morris et al., 2013). The aim of this science was to use methods that allowed for prediction and control to understand behavior, something that Skinner believed was not present in the applied psychology fields at the time (Morris, 1992). Although the original studies were animal studies, Skinner believed that people should not be "expected to be interested in the behavior of the rat for its own sake. The importance of a science of behavior derives largely from the possibility of an eventual extension to human affairs" (Skinner, 1938, p. 441).

The first published instance of the use of operant conditioning with humans was recorded by Fuller (1949). Fuller showed that an 18-year-old male with profound intellectual disabilities increased the number of times he raised his arm when this behavior was reinforced by access to sweet milk. By no means is Fuller's demonstration an example of ABA because arm-raising did not improve the man's quality of life (QoL). Similarly, many current behavior analysts would be shocked at Fuller's description of the man involved in the research as "a vegetative idiot" (p. 588) from a "feeble minded institution" (p. 588) who was only a step above "infra-human subjects" (p. 590) such as rats. The terminology used by Fuller and other researchers during this era, although accurate for a time period in which clinical notes referred to people with IDD as idiots, morons, feeble minded, simpletons, retards, and imbeciles, leaves a lot to be desired as a description by the standards of today. Despite this, Fuller demonstrated that people with IDD who had been labelled as "unable to learn" by medical and psychology professionals could develop new behaviors if the environment supported learning. Through the 1950s and 1960s, the knowledge regarding operant conditioning continued to expand, especially with regard to changing human behavior (Morris et al., 1990).

Although there was a diagnostic criterion for mental retardation (now referred to as IDD), during the early to mid-twentieth century, people with IDD were also often given mental health diagnoses (e.g., psychosis and schizophrenia) and ASD diagnoses (Atkinson & Walmsley, 2010). This lack of specificity makes it difficult to always determine if those involved in early behavior-analytic research did have an IDD. However, subsequent to Fuller's paper there were a number of demonstrations of the application of operant learning to change behavior of people with IDD, or related diagnoses. For example, Barrett and Lindsley (1962) looked at the ability of children with IDD to discriminate between stimuli, and Bijou and Orlando (1961) used multiple schedules with children with IDD. Ayllon and Michael (1959) demonstrated that operant conditioning was not only able to change specific operant behaviors, but that they could teach nursing staff to implement the principles to change problematic behavior on the ward. Their work is often cited as the first example of the application of behavior analysis to changing socially significant behaviors (i.e., behaviors that are important to the person or those around them; Baer et al., 1968). It is also likely the first example of behavior analysis with people with IDD to improve quality of life.

Ayllon went on to publish extensively through the 1960s on the clinical impact that behavior analysis could have with the behaviors of people with IDD (e.g., increased eating behavior; Ayllon, 1965; decreased food stealing and towel hoarding; Ayllon, 1963). In 1968, Ayllon and Azrin published on the use of conditioned reinforcers in the form of a token system, an intervention that is still widely used today. At the same time, Wolf and colleagues were demonstrating the effectiveness of analysis to change behaviors that were important for the person and those around them. They worked with an autistic and developmentally delayed client called Dicky, teaching him to wear his glasses, decreasing aggressive behavior, and increasing toileting (Wolf et al., 1963, 1967).

The work of the early pioneers in the application of behavior analysis and findings that had occurred in the application of stimulus-response

(SR) behaviorism (e.g., Mowrer & Mowrer's, 1938 application of the bell-and-pad method for treating enuresis) led to technologies that could be applied to change behavior. Confusingly, this application of technology is sometimes called ABA and until the early 2000s was often referred to as "behavior modification." There is no doubt that the application of ABA and behavior modification had the ability to present a better solution for behavior change (for those with and without IDD) than had been presented previously (Kanfer & Phillips, 1970). Following the seminal article by Baer et al. (1968) that outlined the characteristics of good applied behavior-analytic research, the examples of applications of the science and practice continued to grow (Cautela, 1986).

The application of ABA (like many technologies) is only as good as the person implementing the technology. Unfortunately, many who took up the use of behavior modification as a tool for working with vulnerable populations, such as people with IDD, were not behavior analysts and this was, in some cases, detrimental to the science and those who received intervention (Abidin, 1971). They did not know about the principles that underpinned the interventions they were using, meaning they were unable to adapt the technology effectively. Nor were they potentially aware of the conversations about the need for ethical practice that were taking place in the field. For example, Skinner took a clear position that although punishment by definition decreased a behavior, it should not be the first intervention of choice. Similarly, he spoke out against corporal punishment (Skinner, 1973). Baer et al. (1968) clearly identified that ABA should be used for socially significant behaviors and Wolf (1978) discussed the concept of social validity (i.e., the acceptability of the intervention and the outcome). Indeed, by the end of the 1970s, some behavior modification was an eclectic collection of applications. Some of the applications had little or no link to behavior analysis and involved a number of aversive interventions (e.g., water misting, electric shocks, slapping, and seclusionary time-out) that raised concerns with advocates and authorities (Johnston et al., 2017). Indeed, Turkat and Feuerstein (1978) reviewed 5 years of articles from the New York Times and found that of 27 articles, over half erroneously claimed to be ABA. As a result of this history, many people still associate ABA and behavior modification with changing behavior through aversive control, restraint, and seclusion. Concerns of poor practice resulted in the creation of credentialing programs that would lay the groundwork for the current BACB (Rutherford, 2006; Johnston et al., 2017).

Although ABA's reputation had been tarnished by association with misuse of behavior modification, this is not to say that ABA was not without its controversy. The vast majority of research from the 1960s to the1980s continued to focus on reinforcement (Todd & Morris, 1992). However, there was research on the use of punishment-based techniques for changing behavior. Punishment is conceptualized behaviorally as the presentation (positive) or removal (negative) of a stimulus that decreases the future likelihood of a behavior. In other words, it is a function-based definition rather than a topographical definition; punishment and aversives are not the same thing. Research was conducted on both positive (e.g., O'Leary et al., 1970) and negative (e.g., Kaufman & Baron, 1968) punishment, and punishment in conjunction with reinforcement-based techniques (e.g., toilet training adult with IDD who had previously been left to be incontinent due to an assumption of an inability to learn; Azrin et al., 1974). Although some of these treatments continue to have high social validity (e.g., timeout; Dupuis et al., 2015), many are now seen as unacceptable (e.g., Lovaas, 1987 use of physical punishment). It should be noted that the field has discussed the concerns of the use of punishment-based interventions and the need to weigh up the consequences for the person of not intervening (e.g., Van Houten et al., 1988). The need to weigh up the rights and choices of the client against the potential outcome of intervention or not having intervention is still legitimate today, but there is a more robust ethical process to resolve concerns. A good example of the potential complexities of the use of punishment was reported by Mudford (1995) who described a case of a man with life-threatening operant rumination for whom a legal court denied the use of a mild electric shock. Although this might be argued to have been protective, the unfortunate outcome was that the man did not receive any successful reinforcement-based interventions (none were identified) resulting in both an intrusive medical procedure and being placed in a restrictive environment.

Deinstitutionalization, Change in the Quality of Life, and the Rights of People with ID

ABA has its roots in the application of behavioral science with people with IDD living in large institutions in the 1950s and 1960s. However, early practitioners trying to apply the principles quickly identified that there were a number of barriers to effective treatment in the institutions (Holburn, 1997). In general, institutions did not provide naturally occurring environmental contingencies to support pro-social behavior. For example, the focus was on the severity of a person's disability with a lack of recognition that all can learn, there were few staff to support the people with IDD, there was no personalization of services, and the environments tended to be barren. Although there were a number of antecedents to deinstitutionalization, one was the societal recognition that institutionalization of people with IDD in custodial care environments was not helpful (and potentially detrimental) to them or the wider community (Beadle-Brown et al., 2007).

Deinstitutionalization moved people with IDD from institutionalizations to smaller community-based residential services, with the aim to increase engagement in activities, contact from care staff, use of community facilitates, opportunities for choice, contact with family and friends, and level of material standard of living. The success of deinstitutionalization in general resulted in improvement in people's lives, although minimally for some facets of life, or with mixed results across people (Beadle-Brown et al., 2007; Larson & Lakin, 1989). It should be noted that the change in challenging behavior as a result of changing settings alone was minimal, especially for self-injurious. Indeed, the ultimate success of the deinstitutionalization for each individual appeared to depend on the match of the environment with the needs of the person (Fox & Karan, 1976). Research reviewing the barriers to improvements in their quality of life unsurprisingly included the location of their home (e.g., access to transport) and the attitudes of the community (Abbott & McConkey, 2006). From an ABA perspective, it was also interesting to note that people with IDD their own skills (or lack of skills) and the staff's ability to provide appropriate support were also essential.

As a result of deinstitutionalization, the focus of support for people with IDD shifted from custodial care to supporting people with IDD to live their life their way. As part of this shift in ideologies, we have seen people seeking a greater understanding of what quality of life (QoL) and dignity means, and a desire to uphold the rights of people with IDD. There is widespread agreement that improving and ensuring QoL should fundamentally underpin service provision. However, QoL is a complex concept defined and measured in numerous ways dependent on theoretical philosophy and current contextual factors (Felce & Perry, 1995). Recently, Townsend-White et al. (2012) reviewed the QoL literature and distillated eight core domains of QoL: "emotional wellbeing, interpersonal relationships, material wellbeing, personal development, physical wellbeing, self-determination, social inclusion, and rights" (pp. 272). The broad scope of behaviors that can be addressed using behavior-analytic research means can contribute to the full range of aspects of QoL. Stark and Goldsbury (1990) suggested that there are two broad aspects of QoL: quantitative measures and subjective experiences. Behavior analysis is well-placed to measure not just the observed changes in behaviors associated with QoL but also the qualitative subjective experience (if subjective experiences are captured in measures of social validity). Wolf (1978) identified three dimensions of social validity; how much people like the (a) selected goals, (b) methods used, and (c) outcomes attained.

As more people with IDD started to live in the community, it quickly became apparent that despite a desire to ensure they had high QoL, many of their basic human rights were not being upheld. In 2006, the *UN Convention on the Rights of Persons with Disabilities* (UNCRPD, 2006) came into force. This convention was designed to move the view of people with disabilities from objects of charity (e.g., who were sick or feeble and in need of protection and fixing) to a view of people with IDD as full and equal members of society, with the same human rights as people without IDD. It should be noted that "disabilities" is a "catch all" term and includes physical, mental health, and intellectual disabilities.

Having one's human rights upheld and the changes in the living environment as a result of deinstitutionalization should improve QoL for a person with IDD. However, there is evidence to show that this is not the case (e.g., Simões & Santos, 2016). People with IDD have been shown to have smaller social networks including fewer people without IDD (Lippold & Burns, 2009), use medical care such as cancer screening less than people without IDD (Havercamp et al., 2004), and participate less often in recreation activities than people without IDD (Sands & Kozleski, 1994). Additionally, people with IDD remain hugely underrepresented in employment figures. Bush and Tassé (2017) found that 16% of individuals with Down syndrome and 14% of individuals with IDD were in employment, and that people with less severe intellectual disabilities were more likely to be in employment than people with more severe intellectual disabilities. These data highlight some key areas in which behavior-analytic methods can be focused to enable people with IDD to access a full range of life experiences if they are to truly improve their QoL.

Use of ABA to Support Dignity, Quality of Life, and Rights of People with IDD

To facilitate an understanding of how QoL, UNCRPD, and ABA research overlap, we direct you to Table 66.1. On this table, we have attempted to map some of the articles from the UNCRPD with Townsend-White et al.'s (2012) areas for QoL, and provide examples of ABA researchers have supported and facilitated QoL and the rights of people with IDD. Readers should note that this is not an exhaustive list of research, rather a sample demonstrating that just like Wolf in 1978, the behavior analytic community remains committed to providing socially valid interventions for socially important behaviors.

Right to Effective Treatment and a Therapeutic Environment

An overarching theme for all behavior-analytic work is to implement behavioral programs that facilitate a good quality of life for people with IDD. Early work by behavior analysts stressed the need for a therapeutic environment and the right to effective treatment (Favell & McGimsey, 1993; Van Houten et al., 1988), which is still true today and aligns with the current code of ethics for behavior analysts (Behavior Analyst Certification Board, 2020; Lee et al., 2018). This right to the therapeutic environment seems to be central to Article 26 of the UNCRPD which outlines a person with disabilities right to environments and programs that support habilitation and the appropriately trained staff to support this habilitation.

Favell and McGimsey defined the features of a therapeutic environment. They suggested that an environment should be least restrictive (e.g., safe access to preferred items, activities, or areas), stable, and safe in order to provide effective and efficient treatments or interventions. They defined a humane environment as one with available preferred activities and interactions that promote the individual's active participation. The environment

Table 66.1 Key articles from the United Nations Convention on the Rights of Persons with Disabilities mapped onto dimensions of quality of life

Article from the *UN Convention on the Rights of Persons with Disabilities* (2006)	Key concepts from the UN article	Relevant quality of life domains (Townsend-White et al., 2012)	Examples of areas to which behavior analysis has contributed
Article 12. Equal recognition before the law	Enjoy legal capacity on an equal basis with others	Material well-being Self-determination	Improving money management
Article 15. Freedom from torture or cruel, inhuman or degrading treatment or punishment	Free from scientific experimentation without consent Protection from harm	Emotional well-being Physical well-being Social inclusion	Challenging behavior, restraint and functional assessment Understanding choice making and preference
Article 16. Freedom from exploitation, violence, and abuse	Taking appropriate education measures to protect people with disabilities	Interpersonal relationships Emotional well-being	Prevention of harm
Article 19. Living independently and being included in the community	Choice of where and with whom live Full inclusion and participation in the community	Interpersonal relationships Self-determination Social inclusion	Increasing independent living skills and self-care
Article 20. Personal mobility	Mobility at time of choice and at affordable cost Training in mobility skills	Personal development Self-determination Social inclusion	Improving mobility
Article 21. Freedom of expression and opinion	Right to express opinion Facilitating augmentative and alternative communication	Self-determination	Facilitating language and communication Understanding choice making and preference
Article 23. Respect for home and the family	Right to marry and found a family	Interpersonal relationships self-determination	Supports for people with IDD as parents
Article 24. Education	Support for effective education Individualized support measures Life and social development skills	Personal development Interpersonal relationships	Education
Article 25. Health	Right to highest attainable standard of health	Physical well-being	Improving health outcomes
Article 26. Habilitation and rehabilitation	Attain maximum independence Full inclusion and participation in community and society	Self-determination Personal development Material well-being Social inclusion Emotional well-being	Right to effective treatment and a therapeutic environment
Article 27. Work and employment	Assistance in finding, obtaining, and maintaining employment Access to vocational training	Material well-being Personal development	Vocation and job training.
Article 30. Participation in cultural life, recreation, leisure, and sport	Access to activities Encourage and promote participation	Social inclusion Emotional well-being	Teaching of recreational and leisure skills

Areas in which behavior analysis has been used to contribute to quality of life are identified for each article should include family members, teachers, or staff who are caring and responsive, and who provide frequent positive interactions (i.e., is engaging). Studies have shown that staff can be trained to focus on engagement, resulting in active client participation and increases in adaptive behaviors (Mansell et al., 2002) and the behavior-analytic literature is full of examples of effective training of support staff through behavior skills training (BST; Parson et al. 2012b). BST is a systematic way of teaching skills that involves four steps: (1) information about what needs to be learned (either in writing or verbally), (2) a demonstration of the skill (either in person or on a video), (3) the opportunity to practice (e.g., role plays or in-vivo opportunities) (4) feedback on skills demonstrated. Each of these steps is repeated until a person shows competency.

Materials in the setting should be selected on the basis of preference and age-appropriateness. In certain situations, client preference will outweigh age-appropriateness (Phillips & Mudford, 2011). While preference for items or activities may be challenging to assess, preference can be indicated by physical contact with an item, motion towards, eye gaze, or idiosyncratic facial expressions such as smiling or positive vocalizations (e.g., Parson et al. 2012a, b; Sigafoos & Dempsey, 1992). The teaching of functional skills (described in subsequent sections) should be emphasized, and this should be embedded in preferred activities, for example, cooking or gardening. Favell and McGimsey also suggested that access to activities in the home or community should be accompanied by measures of active participation.

Treatments should prioritize immediate and long-term welfare and be selected with input from the person with IDD (including input on the goals for intervention). The type of input may be determined by the person's ability to communicate, and family members can be involved in the process (methods for which are discussed in subsequent sections). Goals should facilitate an individual's ability to participate in their home and community. Initially targeted skills may include those that allow access to preferred materials, such as requesting, social initiation, moving to areas of the home, or accessing public transport. The individual may also learn communication to cease events they do not prefer or to take a break. Behaviors that are unsafe or those that prevent inclusion may also be targeted. The increase in skill and/or reduction in challenging behavior should extend to greater freedom, increased development, and enhanced QoL (Favell & McGimsey, 1993).

Positive behavior support (PBS), which many believe has its groundings in ABA, was initially suggested as an approach to avoid the use of aversive techniques for people who engaged in problematic behavior (Horner et al., 1990). PBS at its core focuses on this need for an effective therapeutic environment in order to change behavior. Since its introduction, however, there has been debate over the relation between PBS and ABA, the use of PBS by non-behavioral practitioners, and what constitutes PBS. It is beyond the scope of this chapter to provide an in-depth discussion on this debate; however, for those who are interested, the authors direct readers to Dunlap et al. (2008), Johnston et al. (2006), and Tincani (2007).

Challenging Behavior, Restraint, and Functional Assessment

Article 15 of the UNCRPD states that people with disability should be free from torture or cruel, inhumane, or degrading treatment or punishment. People with IDD are more likely to engage in challenging behavior than the average population, and it is often in "treating" these behaviors that historical interventions would be considered torture, cruel, inhuman, degrading, or punitive.

Challenging behavior may be addressed for a range of reasons. It is known that problematic behaviors are associated with parental stress that affects parents' ability to manage (e.g., Herring et al., 2006) and can be aversive for staff (Tierney et al., 2007) which affects the quality of interactions they have with the person with IDD. However, most importantly engaging in problematic behaviors impacts on the life of the person with IDD. Challenging behavior may preclude a person from engaging in other behaviors or being excluding from settings (e.g., school), these behaviors may put the person at risk of abuse (Emerson et al., 1994), and in some circumstance may put the person themselves at risk of harm or death.

As discussed earlier, behaviorally defined punishment is different than everyday use of the term punishment. The BACB provides clear guidelines for the use of behaviorally-defined punishment to ensure the protection of clients (BACB, 2010). However, since the publications by Carr (1977) and Iwata et al. (1982) the use of even behaviorally-defined punishment-based techniques has reduced both clinically and in research. Carr and Iwata et al.'s work showed that behavior was purposeful and occurred as a result of maintaining environmental contingencies. Since these seminal articles a rich body of ABA research showing effective interventions to address problematic behaviors in people with IDD has emerged. The literature centers around third main themes: first, assessment of function of problematic behaviors (e.g., functional analysis; Iwata & Dozier, 2008; antecedent assessment; Anderson & Long, 2002); second, reduction of problematic and teaching functionally equivalent behaviors; common intervention methods include functional communication training (FCT; Tiger et al., 2008), antecedent interventions such as reducing task difficulty (Dunlap et al., 1991), differential reinforcement (e.g., Chowdhury & Benson, 2011), and noncontingent reinforcement (Carr et al., 2009); third, evaluation of staff training to implement both assessments (e.g., Phillips & Mudford, 2008) and methods to address problematic behavior (e.g., Metoyer et al., 2020). A secondary goal of many modern studies is to find alternatives to aversive or unethical methods such as restraint and seclusion (see Vollmer et al., 2011 for a discussion and ABAI (2010) for a position statement on restraint and seclusion).

Despite good research evidence for effective assessment and interventions for reducing challenging behavior, behavior analysis still has more to do. With regard to assessment and intervention, Lloyd and Kennedy (2014) suggested that more longitudinal research was needed to assess the long-term impact of interventions that further focus on generalization and maintenance is needed, and that methods to incorporate functional assessments into wider service delivery should be explored. There is also a need for greater dissemination of the knowledge of how to ethically intervene in the reduction of challenging behavior to avoid the over prescription of psychotropic drugs that have severe and, in some cases, lasting side effects. For example, Sheehan et al. (2015) found that people who engaged in challenging behavior were more likely to be prescribed antipsychotic drugs in the absence of diagnosed mental illness, and compared to less than 1% of people without IDD, 21% of the people with IDD in their study were prescribed antipsychotics. Finally, if behavior analysts are truly aiming to support Article 15 and improve the QoL for people with disabilities, we must support them giving "free consent" and truly participate in the selection of goals and treatments (Favell & McGimsey, 1993).

Understanding Choice Making and Preference

Choice may be correlated with the ability to make an uncoerced (i.e., free) selection between events, consequences, or responses. Choices may be made via idiosyncratic gestures including looking at an item, physically reaching, or facial expression (Cannella-Malone et al., 2015; Sigafoos & Dempsey, 1992).

The behavior analytic focus on what one does rather than what one says means people with IDD do not need to be able to engage in vocal-verbal behavior to make decisions about their life. For example, which intervention they prefer (e.g., Hanley et al., 1997), working with preferred versus non-preferred staff (e.g., Jerome & Sturmey, 2008), and preference for work requirements (Cuvo et al., 1998). Therefore, this is an area in which behavior analysis can promote self-determination and autonomy among people with IDD. Research such as that by Hanley et al. (2005) has been able to demonstrate that for some people with IDD they preferred to have a functional communication program that replaced their challenging behavior that included a behaviorally defined punishment component over an extinction component. Thus, behavior analytic research that facilitates choice helps to uphold Article 15 of the UNCRPD.

Promoting choice-making in people IDD also improves their QoL through facilitating self-determinism and supports Article 21 of UNCRPD. Article 21 focuses on the freedom of expression and opinion. The behavior analytic research is full of examples of program that facilitate choice making for people with IDD. In some cases, the research has aimed to teach the people with IDD to make choices themselves. For example, Tam et al. (2011) taught people with profound IDD and physical disabilities to make choices between stimuli by activating microswitches. In other cases, behavioral interventions have been designed to teach staff members supporting people with IDD, to provide choice-making opportunities to people with disabilities (Reid et al., 2003). For example, Reid et al. trained job coaches to provide choice-making opportunities to employees with severe intellectual and physical disabilities. Using BST, job coaches were trained to provide choices, such as “Would you like to work with Sam or Jane?” or presenting a choice of two items (e.g., labels and tabs).

It is clear that ABA research is able to teach people with IDD to make choices. However, if we are aiming to support people with IDD to have true self determinism, then we must continue to investigate how to facilitate supported decision making by people with varying levels of IDD about all aspects of their life. This is especially important for those with profound and severe IDD, or those who use alternative augmentative communication (AAC), who may not communicate via traditional verbal-vocal means.

Facilitating Language and Communication

The ability to express one’s self and one’s opinions is upheld in Article 21. Many people with IDD do not acquire formal language (Kent-Walsh et al., 2008); this may be due to speech unintelligibility due to weakened muscles or apraxia (Coppens-Hofman et al., 2016) or behavioral phenotypes (e.g., Fragile X syndrome and Down syndrome; Price et al., 2007). Behavior analysts focus on the contingencies in which language occurs (i.e., a functional approach to language; Skinner, 1957) rather than the topography. As such, we are often able to teach communication skills to people with IDD that are useful for them to express themselves vocally, or through sign language or augmentative communication systems (e.g., PECS).

A commonly targeted verbal operant is a mand; a request for which the reinforcer is functionally related to the response (e.g., a drink is provided contingent on a person asking for a drink; Skinner, 1957). A mand is often targeted as it is a way to improve a person’s QoL by providing them the ability to communicate what they want or need. Mands and what is manded for is highly varied in the literature (e.g., signing for preferred food, Sigafoos, 1995; or using speech generating devices to access preferred food or items, Suberman & Cividini-Motta, 2020) with each strategy dependent on the individual learner’s needs. Pennington et al. (2016) reviewed the literature on teaching mands to people with IDD, reporting that very few studies have been conducted with adults over 18 years of age, and that the majority of mand teaching research has been conducted in educational settings with children.

Like with mands, for other aspects of verbal behavior there is a noted lack of research with adult learners, and it is difficult to distinguish studies conducted with children with ASD from those conducted with children with IDD (including children with ASD and IDD). However, research on teaching intraverbals (e.g., Hicks et al., 2011; Kisamore et al., 2016) and tacts (e.g., McCormack et al., 2020) show the promise for teaching complex social interactions such as conversations. Hood et al. (2020) taught three young people with IDD to pay compliments to a conversation partner. The ability to engage in these more complex conversations may enable access to more interactions and foster friendships, which then enhances QoL.

Similarly, the ability for a person with IDD to engage in receptive language or listener responding (i.e., the ability to respond appropriately to spoken or written language; Leaf & McEachin, 1999) is essential for everyday life activities such as following written or spoken instructions. Both Grow and LeBlanc (2013) and LaMarca and LaMarca (2018) reviewed and provided comprehensive lists and rationales for teaching strategies for receptive language skills including minimizing inadvertent prompts and stimulus-specific reinforcement. Like with other areas of language, there appear to be few studies addressing receptive language skills in adults with IDD, and much receptive language teaching is embedded in Early Intensive Behavioral Intervention (EIBI).

Independent Living Skills and Self-Care

The ability to care for one's own personal hygiene not only improves ones QoL but also promotes dignity for people with IDD. Early studies evaluating behavioral toilet training methods (e.g., Azrin & Foxx, 1971) formed the basis for further studies that have demonstrated these methods to be effective without the need for increased fluid intake and in a home-environment (Post & Kirkpatrick, 2004) and without the use of a potty and alarms (Didden et al., 2001). In addition to urinary hygiene, bowel hygiene (i.e., wiping after a bowel motion) has been effectively taught using correspondence training (in which participants are taught to say what they are going to do, do it, and report that they have done it) (Stokes et al., 2004). Menstrual hygiene has also been taught effectively using chaining procedures (Veazey et al., 2016). However, considerably less attention has been given to hygiene other than toilet training, and more research is needed.

Related to the ability to independently complete self-cares, Article 19 explicitly identifies the right of people with IDD to reside in the community and live independently. However, people with IDD still experience a lack of choice, control, and may not actively participate in decisions about their lives (e.g., Gjermestad et al., 2017). Reed et al. (2014) asked professional and family carers of people with IDD to identify barriers to independent living. They found that the most commonly identified barriers represented skill deficits; safety, household, medication, and daily living skills. Behavior analysts are very well placed to help people with IDD overcome these barriers because of the well-established skill acquisition literature.

With regard to household and daily living skills, a number of studies have shown behavioral methods to be effective in teaching people with IDD a range of skills. For example, video modeling, in which participants viewed videos of models performing the task, has been shown to be effective for teaching skills such as setting the table and cleaning a counter (Aldi et al., 2016). Furthermore, video prompting (in which the task is broken into steps and a video watched prior to each step being completed) has been shown to be even more effective than traditional video modeling, although it is more laborious (Mechling et al., 2014).

Many component interventions such as video modeling include common components such as modeling, feedback, and reinforcement (for example BST). Such interventions have been used to teach vital skills such as making a quesadilla (with the training delivered through videoconferencing; Pellegrino & DiGennaro Reed, 2020), BST to teach fire safety skills (Houvouras IV & Harvey, 2014), simulation training for firearm safety (Maxfield et al., 2019), backwards chaining to teach first aid skills (Gast et al., 1992), and matrix training (in which some combinations of stimuli are taught and some arise through generative learning) to teach time-telling (Curiel et al., 2020). These are all examples of skills that facilitate independent living.

Despite a number of studies using contingency-based interventions (e.g., shaping, chaining, prompting), there are relatively fewer using interventions based on rule-governance. Self-rules, overt or covert verbal behavior in which a contingency is stated, are generated and followed by an individual (Zettle, 1990). Taylor and O'Reilly

(1997) taught self-instruction to people with IDD by teaching participants to articulate four statements (a statement of the problem, a statement of the correct response, a report of the response, and self-acknowledgement). Their participants were able to use self-instruction to effectively complete a shopping list, and they were able to demonstrate that the behavior was under the control of the self-instruction when performance decreased and when participants were unable to state the self-instruction. Faloon and Rehfeldt (2008) furthered this work by showing that self-rule training could be used to teach people with IDD to perform daily tasks such as ironing. They also found generalization to novel settings and stimuli and demonstrated control by the self-rules. The implications of these studies are that people with IDD can be taught generalizable self-instructional skills that can promote independence and reduce reliance on assistance from others.

One way to promote independence is to augment the environment with prompts to help people with IDD complete tasks. A number of studies have evaluated the use of various prompting methods. For example, Gil et al. (2019) used in-situ least-to-most prompting to teach people with IDD to read grocery items from a list on an iPad, identify the item, and place it in the cart. They found that all three participants made gains and successfully conducted the training in the grocery store. However, their results were limited by a lack of generalization to novel items (for two out of three participants) and that no participant ever completed 100% of the steps of the task analysis correctly. By contrast, Lancioni et al. (1998) compared computer-based and pictorial prompts to help people with IDD to complete cleaning or food preparation tasks. They found that the computer prompts were more effective and were able to demonstrate skill acquisition in people with relatively severe IDD.

Parsons et al. (2008) identified a number of barriers to teaching programs for independence for people with IDD, including rejection of complex or labor-intensive approaches by services, and a dearth of current research on intensive teaching programs after the initial cluster of articles in early behavior analysis. One solution might be to target staff behavior rather than that of people with IDD. For example, Towery et al. (2014) used a component intervention of feedback, instruction, and sharing baseline data to increase the number of opportunities to teach people with IDD and decrease the opportunities in which staff completed tasks on behalf of someone.

Prevention of Harm

One of the barriers that is often in place for people with IDD to realize independence is the paternalistic concern that people with ID need to be protected from harm. There is no doubt that there is a need to balance the QoL that comes with self-determination with the concerns about the impact choices may have on QoL with regard to physical and emotional well-being. For example, Article 16 states that people with disability shall be free from exploitation, violence, and abuse; this is not to say that we should not allow them to experience risk. Rather this article ensures there are appropriate laws and processes in place to reasonably protect a person with disabilities from first and foremost being harmed, and if harm occurs, that they are supported through the process of rehabilitation.

Given that most abuse of people with IDD occurs from those who they know (e.g., Mitra et al., 2016), programs are designed to facilitate their ability to not only protect themselves but also to improve their physical and emotional well-being and their ability to have healthy interpersonal relationships. Bollman et al. (2009) used videoed scenarios to teach two women with IDD to identify and respond to inappropriate staff interactions such as yelling, hitting, and inappropriate sexual-verbal behavior. They found that both participants could discriminate between appropriate and inappropriate interactions and report them accurately.

Bullying is a major issue for people with IDD; 66–90% of people report experiencing bullying (Reiter & Lapidot-Lefler, 2007; McGrath et al., 2010). Bullying is stressful for the person with

IDD and impacts upon their quality of life because it decreases their physical and emotional well-being and increases the chance of social isolation (Fried & Fried, 1996). Stannis et al. (2019) used BST with in-situ training to teach four men with IDD to learn to deal with bullying using these four strategies: (a) refraining from retaliating against the bully by avoiding physical contact or vocal statements other than those taught during training, (b) stating a short comment of disapproval, such as “I don’t like that,” (c) walking away from the bully, and (d) telling a staff member about the interaction.

There is not an extensive amount of research on behavioral interventions to reduce harm of people with IDD. However, studies have taught people with IDD to use cell phones when lost (Hoch et al., 2009) and to address potentially harmful situations such as broken glassware (Winterling et al., 1992). One of the behaviors that behavior analysts are often called upon to address is non-compliance. Although non-compliance in the extreme (e.g., aggression and property destruction) is disruptive to learning, behavior analysts must be careful not to teach a person with IDD to comply for the sake of compliance. The reason for this caution is that teaching people with IDD to “always do what someone in authority says” may leave them at risk of being harmed if the person seeking the compliance does not have the person’s interests at heart. Therefore, the authors encourage behavior analysts to consider allowing for a tolerance of non-compliance, and teaching people to say “no” as part of this process.

Improving Money Management

Article 12 of the UNCRPD states that people with disabilities have the right of “equal recognition before the law.” Although there are many areas of life underpinned by legal rights, ABA has had the greatest impact in helping people with DD to control their own finances, which can facilitate independence and material well-being. Browder and Grasso (1999) identified that for someone to be able to manage their money they must be able to (1) demonstrate computational and record-keeping skills, (2) complete banking requirements, (3) budget their money, (4) compare prices, (5) make purchases, and (6) save money. Behavioral approaches have most commonly been used to teach people to make purchases.

The main behavioral methods that have been used to teach people with IDD to make purchases are to teach the person to pay using an amount of money that covers all costs (e.g., handing over $20 for all purchases when the total purchase value is under this amount), the next dollar strategy (e.g., to count out one more dollar than the total dollar value of the purchase to cover the cents; Colyer & Collins, 1996)), to use a calculator (Wheeler et al., 1980), to recognize money (Nietupski et al., 1984), and more recently, to use a debit cards (e.g., Mechling et al., 2003). Other studies have used video modeling to teach people with IDD to use an ATM machine (Scott et al., 2013), and compared time delay prompts or most-to-least prompting to teach making cash withdrawals (McDonnell & Ferguson, 1989). Most studies teaching purchasing skills have used component interventions including prompting, feedback, reinforcement, or either person or computer-delivered instruction (e.g., Cooper & Browder, 2001; Ayres & Langone, 2002). However, because much of the research has focused on purchasing skills, there remains a dearth of research on specific skills such as saving, budgeting, and comparing prices.

Improving Mobility

Facilitating independent mobility will allow people with IDD to contact a broad range of reinforcers (including social and vocational). For people with multiple disabilities that include physical disabilities, there are a number of behavioral studies showing how ambulation can be promoted. Selecting ambulation or posture as a behavioral goal can prevent a person becoming physically more limited and can safeguard against isolation for people who spend a lot of time sitting down (Stasolla et al., 2017). Lancioni et al. (2010), Lancioni et al. (2014), and Stasolla et al. (2017) showed that microswitches providing stimulation contingent on ambulation increased responding. Additionally, Stasolla et al. (2017) found an increase in indices of happiness and ambulation (number of steps) in two children with congenital encephalopathy and perinatal hypoxia when their walkers were fitted with microswitches that provided access to preferred sensory stimuli contingent on taking a step. However, there is currently a paucity of research on other behavioral methods to improve ambulation in people with multiple disabilities.

For people with IDD who do not have physical disabilities, there has been some work conducted in teaching skills required to promote mobility. The ability to move within an environment with minimal restrictions is a right. Early studies include Gruber et al. (1979), who taught four young men with IDD to walk independently to school. After mapping the route from their home to school, and painting lines on the path every 25 feet to assist with data collection (distance travelled), they conducted a component intervention consisting of instructions, prompts, reinforcement, and corrective feedback. Their intervention was effective in teaching all four participants to walk to school without staff assistance, and they attained generalization (participants walked the route in reverse without training) and maintenance after 8 weeks. Similarly, Matson (1980) demonstrated that component behaviors of travelling between two locations such as crossing the street and stopping at an intersection were successfully taught using a mock intersection.

More recently, Batu et al. (2004) found most-to-least prompting to be the most effective prompting strategy for teaching pedestrian skills to people with IDD in a component intervention. Additionally, Price et al. (2018) used total task chaining to teach four young adults with IDD to use Google Maps to travel on public transport. The approach taken by many of the studies on this topic is to identify and define specific ambulation skills, deliver a training package consisting of prompts, instruction, and reinforcement, and train either in mock situations or in-situ. The research shows that this approach is effective and can promote independent mobility. Assistance can be gradually faded, and once acquired, these skills can be generalized to other settings or routes, further broadening access to reinforcement. Despite research on teaching people with IDD to be pedestrians or use public transport, there is a paucity of research teaching driving skills. Bell et al. (1991) successfully used peer tutoring to teach two people with IDD written responses for driving maneuvers. However, despite one of the two participants reportedly having gained their driver's license, practical driving skills were not taught or evaluated in the study. The lack of research could be due to acceptability of driving behavior as a goal for people with IDD; however, we must be cautious to avoid assuming that all people with IDD cannot or should not drive. This is a complex idea that requires further consideration. Driving would not be a suitable behavioral goal for everyone, but we must consider driving as a complex behavior chain able to be taught, and how it might be related to right to mobility.

Supports for People with IDD as Parents

Parents with IDD are capable of parenting effectively and share the right to be parents with their peers without disabilities. However, people with IDD who are parents experience high levels of stress (Feldman et al., 2002), and are disproportionately represented in welfare systems (Zeitlin et al., 2020) in which decisions about supports may be made based on evaluations of parental skills and abilities (Aunos & Pacheco, 2020). From a behavioral perspective, parental skills can be taught like any other skills, and there is a small body of research showing the behavioral methods that can be used. For example, Feldman et al. (1992) used a component intervention of instructions, modeling, feedback, and reinforcement to target specific baby-care skills (e.g., bathing and cleaning bottles) in women with IDD.

In addition to tangible care skills such as bathing and feeding, parents with IDD can be taught communication, play, and interactive skills that will contribute to their child's development. Children with parents with IDD are at increased risk of developmental delay, and at particular risk of language delay (Feldman et al., 1985). Feldman et al. (1986) used instruction, modeling, feedback, and reinforcement to increase social play behaviors in mothers with IDD. They found that vocalizations increased in some but not all children, however, that the training was effective to change the mothers' behavior, that the training did not require adapting for the mothers with IDD, and that gains were maintained after 10 months. Similarly, Feldman et al. (1993) found an in-home training program on interactions for mothers with IDD successfully increased the rate of child vocalizations and Feldman et al. (1989) increased the verbal behavior of children whose parents were taught to vocally imitate them. Common components of such training programs include prompting, instruction, feedback, and modeling.

Because parenting is underpinned by a number of complex behaviors, it can be difficult to determine what sort of support a person may need. However, Zeitlin et al. (2020) validated the Skills Assessment for Parents with Intellectual Disability (SAPID), a tool based on direct measurement of competencies. Tools such as this have obvious advantages of other assessments based on self-report or professional opinion. The SAPID gives a method by which professionals can objectively assess a person's skills, which may help to reduce stigma for parents with IDD. Despite the successful programs that can be implemented to give people with IDD parenting skills, it is important to note that there are a number of prohibitive systemic factors (e.g., poverty, stigma; Feldman et al., 1992) that have not yet been addressed in the behavior-analytic literature. Additionally, there is little research evaluating child outcomes (Feldman, 1994), little behavioral literature from the twenty-first century, and very little conducted with fathers as participants.

Education

People with IDD have the right to fully access and benefit from education (Article 24) and behavior-analytic methods can be used to provide individualized supports to enable this. The behavioral literature on providing support for education falls broadly into two categories; reducing barriers to learning in education settings (i.e., reducing problem behavior) and teaching academic skills.

Engaging in challenging behavior can preclude academic learning by reducing the amount of time the person spends engaged in their work and by reducing the quality of interactions with teachers and peers. Problem behaviors exhibited by students with IDD in academic settings can be associated with non-preferred activities (Foster-Johnson et al., 1994), transitions to activities that provide a leaner schedule of reinforcement to the activity prior (Castillo et al., 2018), and might be emitted to avoid academic demands (Dolezal & Kurtz, 2010). Each of the above studies demonstrated the use of functional assessment (including antecedent assessment) methods to determine controlling variables, and the use of a successful intervention in an educational setting.

Studies that have used behavioral methods to teach academic skills have shown that there is a range of available interventions. For example, computer-based matching-to-sample has been used to teach students with IDD to read Japanese Hiragana characters (Sugasawara & Yamamoto, 2007) and write Japanese Kanji characters (Sugasawara & Yamamoto, 2009). Matching-to-sample training is a method often used to teach relations between stimuli (i.e., equivalence training) and teaching attempting to produce derived relational responding can be useful in academic settings. Rehfeldt (2011) reviewed studies in the Journal of Applied Behavior Analysis that involved derived relational responding, finding that 46% of those studies involved people with IDD, but that reading was the skill most commonly targeted (and suggested others should be addressed) and that the technology has yet to be adapted from individualized to small group instruction.

There are a number of dimensions of behavior that can be targeted in academic interventions, including accuracy, fluency, and duration. Fluency, which describes the ability to produce a response with accuracy and speed (Binder, 1996), is often a target for academic interventions. To achieve fluent academic responding in students with IDD, Clark et al. (2016) used percentile schedules (in which the criterion for reinforcement is linked to previous responses and specified parameters). However, percentile schedules can be complicated for use in applied settings. With regard to accuracy, Cuvo et al. (1995) showed that a simple intervention of prompting and reinforcement increased spelling and sight vocabulary responses in students with IDD. However, although there are a number of articles showing behavioral methods to teach academic responses, the literature does not yet offer a comprehensive method for teaching a range of skills; many studies focus either on a single topography or single technology.

Improving Health Outcomes

Maintaining and improving health is underpinned by a range of behaviors. For example, to improve health outcomes, a person must access health care, engage in physical exercise, eat well, adhere to medication regimes, and avoid behaviors related to ill-health such as smoking. People with IDD experience inequalities in health outcomes (Beange & Durvasula, 2001), and although there are likely other factors that might contribute to ill-health in people with IDD such as socioeconomic disadvantage (Emerson & Hatton, 2014), behavior analysis can be used to promote health by addressing health-related behaviors.

There is a small body of research exploring methods to promote physical activity in people with IDD. For example, Normand (2008) used a self-management package including goal setting, self-monitoring and feedback to increase the number of steps taken by people with IDD. Similarly, Krentz et al. (2016) used a token economy to increase the number of 50-m laps each participant walked, and Li et al. (2019) used goal setting and a lottery system for reinforcers to increase the number of steps each person walked. Many interventions are comprised of multiple components and show good success in increasing physical exercise. It is much more difficult to demonstrate the effect on long-term health outcomes, however.

In addition to long-term health outcomes, behavior analysts should also be concerned with health in people with IDD because there is evidence that health and challenging behavior can be linked. May and Kennedy (2010) reviewed the evidence for relations between health and challenging behavior and suggested that there are two ways in with health problems can affect operant contingencies. First, health problems can increase the value of a reinforcer for a problem behavior (e.g., dysmenorrhea, pain associated with menstruation, can make demands more aversive and therefore escape more reinforcing). And second, problem behaviors directly related to the health problem might be evoked (e.g., head hitting to alleviate a headache). May and Kennedy suggested that practitioners should account for possible health issues in functional assessments, take data on the temporal presence of health issues, and work alongside health professionals to alleviate problems.

Another way in which behavior analysts can contribute to good health outcomes is to teach people with IDD to tolerate or engage with medical procedures or devices. Studies that have taught tolerance to aversive medical procedures have used methods such as stimulus fading to decrease problem behavior during having blood drawn (Stuesser & Roscoe, 2020), differential reinforcement to increase heart monitor wearing (Dufour & Lanovaz, 2020), and shaping to increase lying still in an MRI machine (Cox et al., 2017). Part of promoting health is to help people with IDD be involved in their own health. Ferguson and Murphy (2014) used visual aids to train 28 adults with mild to moderate IDD on the function, risks, benefits, and potential side effects of the medication they were prescribed. They also discussed potential alternatives to the medication, such as avoiding alcohol, the right to ask professionals for further information, and the right to refuse the medication. They showed overall increases in capacity to consent, measured by a specifically tailored measure with relevant vignettes. These studies show how behavior-analytic methods can be used to help people with IDD attain good health outcomes.

Vocational Training and Employment

Early employment opportunities for people with IDD were available in the mid-twentieth century in the form of sheltered workshops; day services in which people learned skills such as assembling (Blick et al., 2016). There is an argument that sheltered workshops were able to provide people with IDD prerequisite skills need to gain community-integrated employment (i.e., alongside peers without disabilities). However, research has shown that sheltered workshops do not necessarily increase employment outcomes (Cimera, 2011), and that many people with IDD would like opportunities for employment outside sheltered workshops (Migliore et al., 2007). The 1980s saw further community-integrated opportunities for employment (Dague, 2012). However, in order to gain and successfully retain employment, people with IDD might benefit from behavioral programs to teach vocational or social skills.

There are a number of skills required to gain employment, and behavioral programs have been used to teach skills to people with IDD to help them compete for jobs in an integrated job market. For example, gaining a job requires skills such as searching for a post aligned with your skills and interests, application skills, and interview skills. Pennington et al. (2014) taught three young men with IDD to write cover letters through a component intervention comprised of modeling, response prompts, self-monitoring, and graphing. They found that all three participants improved the quality of their cover letters.

When someone is employed and in need of support, a first step is to determine what support is required for which skills. One approach is to use the Performance Diagnostic Checklist-Human Services (PDC-HS; Carr et al., 2013). The PDC-HS includes both interview questions and direct observation to determine the specific variables involved in performance deficits in work tasks. Smith and Wilder (2018) used the PDC-HS to assess and improve the performance of people with IDD working in a thrift store. Each participant was paired with a supervisor, who was also a person with IDD. Supervisors used the PDC-HS, observed their supervisee's performance, and provided training using a tailored training package (including instruction and modeling) designed to address the specific task error conducted by their supervisee. They found that not only was the use of the PDC-HS and the subsequent training successful, that the supervisors with IDD reported increased confidence in supervising. An advantage of the PDC-HS is that it provides an objective measure of the work task skill issue, and therefore leads to the selection of a data-based intervention. Other methods to support people with IDD in employment include covert audio coaching (Bennett et al., 2010) and activity schedules (Lora et al., 2020).

Other studies have evaluated the use of specific behavioral methods to teach vocational skills (e.g., problem solving skills; Villante et al., 2020). For example, Kobylarz et al. (2020) compared three backwards chaining methods in teaching people with IDD cleaning tasks. They found that the participant-completion variation (in which participants were assisted to complete untrained steps of the chain using least-to-most prompting) was more efficient than teacher-completion (the instructor completed the untrained steps in sight) and no-completion (the instructor completed the untrained steps out of sight) variations. Lerman et al. (2013) evaluated the use of BST to teach adults with mild IDD to implement discrete-trial teaching (DTT) for young children with autism. Despite some success, they noted a potential relation between the level of participant intellectual disability and the success of the training (i.e., training was less successful for participants with lower IQ scores). Additionally, despite the participants' ability to accurately implement DTT, other elements of their performance such as tone of voice and enthusiasm were rated lower by observers than therapists without IDD. This suggests that people with IDD might need vocational support beyond simply the work tasks to which they are assigned.

Success and productivity in the workplace are likely to be influenced by social factors such as "fitting in" and being able to resist distraction. Otalvaro et al. (2020) used differential reinforcement of low-rate behavior (DRL) to reduce excessive questioning by people with IDD working in an adult training center. The two participants were provided with notecards that indicated the number of questions they could ask in each session. They found that excessive questions decreased, and productivity remained high. Other studies have taught workplace social skills such as responding appropriately to feedback (Grob et al., 2019) and social niceties (Yamamoto & Isawa, 2020). Behavioral programs such as this may help people with IDD learn workplace social skills that enable productive and fulfilling employment.

Recreation and Leisure Skills

There are a number of reasons why leisure skills are a useful target for behavior change programs. First, access to and engagement with preferred activities help people with IDD be included in community groups and clubs (Article 19) and facilitate social interaction. Second, it enables the right to participation in recreational activities (Article 30). And third, access to pleasurable activities might help to reduce the incidence of problematic behavior.

Behavior analysis offers a suite of methods to help people with IDD communicate their preferences for activities and social interactions. For example, Morris and Vollmer (2020) found that pictorially or verbally-presented choices between types of interaction (e.g., praise or high-5) could yield preference hierarchies in some participants (but not all). Similarly, Curiel et al. (2018) found that preferences for video clips could be assessed using an iPad to display and record choices. Offering choice to people with IDD is preferable to simply providing access to preferred items and activities for a number of reasons. Staff predictions of preferred activities are not always accurate (e.g., Newton et al., 1993) and it has been demonstrated that being given a choice can be more valued than being provided with a highly preferred item, even if that choice is between less preferred items (Ackerlund Brandt et al., 2015).

Offering a choice between preferred activities can also be used in behavior reduction programs, especially when the function of the behavior is stimulatory. For example, Leif et al. (2020) found that item engagement increased and automatically maintained problem behavior decreased when preferred items identified through a preference assessment were provided. They found that further treatment effects were produced when participants were prompted to engage with the item, and when differential reinforcement for interacting with the items (DRA) was added. Similarly, Sigafoos and Kerr (1994) demonstrated that providing access to leisure activities reduced problem behavior for people with IDD who were observed to engage in problem behavior when unengaged. Other uses of preference assessments for leisure items that contribute to broader behavior programs include assessing preference for level of physical activity to design interventions to promote physical activity. Pincus et al. (2019) found that two of three participants preferred physical activity to being sedentary and suggested that identifying preferred exercise can individualize interventions.

In addition to assessing preferences and using preferences in behavior programs, behavior-analytic methods can be used to teach people with IDD skills to be able to successfully engage in leisure activities. These skills can be directly related to the leisure activity. For example, chaining and discrete-trial teaching have been used to teach a person to play basketball (Lambert et al., 2016) and lag schedules have been used to teach children to engage in more varied toy play (Baruni et al., 2014).

Alternatively, people with IDD can be taught social skills that facilitate involvement in leisure activities. For example, Foxx et al. (1983) increased social skills in people with IDD through a card game (Stacking the Deck) that taught responses to common social situations such as criticism and social confrontation. Some people with IDD might engage in behaviors that preclude their involvement in leisure activities. Therefore, a goal of behavioral programs might be to replace these behaviors with socially appropriate alternatives. For example, Guertin et al. (2019) gradually disrupted the routines of a young boy with mild IDD to reduce obsessive-compulsive behaviors and concomitantly increase play behaviors. Similarly, Dowdy and Tincani (2020) used differential reinforcement without extinction to reduce problem behavior related to transitioning into a swimming pool. Successfully reducing the problem behavior increased participation in swimming and reduced safety concerns. Interventions such as this enable access to activities for people with IDD.

In addition to the behavior programs targeting the behavior of people with IDD, a number of studies have looked at training needs to increase staff facilitating access to recreation and leisure. Davis et al. (2019) used BST to give volunteers the skills to teach people with IDD motor skills for use in physical education sessions. Parsons and Reid (1993) took a more systemic approach, implementing group active treatment which was comprised of formally scheduling activities, assigning staff specific duties, having a coordinator rotate around the room to prompt and reinforce engagement, and staff training. They found that the intervention was efficient and effective; however, a replication by Sturmey (1995) found staff implementation to be variable. It is likely that implementation fidelity is affected by factors such as competing contingencies for staff. However, it is important to ensure that staff have both the time and skills to promote participation in recreation and leisure activities.

Areas to Improve

Although behavior analysis has much to offer in improving QoL for people with IDD, there are a number of areas for improvement. We have highlighted some specific areas for future development throughout the chapter; however, this chapter suggests some broader areas here. First, many studies have been conducted with children rather than adults with IDD. Adults with IDD are likely to have different goals for intervention and may benefit from programs to teach skills not appropriate for children (e.g., teaching voting skills or safe sex behaviors). We need to broaden the range of behaviors investigated for adults.

Second, there have been calls for the inclusion of more objective social validity measures, particularly from the recipients of behavioral programs. We should seek objective social validity for the targets selected for behavior change, the methods we use to change them, and the outcomes of our programs. There is a small number of studies evaluating social validity from staff or family members (e.g., showing less restrictive interventions are more acceptable than more restrictive interventions; Miltenberger & Lumley, 1997). However, there is little work evaluating how to take objective social validity measures from people with IDD.

Hanley (2010) advocated for the use of concurrent-chain arrangements to involve people in choosing interventions, a method we have discussed in the context of facilitating choice. However, this method can be complex and may not always be feasible in clinical settings. Additionally, this method is largely used to offer a choice between interventions and does not provide a method by which to choose intervention goals with clients. Another method is to measure indices of happiness (e.g., Green & Reid, 1996), under the assumption that more preferred environmental conditions will evoke more indices of happiness than less preferred conditions. This can be especially useful for people with profound and multiple disabilities for whom traditional communication is difficult, and because indices of happiness allow for idiosyncrasies to be captured. We call for more inclusion of indices of happiness as a measure of social validity in both research and practice. We do, however, acknowledge the limitations identified by Dillon and Carr (2007) that there is currently no way to establish a clear relation between indices of happiness and unhappiness and private events, and there is no clear solution when indices of happiness change in a direction not predicted. Happiness is a QoL indicator, and as such should be evaluated systematically and included in service provision (Parson et al. 2012a, b). However, there is again little work on using indices of happiness to choose targets for behavior change programs and therefore more research is needed.

In the last 10 years, there has been an approximate 500% increase in clinicians with the BCBA credential (Behavior Analyst Certification Board, 2020). Given this increase, it is important the field listens to calls and suggested solutions to address misconceptions that continue to be associated with ABA today (e.g., Critchfield, 2014).

Conclusion

Behavior analysis has a lot to offer and certainly has its roots working with people with IDD. Despite a robust body of research to inform clinical practice, there are a number of areas to be explored and improved. Like authors before us, we urge practitioners to keep abreast of the new research (Gillis & Carr, 2014), and to continue to work with people with IDD and their families and caregivers to improve behavior-analytic services. It is important to acknowledge that the impact of our work improves the lives of both the person with IDD and their families (Feldman & Werner, 2002), and our approach is useful to address the broad range of aspects of QoL.

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67 Behavioral Gerontology

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Behavior analysis is the scientific study of the relationship between behavior and its interaction with the environment (Skinner, 1938). That is, behavior followed by reinforcement is more likely to occur under similar stimulus conditions, and behavior that is punished (or placed on extinction) is less likely to occur. In addition, other features of the environment, such as antecedents, discriminative stimuli, setting events, and motivating operations are also considered when attempting to identify the underlying cause of behavior. Applied behavior analysis (ABA) is the application of basic behavioral principles in clinical settings to address socially significant behavior (Baer et al., 1968) and has been successfully implemented across a variety of populations and settings. These include children with autism spectrum disorder (ASD, e.g., Lovaas, 1987), adults with disabilities (e.g., Lattimore et al., 2008), organizational settings (e.g., Ditzian et al., 2015), adolescents with drug and alcohol issues (e.g., Taylor et al., 2011), and increasing levels of activity engagement (e.g., Van Wormer, 2004), just to name a few. Given that a behavioral approach has been successful in changing socially significant behavior across a number of domains, it appears likely that it should also be successful when applied to elderly individuals.

Using behavioral principles to improve the lives of older adults is not a recent application of our science. In 1982, B. F. Skinner gave a talk at the 90th convention of the American Psychological Association entitled "*Intellectual Self-Management in Old Age*." Based on his own reflections and experience, he discussed how ageing can result in a loss of reinforcement in the physical and social environment that affects both a person's behavioral repertoire and private events. His talk gained media attention, including an article published in The Washington Post (Meyer, 1982), showing a mainstream interest in psychological approaches to improving the ageing experience that is still present today. Subsequently, Skinner co-authored a book with Margaret Vaughan entitled "*Enjoy Old Age: A Practical Guide*." Written in lay terms with an appendix in which colloquialisms are translated into behavioral principles, the book describes a range of ageing experiences (and how to self-manage those experiences) such as retiring, fearing death, and physical changes.

If we define ageing behaviorally, as Skinner did, as a person's response to changes in stimulus conditions associated with chronological age, then we are all ageing regardless of which stage of life we are experiencing. Indeed, Skinner's

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J. L. Matson (ed.), *Handbook of Applied Behavior Analysis*, Autism and Child Psychopathology Series, https://doi.org/10.1007/978-3-031-19964-6_67

talk and book were focused on the typical ageing process experienced by the majority of the population. Early studies focused on older adults generally and demonstrated the principle of "behavioral plasticity"; that learning and behavior change can occur at any age (Baltes & Barton, 1977). Examples from the early literature include demonstrations that simple environmental changes could produce concomitant changes in behavior (e.g., access to free coffee and cookies could increase interactions between residents of a nursing home; Quattrochi-Tubin & Jason, 1980). Additionally, studies showed that the application of behavioral principles such the Premack principle, stimulus control, and reinforcement could be used to promote independence in older adults (e.g., self-feeding; Baltes & Zerbe, 1976). However, the more recent research on the utility of behavioral methods for supporting behavior change during the aging process has focused largely on addressing issues faced by people experiencing abnormal ageing (i.e., major neurocognitive disorder).

Behavioral gerontology is the term used to describe the application of behavioral principles to address the behavioral changes that occur with ageing (Burgio & Burgio, 1986), and there has been particular recent emphasis on addressing the excesses and deficits that accompany major neurocognitive disorder (formerly known as dementia) in older adults. The literature includes examples of where this approach has been successful in both increasing desirable behavior (e.g., levels of activity engagement; Engstrom et al., 2015) and decreasing undesirable behavior (e.g., aggression; Cohen-Mansfield et al., 1992).

Major Neurocognitive Disorder

The World Health Organization (WHO) published a report in 2017 showing that the number of individuals worldwide over the age of 60 will increase from approximately 900 million in 2015 to roughly 2 billion in 2050 (WHO, 2017). The WHO (2017) also reported that approximately 5% of the world's elderly population has a major neurocognitive disorder such as Alzheimer' disease (American Psychological Association, 2013). Major neurocognitive disorder is characterized by decreases in cognitive, social, and/or occupational functioning, which can lead to significant detrimental outcomes for these individuals, their families, and communities (WHO, 2017).

Although it is inevitable that these deficits will occur for a person with major neurocognitive disorder, no two people with the same diagnosis will experience major neurocognitive disorder in the same way. A number of factors have been shown to affect the rate of progression (i.e., skill loss), including the age of onset and the extent of cerebrovascular disease (Mungas et al., 2001). Additionally, progression varies across diagnoses. For example, some people with vascular dementia generally experience stepwise changes in which a number of skills will be abruptly affected after an infarct, but this is not the case for all because it depends on the location and number of vascular lesions (Rockwood, 2002). By contrast, people with Alzheimer's disease might experience a more gradual progression (Lee et al., 2019). Additionally, Poos et al. (2020) showed that participants with different subtypes of frontotemporal dementia showed deficits in different cognitive skill domains and experienced loss of different skills at different rates.

The progression of the disease also influences the cost of treatment, with the costs of care increasing with severity (Jönsson & Wimo, 2009). It has been estimated that the annual overall cost of major neurocognitive disorder worldwide is US$604 billion dollars (Wimo et al., 2013). This cost includes all resources required to support a person with major neurocognitive disorder; medical expenditure, economic loss, and both formal and informal care. As the population ages and the rate of major neurocognitive disorder increases, so too will the associated financial costs.

Increasing awareness of the growing number of older adults experiencing major neurocognitive disorder and the disorders impact both financially and socially, along with an increase in political commitments to understanding and addressing the problem (e.g., the United

Kingdom's Prime Minister's Challenge on Dementia; Department of Health and Social Care, 2015) have resulted in an increase in funding for research. For example, the United States Congress voted to increase funding into Alzheimer's disease yearly from 2016 to 2019 (Sauer, 2018). Although much research is focused on underlying medical causes of major neurocognitive disorder, there is a clear opportunity for behavior-analytic researchers to seek funding (and therefore increased visibility) for their work into addressing behavioral and cognitive needs.

Medical and Behavioral Interventions

The deterioration of cognitive functioning that typically accompanies major neurocognitive disorder often coincide with decreased levels of desirable behaviors (e.g., activity engagement; Altus et al., 2002) and increased amounts of challenging behaviors (e.g., agitation; Stadlober et al., 2016). Trahan et al. (2011) reported that the medical model (i.e., pharmacological interventions) largely guided treatment decisions when addressing the behavioral excesses and deficits that accompany major neurocognitive disorder. Unfortunately, pharmacological interventions can lead to potentially dangerous side effects (e.g., delirium, confusion, problems sleeping, loss of appetite, unsteady gait) and does not represent a viable long-term treatment for addressing age-related behavioral concerns (Mueller et al., 2020). Thus, a different approach is needed.

There is an increasing interest in non-pharmacological approaches, including a number of proposed models that allude to environmental factors as contributing to behaviors of concern for people with major neurocognitive disorder. For example, under the Newcastle model (James, 2011) behaviors of concern are conceptualized as resulting from unmet needs occurring in "trigger situations"; a functional approach not dissimilar from a behavioral conceptualization using the three-term contingency. Although a conceptually systematic behavior analyst can see the underlying behavioral principles at work in these models, rarely do the model creators make explicit reference to the field of behavior analysis, and such models are sometimes discussed as being "new," "modern," or "innovative." In some cases, the authors appear to consider their model new, modern, and innovative due to a lack of understanding of behavior analysis beyond an oversimplified conceptualization of the three-term contingency. For example, Cohen-Mansfield's (2000) description of the *unmet needs model* tries to set itself apart from a behavioral model (described as a simple three-term contingency) by including (a) consideration of factors such as behavior as an outcome of frustration, communication, or fulfilling needs (i.e., behaviorally we would consider these factors in the function of behavior and the person's current skill repertoire), (b) influenced by factors such as lifelong habits (i.e., behaviorally we would consider these in relation to the person's learning history), and (c) current physical condition (i.e., behaviorally we would consider these by taking into account underlying medical needs as part of an assessment of setting events). Although behavior analysts can lament about the misunderstanding or misappropriation of behavioral concepts, we would be better served as a science to see it as an opportunity for behavior analysts to contribute their understanding and expertise from behavioral gerontology, in an acceptable and understandable way, to a field in which there is a clear appetite for behaviorally oriented approaches.

Unfortunately, behavioral gerontology has not experienced the same level of exponential growth that has been observed in other areas of ABA, such as ASD. However, much has been written over the past few decades about the importance of behavioral gerontology and the need to grow this area of application (e.g., Aggio et al., 2018; Burgio, 1996; Burgio & Burgio, 1986; Carstensen, 1988; Gallagher & Keenan, 2006). The need to grow behavioral gerontology research and practice to allow the science to develop and refine procedures and methods of providing effective intervention is important for a number of reasons. First, the projected increases in the number of elderly individuals with major neurocognitive disorder in the coming decades represent a huge clinical need. The clinical need will be best met if there is research evidence to support clinicians to engage in evidence-based practice. Second, a large area of existing clinical practice in ABA is with adults with intellectual and developmental disabilities (IDD). There is evidence that adults with IDD are more likely to develop major neurocognitive disorder than their typically developing peers, and at a younger age (Janicki & Dalton, 2000). Therefore, it is likely that behavior analysts working in adult settings will encounter people with confirmed or suspected major neurocognitive disorder. Currently, the research supporting adults with dual diagnoses is scant (Lucock et al., 2019), and more is needed to inform clinical practice. Third, the increased public and government interest in living with major neurocognitive disorder has increased funding opportunities and the social validity of non-pharmacological approaches, allowing for greater participation in behavioral gerontology research. Moreover, the founding minds of behavior analysis envisaged that the science could be used to improve the quality of life of a range of people in a range of settings. In his early work, Skinner stated that the number of applications to human problems was only limited by the number of which people could think (Skinner, 1938). It is congruent with the early philosophy of our field to ensure the widespread application of our science.

Behavioral Gerontology and Underlying Behavioral Mechanisms

The inductive approach adopted in behavior analysis involves asking questions such as "what happens when we…" and places the emphasis on data over developing theories and testing hypotheses (Skinner, 1950). An inductive approach is well suited to exploring the underlying mechanisms responsible for behavioral changes in people with major neurocognitive disorder. Two areas of particular interest for adults with major neurocognitive disorder are changes to their cognition and memory. Memory, behaviorally defined, is engaging in remembering behavior (i.e., the ability to recall events or information from the past, even if the specific stimulus context in which the information was obtained has changed). Cognition might be conceptualized behaviorally as including equivalence learning, concept formation, verbal behavior, rule-governed behavior, and choice responding (Dougher & Hackbert, 2000). There is a paucity of translational research (i.e., that which links research on basic principles to practice; Lerman, 2003) on the ageing process from a behavioral perspective.

There is often a perception that due to the decline in memory that people with major neurocognitive disorder cannot learn from reinforcement. However, Steingrimsdottir and Arntzen (2014) found response latency decreased across trials for the people with major neurocognitive disorder, showing at least for some people the ability to learn from consequences remains intact. Similarly, there are a number of other studies that have shown the sensitivity of older adults to reinforcement. For example, Spira and Edelstein (2007) found that the responding of people with major neurocognitive disorder was sensitive to changes in schedules of reinforcement, but that responding in one participant out of three was less sensitive when the schedule changes were subtle. Burgess et al. (1992) found that people with major neurocognitive disorder were able to learn to respond under fixed interval schedules (i.e., demonstrating temporal control of responding). They also recorded participants' verbalizations during the computer-based task, reporting that although participants showed an understanding of a functional relation between their behavior and the response-contingent stimulus (e.g., "You need to hit it hard," p. 234), they did not show an understanding of the temporal relation (e.g., "The music's a bit faulty" when the response was not followed by a response-contingent stimulus, p. 234). This verbal behavior might indicate deficits in the ability to discriminate all functional properties of stimuli.

Stimulus control underlies many of the suggested mechanisms outlined as influencing cognition and memory, and was defined by

Steingrimsdottir and Arntzen as "the unit of analysis is the functional relationship between the behavior and its environment" (2011a, p. 247). Problems for people with major neurocognitive disorder related to deficits in stimulus control are commonly reported in applied settings. For example, asking a person with a major neurocognitive disorder whether they mind if we talk with them might be met with a topographically irrelevant response such as "I told him that the birds are blue" that is under stimulus control of unseen or past events. Gallagher and Keenan (2006) described examples of behavior that are not problematic due to topography, but because of the inappropriate context in which they occur (e.g., urinating in plant pots that bear similar characteristics to a toilet).

A number of translational research studies have investigated stimulus control deficits in older adults, many of which used a stimulus equivalence paradigm and matching to sample tasks (MTS). Of the studies investigating the effect of procedural variations on correct matching responses in older adults, it has been shown that more comparison stimuli result in more incorrect responses (Steingrimsdottir & Arntzen, 2011a) and longer delays between antecedents and response produce more incorrect responses (Steingrimsdottir & Arntzen, 2011b). Although these examples suggest that the antecedent context influences responding, the applied relevance for intervention of these findings has not yet been explored, demonstrating a need for more applications of translational research.

Despite the lack of obvious clinical relevance from some translational research on stimulus control, some have a more obvious application for clinical assessments. For example, Gallagher and Keenan (2009) compared matching-to-sample (MTS) responding to participant scores on the Mini Mental State Examination (MMSE; Folstein et al., 1975). They found that for some participants, MTS tasks were more sensitive to detecting cognitive deficits than the MMSE, and therefore suggested that assessments of cognitive deficits might include equivalence responding. Additionally, MTS tasks have been suggested as a valuable method by which to track progressive cognitive decline (e.g., Brogård-Antonsen & Arntzen, 2019) and to determine which relations are in-tact and which might need re-teaching (e.g., for facial recognition or object identification).

Although it is important to understand the behavioral mechanisms responsible for cognitive changes in people with major neurocognitive disorder, it is also important to recognize that these deficits in stimulus control are not immutable. Gallagher and Keenan (2006) suggested that remembering behaviors are often placed on extinction in residential settings and that interventions could be focused on replacing now-ineffective stimuli with discriminative stimuli that occasion appropriate responding. However, there is little research on whether prompts can be faded for people with major neurocognitive disorder, or whether they are required for ongoing stimulus control (and therefore act as additional discriminative stimuli rather than temporary prompts). Attempts to improve remembering behavior with stimulus control-based interventions have been successful, including increasing recall using an echoic prompt for participants to vocalize the names of objects (Dixon et al., 2011). Similarly, Bourgeois (1993) and Bourgeois and Mason (1996) successfully used textual and picture prompts to promote conversation in participants with major neurocognitive disorder.

While these studies provide evidence that the behavior of people with major neurocognitive disorder is under operant contingencies despite neurocognitive changes, the research is sporadic and somewhat splintered in its focus. For behavior gerontology to truly provide support for clinicians, and those with whom they work, there is a desperate need for researchers and clinicians to champion an expansion of the science to gain further insight into these underlying mechanisms. Specifically, there is a need for research that bridges these laboratory findings to clinical practice. For example, there is little research on the degree to which discrimination might affect sensitivity to reinforcement schedules or whether straightforward changes to the density of reinforcement schedules in applied settings might promote skill maintenance. The applied literature is currently dominated by evaluations of interventions designed to target specific topographies of behavior. More basic and translational research is needed.

Behavioral Gerontology and Major Neurocognitive Disorder: Application and Intervention

Behavioral gerontology research and clinical application for people with major neurocognitive disorder, especially when conducted over a lengthier period of time, might be affected by changes in a person's behavior. Therefore, irrespective of intervention or target behavior it is important to understand a person's suspected type of major neurocognitive disorder because it might help to explain sudden or gradual changes in the person's skills that occur even when environmental contingencies remain constant.

Behavioral gerontology research and clinical application with people with major neurocognitive disorder falls broadly into four categories: (1) Systemic changes including environmental supports and staff and family training; (2) Decreasing behaviors that are challenging for the person or those around them; (3) Increasing desirable behaviors (novel or reinstated); and (4) Promoting the maintenance of current behavioral repertoires. The first three are ubiquitous in applied behavior analysis with other populations. However, aiming to maintain behaviors that a person already has in their repertoire as they experience biological and neurocognitive changes is unique to working with people with major neurocognitive disorder.

Maintenance of Skills, Re-teaching Skills, and Teaching New Skills

Due to major neurocognitive disorder being progressive, the maintenance of skills and promotion of independence are likely socially valid aims of behavioral interventions, particularly for people with early-onset dementia (i.e., diagnosed under the age of 65). Maintaining behaviors might be the first step in a hierarchical approach to supporting someone's repertoire, with more intrusive and intensive interventions included as needed. For example, an early goal might be to schedule structured social activities to promote and maintain conversation skills. If unsuccessful or as the person's skills deteriorate, the goal might change to re-teaching the skill (e.g., using prompting and reinforcement to increase conversation). Further skill loss might necessitate teaching a new skill that ameliorates the effects of the skill lost (i.e., represents a functional alternative). For example, when the person can no longer communicate using speech, a new method of communication could be taught. Therefore, teaching new skills, re-teaching skills, and promoting the maintenance of current skills are linked areas of practice. There are a number of areas on which one could focus to improve the quality of life for people with major neurocognitive disorder; however, for the purpose of consciousness we will focus on social skills and engagement, physical activity, activities for daily living, and communication and verbal behavior.

Social Skills and Engagement

There is a small body of literature on interventions to promote the maintenance of social skills. Often, the interventions involve enhancing stimulus control or augmenting the environment. For example, Sharp et al. (2019) rearranged the lounge furniture in a residential setting to promote engagement with activities, communication between people with major neurocognitive disorder, and indices of happiness. They found that simply facing seating toward other seating increased social behaviors, which occurred much less when the lounge was arranged with the seating against the walls facing the middle of the room (a typical lounge arrangement in care settings). Their study showed that simple environmental changes could promote the maintenance of social skills, without the need for more intrusive intervention.

In addition to ensuring that the physical environment promotes interactions, a number of studies have evaluated the effect of programmed activities on observable behaviors in residential settings. Both Hensman et al. (2015) and Moore et al. (2007) found that indices of positive affect increased during sensory-based and leisure activities such as a petting zoo and ice cream parlor (respectively); however, these changes did not persist for long after the activity finished. Moore et al. found no increases in persistent positive affect with increasing durations of the activity (5, 10, and 20 min), although found very small increases in positive affect 10-min post activity compared to baseline. These data show that although programmed activities are useful for increasing engagement and positive affect, they should be used in conjunction with other interventions to ensure more than transient increases in these behaviors.

For some people, participation during activities may be low and simply providing access to activities may not be sufficient to promote social skill maintenance. For example, Westberg et al. (2017) found that nursing home residents were engaged for only approximately 50% of an activity. There have been a number of behavior-analytic studies that have used reinforcement and prompting to increase engagement and social behaviors. The check-in procedure (Engelman et al., 1999; Engstrom et al., 2015) involves periodic contact from staff (usually every 15 min) to provide a choice of activities and where necessary a prompt to engage in an activity and praise for engagement. Both studies reported increases in engagement. Prompts were also used by Brenske et al. (2008), who showed that descriptive prompts describing available activities were effective in increasing both engagement and physical presence in the room in which the activities were available.

To maximize the effectiveness of engagement strategies, it is useful to assess a person's preferences for the activities available. There have been a number of studies evaluating the use of stimulus preference assessment procedures for people with major neurocognitive disorder, including a recent review (Wagner et al., 2020). The general findings are that: (1) stimulus preference assessments can be used for people with major neurocognitive disorder, but the modality of the stimuli (e.g., vocal, tangible, textual, or pictorial) that best promotes choice responding differs across people (LeBlanc et al., 2006); (2) preferences for leisure items displace preferences for food items when mixed arrays are used (Lucock et al., 2020); (3) preferences are largely stable 3–5 months after an assessment (Raetz et al., 2013); (4) staff or family reports of preferences are relatively inaccurate when compared to stimulus preference assessment data (Mesman et al., 2011); and (5) stimuli identified in preference assessments can be used as reinforcers (Virués-Ortega et al., 2012). The existing literature provides a foundation for understanding the assessment of preference of people with major neurocognitive disorder, but there is little by way of how this information can be used in everyday care. For example, we need to explore how often activities in care homes should be rotated, how best to support people when they demonstrate preferences for activities that they can no longer complete independently, and how to train caregivers to continue to provide choice opportunities and evaluate preferences. Garcia et al. (2018) also suggested that the social validity and practicality of preference assessments should be explored.

Physical Activity

It has been demonstrated that people living in residential settings spend most of their time physically inactive; either sitting or lying down. For example, den Ouden et al. (2015) found that people were sitting or lying down in between 89% and 92% of their observations. Physical inactivity leads to muscle atrophy and a loss of physical strength. Additionally, physical inactivity has been linked to more rapid brain atrophy (Boyle et al., 2015), which suggests that interventions to increase physical activity might help to attenuate the effects of other skill losses.

Physical inactivity might be encouraged by a lack of positive reinforcement for movement, both for the person and for those caring for them. For example, staff may encourage people to remain seated to minimize fall risks, there might be a lack of programmed physical activities in a care home, staff may provide unneeded or excessive assistance for ambulation, and with aging comes increased rates of arthritis resulting in pain from movement. Behavioral approaches are useful to introduce contingencies that promote physical activity. In a residential setting, Burgio et al. (1986) provided a descriptive prompt for residents (some of whom were diagnosed with dementia) to walk to the table for mealtimes, followed by praise for independent mobility. They found that participants who rarely walked during baseline increased the number of feet they walked and attained generalization across mealtimes for some participants. The participants also ambulated more independently (e.g., required less staff or equipment assistance). Lancioni et al. (2017) used a computer and microswitch to increase leg lifting as a form of exercise. The computer prompted leg lifting every 15 s in the absence of responding, and leg lifting activated a microswitch which produced preferred music or videos. They found that leg lifting increased for all participants, and that some participants (but not all) required fewer prompts across sessions. It is important to note that in both of these studies, the amount of physical activity was insufficient to slow brain atrophy and they both used reinforcers other than praise. Burgio et al. capitalized on the natural reinforcer of reaching the dining table, and Lancioni et al. ensured that the leg lifting resulted in access to preferred stimuli. Introducing contingencies under which physical activity is reinforced in daily activities may help to promote maintenance of such programs by both reducing effort for staff and allowing people with major neurocognitive disorder to contact naturally occurring reinforcers.

Activities of Daily Living

Currently, there does not appear to be any behavior gerontology research evaluating interventions to promote engagement in complex activities of daily living such as using a computer, managing finances, upkeeping a home, managing medication, shopping, or accessing public transport. There is limited research on assisting people with major neurocognitive disorder to engage in activities with fewer components such as preparing a tea or coffee, using a telephone, or getting dressed. The few examples demonstrate the use of technological interventions to help people complete simple behavior chains such as making a snack or shaving (e.g., Lancioni et al., 2009). There is a need for more research in these areas as it has been demonstrated that people with more severe dementia are less able to complete more complex activities such as preparing a meal than people with mild dementia (e.g., Giebel et al., 2017). However, these often studies involve the use of questionnaires or family report rather than direct observation which would provide us more detailed information on how to support people clinically.

Direct observation would allow for individual evaluations of whether skill deficits are restricted to one or a few components of a behavior chain, are due to issues with initiation (i.e., stimulus control), or due to a combination of deficits or unsystematic errors. Additionally, deficits in activities are likely to vary across individuals and diagnoses, and therefore warrant individual assessment. For example, it has been shown that people with Lewy body dementia experience attention, concentration, and visuospatial difficulties that might adversely affect their ability to engage in activities of daily living (Leggett et al., 2011).

One possible reason for the paucity of behavior gerontology research on activities of daily living is that the majority of the research has been conducted in residential settings. Gaugler et al. (2009) conducted a systematic review of articles evaluating factors that affected care home admission. They found that after a diagnosis of dementia and severity of impairment, deficits in activities of daily living were the third most commonly reported predictor of admission (reported in 60% of their reviewed articles). Despite a clear need for preventing further skill loss, opportunities for practicing complex activities of daily living are likely to be reduced, either due to spatial lay-outs in care homes that do not allow for easy identification of room function (Marquardt et al., 2011) or because caregivers do not perceive engagement in such activities to contribute to quality of life (Giebel et al., 2015). Therefore, the current literature might reflect other targets (e.g., reducing behavior that challenges or increasing activity engagement) for behavioral studies that might have been more socially valid for people for whom activities of daily living were likely already in deficit.

Using the toilet is a basic activity of daily living that has been successfully addressed in the behavioral gerontology literature. Burgio et al. (1990) taught staff to prompt people to use the toilet every 2 or 3 h and were able to fade the prompts to every 3 or 4 h. Their intervention resulted in more dry incontinence pad checks, however, did not increase self-initiated trips to the toilet. Despite this promising research, continence issues are currently under-explored in the behavior gerontology literature. There is a need for more research on fecal incontinence, the practicality and social validity of programs to address continence for caregivers, and the interaction between stimulus control, mobility, and physical issues for continence in people with major neurocognitive disorder.

Communication and Verbal Behavior

People with major neurocognitive disorder experience a range of communicative and verbal behavior problems. These can range from word-finding problems in the early stages, to difficulty following instructions, verbal reports of delusions, repetitive questioning, incoherent utterances, and mutism in later stages (Bourgeois, 2002). Although some of these communication problems stem from stimulus control issues, there are few behavioral gerontology studies that have addressed maintenance or re-teaching of specific verbal topographies and functions.

Gross et al. (2013) used Skinner's verbal operants (1957) to develop a function-based assessment for language deficits in older adults. They found that older adults performed more poorly on some tacts than vocal mands and intraverbals. Additionally, participants with a diagnosis of dementia performed more poorly than participants without a diagnosis of dementia. Their findings provide evidence for functional independence of the verbal operants; that a person may not lose a word from their repertoire entirely, but may lose the ability to produce that word under different stimulus conditions (i.e., for different functions). There have not yet been any longitudinal, empirical demonstrations of the likely order in which people with major neurocognitive disorder might lose verbal operants from their repertoire. However, Gross et al.'s findings provide a method by which to assess verbal repertoires in people with major neurocognitive disorder. They also provided some preliminary evidence for the accuracy of Skinner's (1957) prediction that echoics and textuals might be preserved longer, but that his prediction that verbal operants followed by generalized reinforcement might become impaired first (e.g., tacts) might not be accurate.

The few behavioral gerontology studies that have sought to re-teach verbal operants have focused predominantly on mands (e.g., Henry & Horne, 2000). Trahan et al. (2014a) taught three women with dementia to mand for preferred activities by exchanging a picture as an alternative to a vocal verbal response. They suggested that a physical response might represent an easier, functionally equivalent response for people whose vocal–verbal repertoire is in deficit, and that it could be easier to teach than re-teaching vocal responding. Oleson and Baker (2014) used textual prompts (written cards) to teach two women with dementia to mand for preferred activities. They found their method to be successful for one participant but did not increase mands for the second.

The importance of stimulus control in language has been discussed by both Oleson and Baker (2014) and Trahan et al. (2014a). Trahan et al. acknowledged that having the items in sight during trials may have resulted in mands being emitted under the control of the items as discriminative stimuli rather than the establishing operation (i.e., as for a pure mand). Similarly, Oleson and Baker found that the addition of a contingency-specifying stimulus (CSS; Schlinger & Blakely, 1987) regarding the required response was needed for one participant. They suggested that the addition of the CSS may have resulted in stimulus control where the CSS was a discriminative stimulus for the mand, rather than the establishing operation.

In interpreting the application of the findings of these two studies to clinical practice, they show the importance of assessing mands with regard to both motivating operations and discriminative stimuli. It might be that although establishing operations are in place for attention or activities, discriminative stimuli are not. For example, staff look too busy for people to chat with them or to ask them for a cup of tea, or activities may be kept out of sight in cupboards and therefore there is no discriminative stimulus to occasion the mand, despite a potential motivating operation being in place.

Stimulus control is not the only mechanism to consider when trying to understand the reason for manding deficits among people with major neurocognitive disorder. The competing contingencies in care homes for staff to complete other tasks might mean that communicative behaviors are placed on extinction or inadvertently punished. For example, Qian et al. (2012) found that care staff spent about 31% of their time engaged in direct care such as assisting people to eat or transfer. They also found that care staff engaged in communication between 47% and 64% of the time. However, communication included exchanges between staff as well as between staff and people with major neurocognitive disorder. And while representing a large percentage of overall time, individual occurrences were of short duration (two thirds were less than 1 min). Staff under pressure to complete required personal care tasks may not have the time to engage with people in activities or social chatter. Under such circumstances, a person's communicative repertoire might diminish, or alternative, less appropriate, behaviors that access attention and activities may be reinforced.

Decreasing Challenging Behaviors

There are a number of topographies of behavior which are associated with major neurocognitive disorder that are challenging. However, a lack of agreement on definitions for topographies, severity, and inconsistencies in measurement make it difficult to be conclusive about prevalence (Gerritsen et al., 2019). Two of the most commonly reported topographies, disruptive vocalizations and physical aggression, have been estimated to occur in 2% and 12% (respectively) of people in specialist dementia care facilities (Veldwijk-Rouwenhorst et al., 2020). Along with aggression (Baker et al., 2006) and disruptive vocalizations (Buchanan & Fisher, 2002), other topographies that cause problems for the person with major neurocognitive disorder or those around have been addressed in the behavioral gerontology literature including sundowning (Stadlober et al., 2016), wandering (Heard & Watson, 1999), and hoarding (Donaldson et al., 2014).

It is interesting to note that none of these topographies are exclusively associated with people with major neurocognitive disorder, except perhaps for sundowning. Sundowning is widely described as an increase in disruptive behaviors later in the day (i.e., as the sun goes down); however, there is no agreed-upon definition or description of sundowning (Canevelli et al., 2016). A lack of agreement on the topography of the behavior has resulted in hugely variable estimates of prevalence (e.g., 2–82%; Boronat et al., 2019), and underlying causes (e.g., circadian, hormonal, physiological, epidemiological, environmental, medical, and pharmacological correlates have all been suggested; Gnanasekaran, 2016). Stadlober et al. (2016) conceptualized and evaluated sundowning from a behavioral perspective. Working with two people in a care home identified by staff as "sundowners," they found that the topography and function of sundowning varied and that only one of the two participants engaged in the behavior in temporal patterns congruent with typical sundowning. They concluded that sundowning was unlikely to be a topography of behavior unique to people with major neurocognitive disorder, but a description of the distribution of behavior across a day. Stadlober et al. also suggested that an explanation for the occurrence of sundowning might be found in environmental variables likely occurring at that time of day (e.g., shift changeovers, busy mealtimes in which attention is less available and there is more noise). Their study is an example of a conceptually systematic approach to problems associated with people with major neurocognitive disorder.

Assessment

Congruent with behavior-analytic approaches to assessing and reducing challenging behavior in other populations (e.g., children with ASD), a number of studies have used functional assessments (including experimental functional analyses; Iwata et al., 1982) to guide the selection of function-based interventions (e.g., Baker et al., 2006). For example, Buchanan and Fisher (2002) conducted pairwise functional analyses to identify the reinforcers for disruptive vocalizations in three people with dementia and subsequently used non-contingent reinforcement as an intervention. However, because it has been postulated that people with major neurocognitive disorder experience stimulus control deficits (Gallagher & Keenan, 2006; Skinner, 1983) antecedent assessments might be as important, if not more important, than the focus on consequences in traditional functional analyses.

Trahan et al. (2014b) found that an antecedent analysis yielded clearer differentiation between conditions than a traditional and modified functional analysis in which consequences for bizarre speech were manipulated. Additionally, Williams et al. (2020) developed a demand assessment to determine the specific antecedents under which "rude" vocal responses were emitted in a woman with dementia. Analyses like those conducted in these two studies are useful for informing interventions for the specific participants for whom they are implemented, but also may help to inform how caregivers are trained to interact with people with major neurocognitive disorder, e.g., avoiding open-ended questions (Trahan et al., 2014b) or considering social niceties (Williams et al., 2020). It is interesting that these two studies which found antecedent analyses to be useful focused on vocal responses. Because verbal behavior in adults with long and typical learning histories is often multiply controlled and complex (Trahan et al., 2014b), our current suite of assessments that were developed through working with other populations may not be sufficient or may require adaptation for people with major neurocognitive disorder.

Intervention

The majority of studies aiming to reduce problematic behavior in people with major neurocognitive disorder have used antecedent interventions (e.g., offering choices; Williams et al., 2020). A particularly effective antecedent strategy is to identify the maintaining reinforcer for a behavior and provide noncontingent access to that reinforcer. A number of studies have demonstrated the usefulness of noncontingent reinforcement. Baker et al. (2006) provided 10 s noncontingent breaks every 20 s during bathroom routines for a person with dementia whose aggressive behavior was maintained by escape. Buchanan and Fisher (2002) provided noncontingent attention to successfully reduce disruptive vocalizations maintained by attention. Noncontingent reinforcement interventions are a relatively simple intervention to address problematic behavior, and do not require alternative behaviors to be taught when used as a single component intervention. However, in order to be effective, a functional analysis needs to be conducted to identify the relevant reinforcer, and there is some evidence that very dense fixed-time schedules might be needed for some behaviors (e.g., Baker et al., 2006). Buchanan and Fisher (2002) found music to be successful in reducing stimulatory disruptive vocalizations, but only when the density of the schedule was increased from FT 80 s to FT 40 s. It is unlikely that staff in a care home have the capacity to provide reinforcers on such dense schedules.

Another way to provide noncontingent reinforcement is to provide continuous (rather than FT) access. Locke and Mudford (2010) compared the effectiveness of ambient music, silent headphones, and music on headphones to decrease disruptive vocalizations in a man with dementia. They found that music played through headphones was the most successful intervention and suggested that the matched stimulation (i.e., music was an alternative to the sound produced by vocalizing) was the underlying behavioral mechanism for the effectiveness of the intervention. However, they did acknowledge that the music may have also acted as a punisher or abolishing operation; reducing the quality of the stimulation gained from vocalizing.

Because stimulus control appears to be a deficit for people with major neurocognitive disorder, it is logical to explore interventions based on stimulus control. Feliciano et al. (2004) used an eye-level cloth barrier as a visual stimulus to signal that entry was not permitted and reinforcement was not available in a restricted area. Redirection involved minimal social interaction and social interaction was available outside the restricted area. They found that they were able to gradually fade the barrier to a minimal size while maintaining a decrease in entry attempts. There is a need for more research on interventions attempting to place behaviors under appropriate stimulus control for people with major neurocognitive disorder, especially given they often lose previously learned stimulus control.

Few studies have evaluated differential reinforcement (DR) interventions for people with major neurocognitive disorder. Dwyer-Moore and Dixon (2007) used differential reinforcement of alternative behavior (DRA) and extinction to increase appropriate and reduce disruptive vocalizations. However, the participant was not taught any new alternative behaviors; appropriate vocalizations already in their repertoire were reinforced. Heard and Watson (1999) implemented DR to reduce wandering but acknowledged that the schedule of reinforcement was dense and impractical (15–30 s). It might be that DR interventions using a leaner schedule of reinforcement, that require a novel response to be taught, or for use with people with vocal verbal behavior deficits might be more difficult to implement.

Although there is promising evidence for the use of behavioral interventions to decrease problematic behaviors in people with major neurocognitive disorder, we suggest that a fruitful way forward would be to gain a better understanding of the relevant behavioral mechanisms (e.g., stimulus control), rather than research focusing on specific topographies of behavior. Additionally, more research on how our assessments and interventions should be adapted to be more effective and socially valid for people with major neurocognitive disorder is needed.

Working Within Systems

Although the majority of behavioral gerontology research has been conducted in residential homes, there are a number of settings in which people with major neurocognitive disorder live, work, and engage where behavior analysis can be used (e.g., hospitals, family homes, nursing homes). In addition to targeting the behaviors of people with major neurocognitive disorder, a contextual approach allows a behavior-analytic practitioner to consider the physical environment and the behavior of caregivers as a way of improving the quality of life for people with major neurocognitive disorder.

Physical Environment

There are a number of recommendations for and trends in environmental design, for example the inclusion of therapeutic kitchens (Marsden et al., 2001), unique room door designs (Varshawsky & Traynor, 2019), and dementia villages (Peoples et al., 2018). However, recommendations are often based on expert opinion and infrequently derived from direct measures of behavior. Day et al. (2000) conducted a review of the empirical research on therapeutic design for care homes, concluding that a lack of consistent theoretical underpinnings, and lack of measures of behaviors, other than problematic ones, limited the research.

Given that behavior analysis recognizes the influence that the environment has on behavior and its use of direct observation measures, the impact of the environment on the quality of life of people with major neurocognitive disorder seem like this should be an area in which behavior analysis would excel. However, there have only been a few studies that have used a behavior-analytic approach to evaluating the effects of environmental design. Cash et al. (1995) evaluated "room management" in which chairs were arranged in a horseshoe shape, activities were made available, and a helper assisted people with major neurocognitive disorder to engage. They found that engagement increased. However, it was unclear in the Cash et al. study whether the increase in engagement was due to the environmental change or the increased helper assistance. Sharp et al. (2019) evaluated the effect of just the placement of furniture in the lounge on engagement and Ilem and Feliciano (2018) evaluated the impact of shadowboxes (containing personal, photographic, or textual stimuli) outside people's rooms on wayfinding. Both Sharp et al. and Ilem and Feliciano found that these simple environmental changes improved engagement and way finding respectively for the participants with major neurocognitive disorder without the need for additional staffing support. It should however be noted that Ilem and Feliciano found that for some participants personalized boxes were needed to improve wayfinding.

Although Ilem and Feliciano (2018), Cash et al. (1995), and Sharp et al. (2019) showed promising results using a behavioral framework to assess the impact of environmental design on the observable behavior of staff and people with major neurocognitive disorder, further research is most definitely needed. Elements of care home design such as personalized wayfinding aids and outdoor space have been shown to be valued by people with major neurocognitive disorder and their caregivers (Innes et al., 2011), and therefore the social validity of physical environments should be evaluated in future research.

Addressing the Needs of Caregivers

A person with major neurocognitive disorder has a range of supports in their lives ranging from naturalistic supports in the form of family and friends to formalized supports in the form of professional staff. As a person's major neurocognitive disorder progresses, the stressors and stains on these supports also change. Just as behavior analysis acknowledges the impact of the physical environment of the quality of life of people with increased support needs, it too acknowledges the impact that those supporting them also has.

Family Caregivers It is estimated that there are approximately 16 million unpaid caregivers in the United States (Alzheimer's Association, 2020), therefore this group needs support and evidence-based interventions. Family caregivers of people with major neurocognitive disorder might find their caring role gradually change as the person's major neurocognitive disorder progresses, including adopting proxy decision-making, healthcare advocate, and behavior management roles (Black et al., 2013).

Relative to the intellectual disability sector, less is known about how behavior analysis might benefit the family caregivers (e.g., spouses, children) of people with major neurocognitive disorder residing in the community. However, the small amount of research suggests that behavior analysis could be useful to teach caregivers strategies to more effectively manage behavior that challenges, maintain independent behaviors, and self-care skills. There are a few examples of training caregivers to maintain skills in people with major neurocognitive disorder in the behavior-analytic literature. Bourgeois (1990) taught three husbands to teach their wives conversation skills using memory aids. They found that not only was their method effective in increasing on-topic conversation statements, it could be taught effectively to the husbands. However, they also found that the husbands' interpretations of correct responding were stringent, and while this was a demonstration of high treatment fidelity, it may have inhibited novel responding. By contrast, Adkins and Mathews (1997) did not measure treatment fidelity but reported anecdotally that family caregivers to whom they taught a prompted voiding procedure (to increase using the toilet) were still successfully using the procedure 6 months later. These studies show the utility of behavioral approaches to teach caregivers methods to maintain independent skills in their family member.

Although maintaining independent skills is important, family members may need assistance in managing behaviors that challenge, especially as challenging behavior is the leading reason for a person needing to enter care (Thomas et al., 2004). Behaviors that challenge might be more salient (and problematic) for family caregivers. For example, Bourgeois (1990) found that the husbands in their study did not notice the increases in conversational skills and offered a lack of salience of the changes as an explanation for their finding. Polenick et al. (2020) found that the most commonly reported strategies used by caregivers were general, e.g., humor, social support, and activity engagement. Caregivers also reported modifying their interactions and the care environment; however, there would be clear benefit to enhancing these strategies with individualized, function-based interventions. Currently, there do not appear to be any studies teaching family caregivers to implement functional analyses or function-based interventions for behavior that challenges, despite a body of literature teaching caregivers of other populations (e.g., ASD; Gerow et al., 2019).

Direct Care Staff Professional caregivers (direct care staff) of people with major neurocognitive disorder come from a range of training and education backgrounds and vary across countries and services. Often, professionals with higher levels of education are responsible for overseeing care or for specific elements of care (e.g., medical), while untrained caregivers provide day-to-day care (Hallberg et al., 2016). Although behavior-analytic research is full of examples of training care staff to competency in the intellectual disability sector, there are a number of barriers to training direct care staff to work with people with major neurocognitive disorder. First, there is a paucity of research on training caregivers working with those with major neurocognitive disorder to complete behavior-analytic assessments or interventions. Second, resource constraints mean that staff may be too busy to implement behavioral assessments or interventions. Finally, staff may not contact reinforcement for implementing behavioral assessments or interventions even when they have time to do so, and therefore they do not continue to engage in assessment or interventions.

Staff in residential homes may find that competing contingencies to complete tasks such as cleaning, infection control, meal preparation, and documentation preclude spending time in interactions with people that does not involve direct personal care (e.g., dressing). An adverse outcome of this can be that dependent behaviors are reinforced and independent behaviors either punished or placed on extinction (Baltes et al., 1980; Burgio et al., 1986). That is, it is quicker and easier for staff to complete tasks for people rather than use difficult or time-consuming prompting procedures. Therefore, one goal for behavior-analytic work is to identify problematic contingencies maintaining competing staff behaviors and work with management to change them. Additionally, small environmental changes that preclude the need for more complex interventions can be easily evaluated using direct measures of behavior. For example, Munyisia et al. (2013) introduced an electronic documentation system and measured whether the time staff spent documenting reduced.

Some studies that attempted to train staff to continue the intervention once established (e.g., Engstrom et al., 2015) reported a lack of success. Other studies have found that staff report new practices to be burdensome (e.g., Noguchi et al., 2013). One reason could be because the interventions lack social validity (i.e., are too complex, too time-consuming, or not considered to be useful or effective). Trahan et al. (2014a) called for the social validity of interventions with people with dementia to be explored, which is an area currently under-explored.

There is some evidence that some direct care staff may not find interacting with people with major neurocognitive disorder reinforcing. For example, Brodaty et al. (2003) found that a quarter of the staff they interviewed stated that interacting with the people with major neurocognitive disorder provided no job satisfaction. Similarly, Schnelli et al. (2020) identified staff fear of people with major neurocognitive disorder was a key barrier to addressing behavior that challenges. Factors such as these might mean that the reinforcement for avoiding interactions might be greater than the reinforcement available for addressing behaviors proactively. Similarly, for those who do find reinforcement, it may be that there are reinforcers for "caregiver behaviors" (i.e., ensuring an older person is well cared for) rather than support behaviors (i.e., ensuring an older person has supports in place to maintain independence). There are a number of solutions grounded in behavior-analysis.

The first is to give staff skills to effectively reduce problematic behavior (e.g., using behavioral skills training; Parsons et al., 2012), therefore reducing the aversiveness of interacting with the people for whom they provide care. It would also be useful to use behavior-analytic methods to help staff to build relationships with the people for whom they provide care, for example, by facilitating familiarization (e.g., Parsons et al., 2016) or helping staff to conceptualize the causes of problematic behavior. For example, there is some evidence that staff attitudes (i.e., verbal rules and verbal behavior) toward people with major neurocognitive disorder affect the quality of care and occurrence of problematic behaviors (Gerristen et al., 2019). To enhance staff understanding of problematic behavior, it is important to teach a functional approach. Training should emphasize that the person is not engaging in problematic behavior because they have major neurocognitive disorder, but because their major neurocognitive disorder has changed the way they interact with their environment. Thus, the only way to change the behavior is to change the environment.

In addition to increasing staff knowledge, another avenue is to explore preference-based workplace adaptations (e.g., Task Enjoyment Motivation Protocol; TEMP), a strategy developed by Green et al. (2008). They helped staff to identify nonpreferred work tasks, implemented changes to decrease the aversiveness of the tasks, and found that staff subsequently reported their quality of work life to be better. Behavior analysts are concerned with behavior (both physical and verbal) in context, and therefore there is value in exploring interventions that address a broader range of goals than simply increasing individual caregiver skills.

Use of Technology

Technology is playing an ever-increasing part in the care and support for people with major neurocognitive disorder. The specific type of technology can take many forms, from simple digital alarms that prompt a person regarding the day, time, and important activities (e.g., Nishiura et al., 2019) to more complex virtual reality (VR) programmer to improve physical skills (e.g., Liao et al., 2019). The technology can be used to increase or maintain independence (e.g., the teaching of kitchen skills using VR; Yamaguchi et al., 2012), assist a person to stay in their home (e.g., the use of tele-assistance and automatic light paths; Tchalla et al., 2013), and promote language skills (e.g., Lancioni et al. (2014) used a computer-aided program to facilitate reminiscence conversational skills). Due to the fast pace with which technology advances, becomes more accessible, and is adopted by consumers, the research on the utility of technology must also keep pace. For those with major neurocognitive disorder, the use of technology is relatively new, and even newer within behavioral gerontology research. Much of the drive within the field of behavioral gerontology has come from Lancioni and colleagues. For example, they have produced a range of research that explored the use of automated verbal prompts to teach and maintain a range of activities (Lancioni et al., 2009), the use of pictorial instructions provided by a portable computer to increase activity (Lancioni et al., 2013) or via use of a tablet or smart phone

(Lancioni et al., 2019), motion sensitive sounds and light systems to facilitate independent ambulation (Lancioni et al., 2013), and independent choice of music (Lancioni et al., 2014).

Although Lancioni and colleagues have produced behavioral gerontology research in the technology space, the vast majority of research looking at the effectiveness of technology for people with major neurocognitive disorder would not meet Baer et al.'s (1968) criteria to be considered ABA research. Most of the research in the area lacks a clear behavioral definition of the dependent variable and has poor experimental design, which is indicative of a lot of exploratory research in the subfield. However, the research does appear to meet the criteria for *applied*, with both the behavior change and the intervention being socially valid.

Although technology has the potential to have a large impact on the quality of life for people with major neurocognitive disorder, it should be noted that behavior analysts should not adopt it blindly. Rather, like the models discussed at the start of the chapter, they should consider the mechanisms by which the technology is likely to obtain behavior change. For example, the desirable impact of technology assessed in the non-behavioral literature can often be explained in behavioral concepts, including prompts, increased saliency of natural stimuli, and the provision of natural reinforcers. With this conceptually systematic understanding behavior analysts are well poised to use our skills in measurement and data analysis to assess the impact of the technology impact on the quality of life for people with major neurocognitive disorder.

Conclusion

BF Skinner is regularly quoted as saying "old age is rather like another country, you will enjoy it more if you have prepared yourself before you go." Behavioral gerontology research has provided us with some of the information required to prepare one's self. However, there remains a need for researchers to aid our understanding of the underlying behavioral mechanisms relevant to the aging process for people with major neurocognitive disorder and to continue to provide evidence of the clinical utility of adapted behavioral assessment and intervention methods. Of equal importance is the need to increase the number of behaviorally trained clinicians working with people with major neurocognitive disorder. Despite an ever-growing need within the population, it remains the case that few behavior analysts work with older adults as their primary area of professional emphasis (0.13%; Behavior Analyst Certification Board, n.d.). However, there is good evidence that behavior analysis can contribute to solving problems of ageing, and there is guidance for practitioners interested in expanding their scope of competence to allow them to engage in a meaningful and collaborative manner with others in the sector (Brodhead et al., 2018). Therefore, it is hopeful that future behavior analysts will heed this call. This call is especially important as there will be very few of us whose lives are not touched by living with, caring for, supporting, or at the very least being aware of someone living with major neurocognitive disorder. Behavior analysts are in a strong position to contribute to preparing people for the aging process and ultimately improving the quality of life of older adults, we must just accept the challenge.

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