Chapter 3
Discrete Trial Training

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Introduction

More than 40 years of research and practice supports the efficacy of Discrete Trial Training (DTT) for remediating the myriad of social, communication, academic, and self-help difficulties that are associated with a diagnosis of autism spectrum disorder (ASD). The term *discrete trial training* originates from the early work of Lovaas (1987) at the University of California—Los Angeles. DTT is a teaching procedure grounded in applied behavior analysis (ABA), but the term also commonly refers to the structured model and curriculum for early intensive behavioral intervention developed by Lovaas, called the UCLA programming model. It is important to note that the terms DTT and the Lovaas or UCLA model are not synonymous. As a teaching procedure, DTT consists of structured learning opportunities that include an antecedent, the learner's response, and a consequence. Taking this framework into account, DTT is often embedded within other approaches to early intervention, such as natural environment teaching and teaching based on verbal behavior taxonomy (i.e., applied verbal behavior; Sundberg & Partington, 1998). Furthermore, early intervention programs that are based on Lovaas' model typically supplement DTT with other ABA-based teaching procedures, such as chaining and incidental teaching (e.g., Fenske, Krantz, & McClannahan, 2001). DTT models focus on establishing early learning repertoires, such as attending and imitation, to facilitate greater fluency in acquisition of all skill sets.

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Multiple strategies are employed to ensure that the desired behaviors occur under the appropriate stimulus conditions. The goal of this type of programming is to systematically teach the child to respond to language and social stimuli in meaningful ways (e.g., talking, playing).

In this chapter, we focus on DTT as both a teaching procedure and as a model of programming for early intervention. We begin by providing a description of DTT and the characteristic features of DTT programming models. We then describe current research and practice in teaching others to implement DTT, research outcomes for the model, and suggestions for future research.

DTT: Teaching Procedures and Variations

The discrete trial refers to a carefully designed interaction with several critical components: A discriminative stimulus (S^D), a structured prompt sequence as needed, the target behavior, a reinforcer, and an intentionally short interval before the next trial is initiated. The repeated presentation of the S^D with reinforcement for a specific response establishes stimulus control. Thus, in the future, the child will readily respond to that stimulus under naturally occurring conditions. For example, an instructor might present an apple with a prompt "apple" and deliver praise when the child repeats the word apple. Initially, the child will not respond to the presence of the apple by naming it. As a result of the many repeated discrete trials with different apples and with apples in different contexts, the apple begins to exert stimulus control over the child's responses so that he says "apple" when he sees it on a tree, or in a book, or in his kitchen.

Guidelines for implementing DTT procedures published in numerous texts and curriculum manuals over the past 20 years (e.g., Leaf & McEachin, 1999; Lockshin, Gillis, & Romanczyk, 2004; Webber & Scheuermann, 2008) have been drawn largely from the seminal work of Lovaas (1981, 1987). Nonetheless, they also have incorporated some procedural variations based on research findings and clinical experience. In the following sections, we describe commonly recommended components of DTT (e.g., prompt fading, reinforcement, measurement), along with procedural variations and their existing supporting evidence.

Prompt Fading and Error Correction

Prompts are antecedent stimuli that increase the probability of a correct response in the presence of the S^D. Prompts may be combined with the S^D at the start of the discrete trial to ensure that the learner responds without error. In such cases, the prompt must be gradually faded to transfer control from the prompt to the S^D. Prompts also may be delivered as part of an error correction procedure when the learner responds incorrectly or fails to respond to the S^D. The contingent delivery of

prompts is intended to evoke the correct response within the same instructional trial and/or to increase the likelihood that the learner will emit the correct response on the next trial. A relatively large number of studies have examined variations of prompt fading and error correction methods.

Research has demonstrated the effectiveness of the most commonly used approaches to fading prompts, including most-to-least prompting (MTL), least-to-most prompting (LTM), graduated guidance, and prompt delay (see MacDuff, Krantz, & McClannahan, 2001, for a review). In general, results of studies comparing these common approaches have resulted in recommendations to use methods that minimize errors. For example, with MTL prompting, the instructor combines the initial S^D with the most intrusive prompt needed to evoke the correct response (e.g., a model prompt). Contingent on correct responding across a certain number of trials, the instructor transitions to less intrusive prompts (e.g., a gesture prompt) until the learner responds correctly in the absence of prompts.

Nonetheless, some recent research suggests that errorless approaches to teaching might lead to overreliance on prompts (Leaf et al., 2014; Libby, Weiss, Bancroft, & Ahearn, 2008). For example, in an interesting variation of MTL, Libby et al. (2008) inserted a 2-s delay between the S^D and prompt to give the subjects an opportunity to respond independently on each trial. Results indicated that this method was just as effective as LTM but was associated with fewer errors.

In addition to these methods, other ways to fade prompts have been described in some texts and curriculum guides. These methods, which include "no-no prompt (NNP)," "flexible prompting," and "simultaneous prompting," have been examined more recently in the literature (e.g., Fentress & Lerman, 2012; Leaf et al., 2013; Leaf, Leaf, Taubman, McEachin, & Delmolino, 2014; Leaf, Sheldon, & Sherman, 2010). With flexible prompting, the therapist does not employ a structured, invariant prompting procedure but instead relies on his or her own judgment about whether to use a prompt on a given trial and, if so, what type of prompt to deliver. The therapist is told to use the least amount of assistance needed while aiming for a high level of success and to provide prompts if the learner has a recent history of making errors with the task (Leaf, Leaf, et al., 2014). Results of several studies indicated that flexible prompting was just as effective in teaching new skills as other more commonly used methods (Leaf, Leaf, et al., 2014; Soluaga, Leaf, Taubman, McEachin, & Leaf, 2008).

With simultaneous prompting, a controlling prompt is always delivered at the same time as the S^D and is not systematically faded across teaching trials. Instead, the learner is periodically given opportunities to exhibit the response independently during "probes" (see Waugh, Alberto, & Fredrick, 2011, for a review). Advantages of this approach are that it does not require the therapist to fade prompts or collect data on performance during instruction (performance is only measured during probes). Although research findings have demonstrated the effectiveness of this approach, results of some comparison studies suggest that other methods may be more successful (e.g., Leaf et al., 2010). NNP is a method of fading in which a prompt is only delivered following two consecutive trials without correct responses. One advantage of this method is that it may reduce the likelihood of prompt

dependence. Two studies comparing the effectiveness of this prompt fading method to other methods (simultaneous prompting and MTL prompting) found that learners acquired targeted skills more quickly under the NNP method (Fentress & Lerman, 2012; Leaf et al., 2010). However, Fentress and Lerman further found that skills taught via MTL showed better maintenance than those taught via the NNP procedure.

Instructors also may use a variety of different consequences for errors. These consequences include delivering vocal statements (e.g., saying "no"), withdrawing attention, demonstrating the correct response, and requiring the learner to practice the correct response one or more times (Leaf, Alcalay, et al., 2014; McGhan & Lerman, 2013; Rodgers & Iwata, 1991; Smith, Mruzek, Wheat, & Hughes, 2006; Worsdell et al., 2005). In general, research suggests that all methods can be effective when teaching new skills. Comparisons of different error correction methods have produced inconsistent results but generally have found that strategies that include a response requirement (e.g., learner must practice the correct response one or more times) are more effective than approaches that do not (e.g., providing vocal feedback or demonstrating the correct response).

Reinforcement

Correct responses are followed by brief praise or access to a preferred item. Research has demonstrated the importance of using highly preferred reinforcers during DTT, which are typically identified via systematic preference assessments (e.g., Lang et al., 2014). A procedural variation that may further enhance the effectiveness of DTT is to give the learner opportunities to choose the reinforcer at the moment that it is earned. Reinforcement choice may improve performance by ensuring that the learner receives the most preferred consequence (Sellers et al., 2013) or by reducing the effects of satiation via varied reinforcement (North & Iwata, 2005). Some research findings indicate that choice itself may function as a reinforcer (e.g., Tiger, Hanley, & Hernandez, 2006); in such cases, providing opportunities to choose contingent on responding may enhance the quality or value of the reinforcement contingency (Elliott & Dillenburger, 2014).

A commonly used procedural variation related to the delivery of contingent praise is to refer specifically to the targeted behavior in the praise statement (e.g., "Nice job pointing to the cup!" rather than "Nice job!"). Despite the ubiquity of this recommended variation, few studies have directly examined the benefits of using descriptive (or behavior-specific) versus general praise statements. Furthermore, research findings thus far have not revealed consistent, sustainable, or notable differences in acquisition with these two forms of praise (Polick, Carr, & Hanney, 2012; Stevens, Sidner, Reeve, & Sidener, 2011). As discussed by Polick et al., specific praise may be beneficial for certain individuals (e.g., those with good intraverbal repertoires), suggesting that further research is warranted.

A useful strategy for reducing prompt dependency is to provide differential consequences following prompted versus unprompted responses. Although the use of differential reinforcement is commonly recommended in texts and curriculum guides on DTT, only a handful of studies have examined procedural variations of this approach. Research findings indicate that providing a denser reinforcement schedule (Hausman, Ingvarsson, & Kahng, 2014; Olendick & Pear, 1980; Touchette & Howard, 1984) or higher quality reinforcers (Cividini-Motta & Ahearn, 2013; Karsten & Carr, 2009) for unprompted responses relative to that for prompted responses will enhance acquisition. Furthermore, it appears that acquisition may occur more rapidly for some learners if reinforcement is completely withheld following prompted responses.

Task Interspersal

A common practice is to alternate among two or more instructional targets during teaching sessions with a learner. A number of studies have examined different ways to arrange instructional trials within teaching sessions (Chiara, Schuster, Bell, & Wolery, 1995; Dunlap, 1984; Majdalany, Wilder, Greif, Mathisen, & Saini, 2014; Volkert, Lerman, Trosclair, Addison, & Kodak, 2008). Research findings suggest that learners may acquire skills more quickly when the therapist presents S^Ds for several different targets (e.g., "stand up," "Point to green," "What animal goes 'moo'?") rather than for the same target (e.g., "Point to green.") across consecutive instructional trials (e.g., Chiara et al.; Dunlap). Authors have speculated that task interspersal procedures improve performance by functioning as a motivational operation (MO). However, studies in which unknown targets were alternated with known targets have produced inconsistent findings (see Benavides & Poulson, 2009; Charlop, Kurtz, & Milstein, 1992; Dunlap, 1984; Majdalany et al., 2014; Volkert et al., 2008). As such, the conditions under which task interspersal procedures are beneficial have not yet been delineated and warrant further study. A somewhat different approach to task interspersal is to alter the instructional context by incorporating game-related stimuli (and reinforcers) into DTT. In Geiger et al. (2012), for example, the therapist taught one subject receptive object labels within the context of a train activity. The subject had access to the train activity materials for 30 s. The therapist removed the materials, presented a learning trial with stimuli (attached to pieces of the train track), and provided access to (the additional piece of train track) for 30 s contingent on a correct response. (Another child learned receptive discriminations by jumping to the correct stimulus in a 3-item array that were pasted into a Twister® mat.) Results of a subsequent preference assessment indicated that the (each child preferred their game-based) learning arrangement to a more traditional DTT format conducted at the table in a traditional format.

Intertrial Interval (ITI)

A pause between instructional trials provides a clear demarcation point between the end of a trial and the beginning of the next trial. The length of this ITI may impact performance. For this reason, it is commonly recommended to deliver instructional trials at a rapid pace during DTT. Research findings have shown that acquisition is enhanced with short (e.g., 2-s to 3-s) versus long (e.g., 10-s to 20-s) it is (e.g., Koegel, Dunlap, & Dyer, 1980; Majdalany et al., 2014). Some research, however, also suggests advantages to presenting additional instructional stimuli during ITIs (e.g., Loughrey, Betz, Majdalany, & Nicholson, 2014; Reichow & Wolery, 2011; Vladescu & Kodak, 2013). With this approach, the therapist inserts supplementary information immediately prior to or following instructional trials, with no response required of the learner. The additional stimuli (sometimes called secondary targets) may be related or unrelated to the primary targets (e.g., stating, "Dog have tails," after asking the learner to point to the picture of a dog versus asking the learner to point to the letter "A"). This approach appears to enhance acquisition of the secondary targets without compromising progress on the primary targets. Studies have shown that some learners with autism will acquire the secondary targets either prior to or simultaneously with the primary targets (Reichow & Wolery, 2011; Vladescu & Kodak, 2013). The conditions under which learners will acquire supplementary information in the absence of direct training are unclear, but Vladescu and Kodak noted that their subjects tended to echo (i.e., vocally imitate) the secondary stimuli presented by the therapist. Further research is needed to determine if a strong echoic repertoire is a necessary pre-requisite for learning in this instructional context.

Individual Versus Group Format

DTT is typically conducted within the context of individualized (i.e., one-on-one) instruction. Nonetheless, a number of studies have demonstrated successful learning outcomes when DTT was embedded within a group instruction format (e.g., Leaf et al., 2013; Taubman et al., 2001). In Taubman et al., for example, a teacher delivered the S^D to multiple children who were expected to respond simultaneously. During other lessons, the teacher delivered the instructional trials sequentially across children. Results showed successful acquisition of targets via the group instructional approach. Leaf et al. (2013) directly compared individual versus group instruction formats for six children with autism. The instructor delivered instructional trials sequentially across three children during the group instruction format. Results not only showed that the group format was as effective as individual instruction for teaching new skills, but the children learned some of the targets that had been delivered to other children in the group.

Conditional Discriminations

A large portion of instruction during DTT is devoted to teaching conditional discriminations, in which the correct response in the presence of the S^D depends on the stimulus context. These discriminations are typically taught within the context of match-to-sample tasks. For example, suppose the therapist is teaching a child to discriminate among red, blue, and green. The therapist might present stimuli of each color to the child and state, "Point to blue." In the presence of the blue stimulus, pointing to the blue stimulus is correct only if the therapist has stated, "Point to blue." Curriculum manuals and guides recommend two approaches for teaching this type of auditory-visual discrimination. In one approach (called the "simple-conditional method"), the therapist first targets simple discriminations, in which the learner is taught to respond one stimulus only (e.g., point to blue). The other discriminations (e.g., red and green) are successively introduced, and the learner is then required to respond to each of the stimuli based on the auditory stimulus presented by the therapist. In the other approach (called the "conditional-only method"), the learner is taught all relations simultaneously from the outset of instruction. Results of several recent studies suggest that the conditional-only method is more effective and efficient than the simple-conditional approach (e.g., Grow, Carr, Kodak, Jostad, & Kisamore, 2011; Grow, Kodak, & Carr, 2014). A more detailed overview of instructional strategies for teaching simple and conditional discriminations can be found in Grow and LeBlanc (2013).

Generalization

Ensuring that newly taught skills generalize across relevant responses and contexts (e.g., in different settings and with different people, instructions, and materials) is a critical component of DTT. One of the most common approaches for promoting generalization is to include multiple exemplars in training. The instructor might (a) arrange for different people to deliver the SD (e.g., different instructors, caregivers), (b) present the S^D in multiple locations (e.g., classroom, lunchroom), (c) vary the wording of the S^D (e.g., "Touch green." "Show me green."), and (d) present different stimulus materials (e.g., different sized letters, different colored objects). Research on the multiple exemplar strategy indicates two primary approaches: (a) introducing each new exemplar in a sequential fashion, waiting until the learner demonstrates mastery with an exemplar before introducing the next (often called "serial training"), or (b) teaching multiple new exemplars at a time to the learner (often called "concurrent training"). Both approaches continue until the learner demonstrates generalization across untrained exemplars. Although research findings suggest that both procedural variations lead to the acquisition and generalization of skills, results of several studies indicate that the concurrent training approach may promote generalization more efficiently and effectively for some learners (Schroeder, Schuster, & Hemmeter, 1998; Wunderlich, Vollmer, Donaldson, & Phillips, 2014).

Other approaches for promoting the likelihood of generalization include (a) incorporating materials, situations, and other stimuli from the child's natural environment into training, (b) teaching responses that are likely to contact reinforcement in non-training settings, (c) thinning the schedule of reinforcement in the training setting, and (d) recruiting caregivers and others to prompt and reinforce targeted responses in non-training settings (Stokes & Baer, 1977).

Measurement

Monitoring a learner's progress through trial-based recording of performance is a hallmark of DTT. The authors of many curriculum manuals and guides recommend that therapists record the outcome of every learning trial, summarize performance across blocks of learning trials, and examine the data frequently to make decisions about learner progress and potential program changes. An alternative to this labor-intensive approach to measurement, called continuous recording, is to record learner performance on just a subset of trials or instructional sessions. When using discontinuous recording, the therapist might record the outcome of the first trial, the first three trials, or the first five trials of instructional sessions that consist of nine to ten trials. Despite the potential ease of sampling in this manner, obtaining less data may alter the accuracy or sensitivity of measurement. Results of several studies comparing continuous and discontinuous recording during DTT suggest that the possible benefits of discontinuous recording (in terms of ease and efficiency) may not outweigh the costs (Carey & Bourret, 2014; Cummings & Carr, 2009; Lerman, Dittlinger, Fentress, & Lanagan, 2011; Najdowski et al., 2009; Taubman, Leaf, McEachin, Papovich, & Leaf, 2013). For example, data collected on just a subset of trials may lead therapists to conclude prematurely that a learner has mastered a skill and may be less sensitive to changes in performance (Carey & Bourret, 2014; Lerman et al., 2011). Furthermore, Taubman et al. (2013) found that continuous and discontinuous recording methods required nearly the same amount of therapists' time.

The DTT Programming Model

Many behavioral programs involve similar trial components (i.e., specific antecedent, behavior, and consequence) because the three-term contingency (A-B-C) represents the critical behavioral learning unit. However, DTT programming is typically more structured in the presentations of the trials and the specifics of the prompting sequence, more rapidly paced, and more contrived in the initial learning environment which typically has been stripped of most distracting stimuli. Three critical features of DTT programming likely account for the dramatic and potentially

developmental trajectory altering effects for children with autism. First, DTT is initially conducted in a distraction-free environment to promote attending. Second, DTT programs focus heavily on "learning to learn" repertoires that accelerate acquisition in subsequent programming. Third, the DTT programming model emphasizes intensive intervention with teaching occurring across a great number of hours (e.g., 25–40 per week) and with a great density of learning units in each of those hours.

Distraction Free Environment

DTT is typically presented in a distraction free environment to increase the likelihood that the child with autism attends to the teacher and S^D. The distraction free environment is most important for young children who have not yet learned to attend to people or items in a sustained fashion, which is a critical pre-requisite skill for learning. Initial sessions often occur at a small table or with the adult and child sitting face-to-face in chairs. Items such as pictures, posters, toys, television, computers, or other distracting and preferred stimuli are removed from the instructional area. As the child develops attending skills and basic compliance and direction-following skills, teaching begins to occur across settings in more natural contexts to facilitate generalization of newly learned skills.

Structured Curriculum

Typically, a structured curriculum is used as a basis for building the instructional objectives for a DTT program. Commonly used published curricula include those by Leaf and McEachin (1999), Lovaas (2002), Maurice, Green, and Luce (1996), and Sundberg and Partington (1998). These curricula describe the basics of the intervention approach, the specific components of programming, and the progression of skills targeted throughout multi-year intervention efforts (i.e., the curriculum). Initial teaching efforts focus on establishing critical learning repertoires that will facilitate acquisition of later skills and accelerate developmental progress. Children learn to attend, to imitate sounds and movements, to match objects and pictures, and to comply with basic directions. The discriminations become progressively more complex (e.g., two-step directions, three-step directions) and expand to encompass an array of spoken language (e.g., requests, labeling, asking and answering questions), social and play skills (e.g., functional play, parallel play, interactive play, sharing, initiating) and adaptive targets (e.g., toileting skills, self-feeding, dressing) appropriate for children aged 2–6 years. The curriculum is hierarchical in that early skills must be mastered before moving up the hierarchy to later, more difficult skills.

Trials and Intensity of Intervention

The pace of instruction in DTT is typically brisk, particularly for early learners who may have difficulty attending for extended periods of time. An individual trial may last for approximately 5–30 s depending on the targeted skill and the level of prompting required to produce the response. The goal is to have many trials of a specific type of program (i.e., receptive identification) within just a few minutes so that the learner experiences potentially 1000 s of trials across all program types throughout the day almost every day. This volume of learning opportunities actually approximates the number that a typically developing toddler or preschooler might experience in a given day with a difference that the typically developing toddler is often initiating those learning opportunities and readily learning from events happening in their environment without the need for such explicit instruction. Intervention typically occurs at this level of intensity for 1–2 years with an additional year of programming that may occur at lower intensity (e.g., few hours per week, no longer 1–1 ratio) and in natural environments such as preschool or center-based settings.

The critical features described above are common in DTT programs. However, the specific instructional programs and procedures may vary as they are individualized to the learner. A team of professionals typically work together to coordinate and implement programming. For example, the child may work directly with several different instructors for multiple hours per week. This allows for generalization programming so that new skills are more likely to occur in interactions with a wide variety of people. These direct intervention services are overseen by a professional with a higher level of education and credentialing (i.e., Board Certified Behavior Analyst) who creates the programming, assess progress, and develops intervention plans for problematic behavior. This approach to intervention with children with ASD has a substantial evidence base to support the consistent positive effects that are produced when implemented at an early age and at a high level of intensity and duration (see Outcomes Research section below). The following section provides general information to guide a new practitioner through the critical steps for implementing a DTT program effectively.

Guidelines for Implementing the DTT Programming Model

Most curricula and resource manuals for DTT provide information about establishing and monitoring the progress in programs (Leaf & McEachin, 1999; Lovaas, 2002; Maurice, 1994; Maurice et al., 1996). The fact that entire books are devoted to this task is a clear indication that the brief description provided here is only a starting point for those who actually intend to implement this type of programming. Although not detailed enough for a stand-alone resource, this section is designed to provide the process and major milestones for program implementation along with direction to more complete resources for each step.

Starting the DTT Program and Services

Establishing DTT services requires several critical preparatory and preliminary steps. First, families should be oriented to basic information about DTT programming and the evidence regarding effectiveness (i.e., the information provided in sections above and below). This orientation is a critical part of rapport building and should occur in a supportive manner given the stressful and painful context of a newly delivered diagnosis of an ASD for the family. The orientation to services might include a live discussion, provision of reading materials, or a visit to a center-based program to see ongoing services for other children. Consider written materials such as *Right From the Start: Behavioral Intervention for Young Children with Autism* (*2nd Edition*) (Harris & Weiss, 2007) and *Making a Difference: Behavioral Intervention for Autism* (Maurice, Green, & Foxx, 2001), as these materials are family friendly. The orientation should cover the basic expectations about DTT programs (e.g., intensity, location and frequency of sessions, parental involvement in selection of targets and implementation of programming, structure and responsibilities of the treatment team). It may also be useful to provide general information about autism and adjusting to having a child with special needs such as *A Practical Guide to Autism: What Every Family Member, Teacher and Professional Needs to Know* (Volkmar & Wiesner, 2009) or *Children with Autism: A Parent's Guide* (*2nd Edition*) (Powers, 2001).

Second, the instructors and supervising behavior analysts should establish rapport with the child and establish themselves and a wide range of leisure items as highly preferred. This process is often referred to as "pairing" and typically involves conducting preference assessments, engaging in highly preferred play activities with the child, and minimizing instructional demands for the first sessions. Once the treatment team has been paired sufficiently with positive experiences, the child will likely readily approach instructors and willingly interact with them. Instructional demands are gradually introduced and interspersed with ongoing pairing activities to ensure a rich and positive interaction schedule. Many of the first demands that are presented are designed to assess the child's existing skills and deficits with respect to a previously chosen curriculum of programming. The results of these assessment activities are used to select a reasonable array of programs. It is important to distinguish between the term "program" when used to refer to the comprehensive program, which includes all of the tasks, goals and objectives included in an entire DTT program, versus a specific program, which includes a specific goal within the overall comprehensive program. For the purpose of this chapter, the term "program" will be used to refer to the comprehensive program, whereas "specific program" will be used to refer to the specific goals and objectives included in the comprehensive program (e.g., receptive body parts). Many early specific programs and incidental teaching interactions are designed to establish a readiness repertoire (e.g., sitting for a brief period, looking at an adult or items, following simple directions) for more structured programming. The family may be involved in services from the very beginning by participating in pairing sessions and providing information about preferred items and activities.

The next critical step in a successful program is establishing a partnership between the family and the provider team. Participation and input from the family is recruited to establish goals for programming and important behavioral needs (e.g., problem behavior, food selectivity, sleep problems, safety issues). An initial parent interview can be helpful in learning information about environmental determinants of problem behavior, the family's short- and long-term goals for the child, and the behaviors that the family sees as most important and relevant. For example, the behavior analyst might assess skills and determine that a child has receptive language deficits and minimal direction following skills. The behavior analysis would then create a specific program to teach the child to learn the names of common objects (i.e., receptive identification of objects, listener responding) and follow simple directions. The family plays a important role in determining the specific items to target based on information that the family eats a variety of fruit and that they would like their child to be able to "go get a banana" for his snack when asked to do so. Thus, the family provides suggestions and priorities that inform the comprehensive program and enhance its relevance for their lives. The next section will focus on the components and structure of an effective DTT program.

Programs and Targets

The comprehensive program is developed based on the specific curricular assessment conducted, clinical judgment, the current level of the child's functioning, and parental input. Once a specific program is established, individual items, often called "treatment targets," are selected that will serve as the primary focus of intervention. For example, an overall specific program may be "receptive identification of body parts" whereas the treatment targets might be "nose," "head" and "ears." Treatment targets often change as the child masters them until a pre-determined overall goal is met (e.g., the child can receptively identify at least 12 body parts on self, others and in pictures).

The number of specific programs and number of targets in a comprehensive DTT program might vary significantly based on the language level of the learner, number of intervention hours per week, and family goals and priorities. For example, a very early learner may have only three specific programs (e.g., requesting, eye contact, and receptive instructions) with two to three targets in place for each of the programs (e.g., request ball and juice, respond to "sit down," and "clap"). In contrast, a more advanced learner may have 15 or more specific programs across language, social, play, and adaptive skill domains with many targets in each specific program. Generally, the age of the child, number of intervention hours, and type of program (i.e., comprehensive vs. focused) will be important factors guiding decisions about the number of programs and targets within those programs.

Components of the Specific Instructional Program

Each specific instructional program may vary across learner, but a quality DTT program contains the following components: A clear purpose and rationale, a list of needed materials, and a precise procedural description, including specific S^D, description of the target response and acceptable variations, a description of prompts and criteria for fading prompts, reinforcers, and error correction procedures. A quality specific program also includes instructions on target interspersal and target rotation, data collection, and mastery and generalization criteria. For a sample specific program for receptive body parts, see appendix A.

Analysis of Progress and Program Modification

Once specific programs and targets are selected and implementation has begun, the focus shifts to analyzing the learner's progress and making modifications as necessary to ensure optimal efficiency of learning. Data on the learner's behavior must be graphed and analyzed regularly to accomplish this. These data are used to evaluate the effectiveness of a specific program. Consideration may be given to the following points of measurement: At least 80 % of active programs should have multiple targets mastered, the consumer should master a reasonable number of targets every 2–4 weeks ("reasonable" should be based on a consumer's age, number of service hours, and type of service/programming), and the number of trials or probes to criterion for consecutive targets in a program should follow a low stable or decreasing trend. Additionally, mastered targets should maintain over time, or are reintroduced to active status with a maintenance programming component.

As the data are analyzed, complete programs will become mastered and replaced with new ones. The overarching goal is to teach children a variety of language, motor, and adaptive skills to ensure they exhibit skills consistent with those exhibited by same-age peers. A strong focus on generalization of skills in naturally occurring situations is imperative.

Facilitating and Evaluating Progress Towards Socially Meaningful Outcomes

As a child acquires skills in DTT, generalization becomes an important focus of programming. It is important to continuously program for and evaluate both stimulus and response generalization in DTT. This can be an important indicator of both the effectiveness of and necessity for ongoing intervention. Various strategies for promoting generalization, as described above, are embedded into DTT, and a consumer's entire comprehensive program may focus completely on generalization activities.

As stimulus and response generalization occurs, it is important to both assess and facilitate the readiness of the natural environment to sustain treatment gains. For example, a child may have acquired the skill of greeting his peers and due to DTT; he has generalized that skill to use it in the school environment, home environment, at the park and with a variety of peers. An important element of ensuring this skill is sustainable over time is that the individuals in his natural environment will provide appropriate and natural consequences that will maintain this skill over time. That is, just because a child can greet his peers in these situations, does not necessarily mean that when he does so; the natural contingencies of greeting one's peers will maintain responding. It may be important to examine the child's environment and determine any refinement of that skill to ensure the natural contingencies ultimately maintain responding.

As critical repertoires develop, another important consideration is transition into the next environment. This next environment will differ greatly depending on the age and overall functioning of the learner. For example, a small child may need to focus on kindergarten readiness skills, whereas an older child may need to focus on self help and adaptive skills to transition into an independent living situation. An important part of DTT is identifying and specifically planning for the repertoires that will be necessary for success, no matter what the next environment will be. In order to adequately plan for the transition, asking the following questions may prove helpful: first, what do other individuals in this environment do? That is, what are the repertoires that make others successful in the environment? For example, a child in kindergarten may be expected to recite the alphabet, socialize on the playground and sit in a group setting for a period of time. In this case, ensuring the individual with a disability can engage in these behaviors in a similar manner is crucial for success in that new environment. Second, what are the critical behaviors the environment requires for participation? For example, a group home might require independence with dressing or a classroom may require self-initiation of toileting. These behaviors should be specifically incorporated into DTT prior to transition into the new environment to ensure ultimate success.

Teaching Others to Implement DTT

Research findings indicate that therapists with diverse backgrounds and levels of expertise can learn to implement DTT, generalize those skills across learners and targets, and maintain these skills over time. Learner performance, in terms of both acquisition of skills and levels of disruptive behavior, are directly related to the integrity of DTT procedures (e.g., Dib & Sturmey, 2007; Reed, Reed, Baez, & Maguire, 2011). DTT should not be implemented exclusively by specialized behavioral therapists but also by parents, teachers, and any other care providers who are responsible for the social, educational, and behavioral development of the child. The majority of studies showing good outcomes with DTT have included a caregiver training component (see next section below), and results of some studies

suggest that DTT outcomes may be similar regardless of whether parents or trained professionals serve as the children's primary therapist (e.g., Sallows & Graupner, 2005). In the following sections, we describe the components of effective staff and caregiver training, along with research findings on alternative modalities for improving the efficiency, accessibility, and cost of training (see also Thomson, Martin, Arnal, Fazzio, & Yu, 2009, for a review).

Behavioral Skills Training

Behavioral skills training (BST), the most commonly used evidence-based approach to training DTT skills, is an explicit, active-response training procedure that involves four critical components—instructions, modeling, rehearsal and feedback (Miltenberger, 2003). Trainers use performance-based criteria to determine when the trainee has mastered the skills. For example, training may continue until the trainee performs the DTT procedures with at least 90 % accuracy across three consecutive practice sessions. Results of numerous studies have shown that BST is highly effective for teaching DTT to teachers, parents, and other staff (e.g., Dib & Sturmey, 2007; Lafasakis & Sturmey, 2007; Lerman, Tetreault, Hovanetz, Strobel, & Garro, 2008; Sarokoff & Sturmey, 2004). Training typically begins with spoken and written instructions that delineate the components of DTT. The next step of BST, modeling, is implemented live or through video and might include examples of both correct and incorrect applications of the procedures and demonstrations of DTT with multiple learner targets. Modeling also might be provided immediately after the trainee has had an opportunity to rehearse (practice), and the trainer demonstrates DTT components that were performed incorrectly by the trainee (e.g., Lafasakis & Sturmey, 2007; Sarokoff & Sturmey, 2004). The rehearsal (practice) with feedback phase may be accomplished through role play with the trainer, through actual teaching sessions with the learner, or both. Practice should include multiple targets and materials to promote generalization of the DTT skills (Ducharme & Feldman, 1992). Feedback typically consists of vocal statements describing DTT components implemented correctly and incorrectly, along with suggestions for correcting implementation errors. Practice with feedback continues until the trainees implement DTT with a high degree of accuracy. However, trainees must continue to receive specific feedback about their performance (McKenney & Bristol, 2015), combined with praise that is contingent upon aspects of DTT implementation, to improve and maintain performance over time (Alvero, Bucklin, & Austin, 2001; Komaki, Desselles, & Bowman, 1989).

A few supplemental procedures have been evaluated for enhancing the effectiveness of BST when teaching DTT skills to others. In May, Austin, and Dymond (2011), for example, therapists engaged in higher levels of accurate responding when BST was combined with stimulus prompts. The prompts consisted of cards listing the learner's targets along with a laminated board showing the differential responses of the therapist for all possible learner responses on each trial. The therapists

were taught to place each card in the corresponding section on the laminated board based on the learner's response to the S^D. Thomas (2013) found that DTT implementation of paraprofessionals improved after they were taught to observe and score the accuracy of their peers' teaching sessions.

Alternative Modalities

BST is often considered the gold standard for training others to implement behavioral interventions. However, this approach can be fairly expensive and time-consuming, and it requires the availability of experts to provide the training. Training efficiency is particularly important in settings with high therapist turn-over or when large groups of individuals need to be trained. In some rural or remote areas, experts are not readily available to provide training on DTT. As such, some investigators have developed alternative training modalities to enhance the efficiency, cost, or availability of BST. These approaches vary in terms of the extent to which they incorporate the components of BST.

Training modalities that might eliminate the need for live trainers, including written manuals, videos, and computer-based instruction, have been evaluated in a number of studies on DTT. For example, Thiessen et al. (2009) developed a 37-page manual that provided comprehensive written instructions on (a) the basic principles of applied behavior analysis, (b) preparation for an instructional sessions, (c) antecedents and consequences for correct responses, (d) antecedents and consequences for incorrect responses, and (e) prompt fading. The trainees, undergraduate students, were required to complete a knowledge test after reading each unit in the manual and answer all of the questions correctly before proceeding to the next unit. The manual also instructed trainees to imagine conducting DTT with a child using the components covered in the unit and to evaluate their self-practice via a rating form. After completing the training manual, the trainees demonstrated high levels of procedural integrity when conducting DTT in role play with an experimenter, although integrity decreased somewhat when the trainee implemented DTT with a child with autism. Trainees required 2–5 h to master the manual.

In a subsequent study, Thomson et al. (2012) evaluated the outcomes of the same instructional manual with newly hired tutors providing in-home DTT programs for children with autism. After completing the manual, tutors who did not implement DTT with 80 % accuracy (the mastery criterion) during role play with the experimenter watched a 17-min video that reviewed the information contained in the manual and showed an expert implementing DTT with a child. Five of the eight tutors required the video component following the self-instructional manual and met the mastery criterion after watching the video. Less promising outcomes were obtained when the instructional manual and video were used with parents (Young, Boris, Thomson, Martin, & Yu, 2012). All but one of the five parents required the video component, and two of the parents did not meet the mastery criterion after completing the self-instructional manual and watching the video. In a second

experiment, Young et al. replaced the self-practice component of the manual with role play plus feedback. This substitution improved the overall outcomes for the parents, but it required the availability of a trainer. Together, these results suggest that written instructions alone may not be a viable substitute for live BST. However, for some individuals, the addition of video models may be a useful supplement to written instructional manuals.

Results of several studies suggest video instruction alone may eliminate the need for live trainers. In these studies, video modeling with voiceovers that described the critical components of DTT was effective for teaching direct service staff to implement DTT with a high degree of integrity during role play with the experimenter (Catania, Almeida, Liu-Constant, & Digennaro, 2009) and during teaching sessions with children (Vladescu, Carroll, Paden, & Kodak, 2012).

Similar to written manuals, computer-based instruction is designed to eliminate the need for individualized trainers. However, use of the computer permits the inclusion of the modeling component of BST via videos. Nosik, Williams, Garrido, and Lee (2013) compared the outcomes of live BST to computer-based training for direct care staff in a day program for adults. The computer-based instruction included written text, videos, and quizzes with feedback. Results showed that the subjects who received BST implemented DTT with a higher degree of procedural integrity immediately following training and at a 6-week follow up than those who received computer-based instruction. Using a similar computer-based instruction program Pollard, Higbee, Akers, and Brodhead (2014) obtained promising results with four college students who had no prior DTT experience. Three of the four participants met the mastery criterion immediately after completing the training modules and then generalized their teaching skills to a young child with autism. The third participant showed an immediate improvement in performance after receiving a single performance feedback session.

Lack of rehearsal (i.e., hands-on practice with feedback) that is a typical component of BST may compromise the effectiveness of computer-based instruction. If so, one way to improve the outcomes of computer-based instruction would be to incorporate a performance-based component via interactive simulation software. A tested version of this software, called DTkid, permits the trainee to simulate teaching sessions with a child while receiving real-time feedback on performance or an evaluative summary on procedural integrity at the conclusion of the teaching session (Eldevik et al., 2013; Randall, Hall, Bizo, & Remington, 2007). Preliminary research on DTkid suggests that this may be a promising self-instructional approach, but further research is needed.

Another potential approach for increasing the accessibility of staff and caregiver training is to provide BST through videoconferencing. Although this modality does not eliminate the need for live trainers, it may be helpful for reaching individuals who reside far from qualified trainers. Videoconferencing requires access to the internet, a computer, web camera, and conferencing software (e.g., Skype, MoviTM-client). Research suggests videoconferencing is a promising approach for teaching staff and caregivers to implement behavioral assessments and interventions (e.g., Vismara, Young, Stahmer, Griffith, & Rogers, 2009; Wacker et al., 2013a, 2013b).

In one of the few studies to evaluate this modality for teaching DTT, Hay-Hansson and Eldevik (2013) found no differences in the performance of school staff who were taught via live BST versus videoconferencing.

DTT Intervention Research: Large-Scale Outcomes

The landmark study that investigated the effectiveness of DTT with children with autism was conducted by Lovaas (1987). Results of this study are often cited and recognized as the first demonstration that EIBI focused on DTT is highly effective in producing positive outcomes for this population. Specifically, 47 % of the children in the Lovaas study were placed in general education, obtained an average increase in IQ score of 37 points, and had substantial decreases in symptoms of autism. In significant contrast, only 2 % of the control-group children achieved normal educational and intellectual functioning (the remaining were placed in language delayed classes or special classrooms for autism and/or mental retardation).

Since 2000, many researchers have compared the effects obtained with DTT (typically at least 25 h per week of intervention) with those obtained by other non-behavioral (i.e., "eclectic" or "treatment as usual") interventions, with lesser intense DTT models (typically less than 15 h per week), and with no treatment at all. This literature can be categorized into two main areas. First, studies have compared DTT to some other approach, often termed a control group, that either consists of an eclectic approach, no treatment at all, or treatment as usual. The second area includes meta-analyses or systematic reviews in which researchers reviewed and summarized multiple studies to examine the overall effects of DTT.

For the purpose of this chapter, only studies that clearly focused on DTT were included. Although much of the literature on early intensive behavioral intervention (EIBI) includes DTT in some regard, studies were excluded in this review if other approaches were utilized (e.g., Early Start Denver Model, pivotal response training, natural environment teaching, incidental teaching, etc.) either in addition to or in place of DTT. We did not exclude comparisons to these models but excluded any studies that appeared to use these approaches in place of DTT. It should be noted that the terms "early intensive behavioral intervention," "discrete trial teaching," "ABA," the Lovaas method," and "the UCLA model" are often used interchangeably in the literature. However, only studies that focused on structured DTT, as described in this chapter, are included in this review. Studies that did not include a control or comparison group and those that focused on children with disabilities other than autism also were excluded. Although many studies have examined the overall effectiveness of DTT without the use of control groups, these are best reviewed separately (see LeBlanc, Parks, & Hanney, 2014, for a complete review of these studies published between 2000 and 2012).

Two tables are provided to summarize this extensive body of literature (Table 3.1: comparison outcome studies; Table 3.2: meta-analyses and systematic reviews).

Table 3.1 Comparison outcome studies

Authors	Title	Year	Type of article	Purpose	Participant groups	Dependent variables	Summary of findings
Eikeseth, Klintwall, Jahr, Karlsson	Outcome for children with autism receiving early and intensive behavioral intervention in mainstream preschool and kindergarten settings	2012	Comparison outcomes study	To compare DTT group with TAU on adaptive functioning and autism symptoms	35 DTT (23 h/week)	Adaptive	DTT achieved higher scores in adaptive functioning and reduced autism symptoms
					24 TAU	Autism symptoms	No significant difference on adaptive skills or symptoms in TAU group
Eldevik, Hastings, Jahr, and Hughes	Outcomes of behavioral interventions for children with autism in mainstream pre-school settings	2012	Comparison outcomes study	To compare scores on intellectual and adaptive functioning between DTT group and TAU group	31 DTT (13.6 h/week)	Intellect	DTT significantly greater outcomes on intellect and adaptive skills
					12 TAU (eclectic; 5 h/week)	Adaptive	No significant change in IQ or symptoms for control group
Flanagan, Perry and Freeman	Effectiveness of large-scale community-based intensive behavioral intervention: a waitlist comparison study exploring outcomes and predictors	2012	Retrospective outcome comparison study	To compare DTT to treatment waitlist on intellectual functioning, adaptive skills, and symptoms	61 DTT (25.8 h/week)	Intellect	DTT group achieved significantly higher intellectual and adaptive functioning, showed less autism symptoms
					61 no treatment control	Adaptive	No significant change in IQ, adaptive skills or symptoms for control group
						Autism symptoms	

(continued)

Table 3.1 (continued)

Authors	Title	Year	Type of article	Purpose	Participant groups	Dependent variables	Summary of findings
Strauss, Vicari, Valeri, D'Elia, Arima and Fava	Parent inclusion in early intensive behavioral intervention: the influence of parental stress, parent treatment fidelity and parent mediated generalization of behavior targets on child outcomes	2012	Comparison Outcomes study	To compare DTT with eclectic approach on IQ, language, autism severity	24 DTT (35 h/week)	Intellect	DTT achieved higher IQ scores, language and less symptom severity
					20 eclectic (12 h/week)	Language	Both groups made significant gains in adaptive behavior and receptive language
						Autism severity	
						Adaptive	Parents in the eclectic group had significant stress reduction; DTT group parents had not change in stress reduction
						Parental stress	
Fava, Strauss, Valeri, D'Elia, Arima and Vicari	The effectiveness of a cross-setting complementary staff and parent mediated early intensive behavioral intervention for young children with ASD	2011	Comparison outcomes study	To evaluate the effects of DTT and eclectic approach intellectual functioning, autism symptoms and problem behavior	12 DTT (14 h/week)	Intellect	DTT significant increases in intellectual functioning and significant decreases in autism symptoms and problem behavior
					10 eclectic (12 h/week)	Autism symptoms	Eclectic group no significant change in behavior, symptoms and IQ scores
						Problem behavior	

Downs, Downs, Fossum and Rau	Effectiveness of discrete trial teaching with preschool students with developmental disabilities	2008	Longitudinal Comparison Outcome study	Evaluate effects of two levels of DTT on	3 (1 year of three 10–15 min DTT sessions/ day)	Communication	Participants acquired more skills and learned more quickly when DTT was provided in one longer session
					3 (1 year of three 30–45 min DTT sessions/ day)	Motor skills	
						Language	
						Social	
						Adaptive	
						Cognitive	
Ben-Itzchak, Lahat, Burgin, and Zavhor	Cognitive, behavior and intervention outcome in young children with autism	2008	Comparison Outcome study	Evaluate effects of DTT on IQ and to determine effects of initial cognitive level on outcomes	44 DTT (45 h/ week)	Intellect	Greater IQ gains in DTT group after 1 year of treatment; pre-cognitive levels did not predict changes in symptoms
					37 TAU		TAU did not show significant changes in IQ scores
Eikeseth, Smith, Jahr and Eldevik	Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: a comparison controlled study	2007	Comparison Outcome study	To compare DTT vs. eclectic intervention on IQ, adaptive functioning and social and behavioral problems	13 DTT (28 h/ week)	IQ	Significantly greater improvements in IQ and adaptive skills in DTT group
						Adaptive	Less social and behavior problems in DTT group
					12 eclectic (29.1 h/week)	Social	No significant improvements in any area for eclectic group
						Behavior	

(continued)

Table 3.1 (continued)

Authors	Title	Year	Type of article	Purpose	Participant groups	Dependent variables	Summary of findings
Magiati, Charman and Howlin	A 2-year prospective follow-up study of community based early intervention and specialist nursery provision for children with autism spectrum disorders	2007	Prospective comparison outcome study	To compare DTT with autism-specific nursery services on intellect, adaptive, language, play and symptoms	28 DTT (32.4 h/week)	Intellect	Similar outcomes for both groups on all measures, except DTT scored higher on daily living skills
						Adaptive skills	
						Language	
					16 autism specific nursery (25.6 h/week)	Play	
						Symptoms	
Reed, Osborne and Corness	The real-world effectiveness of early teaching interventions for children with autism spectrum disorder	2007	Comparison Outcome study	Compare effects of DTT, eclectic and portage intervention on educational functioning	12 DTT (30.4 h/week)	Educational functioning	DTT higher intellectual functioning than other two groups
					20 eclectic (12.7 h/week)		DTT and eclectic group scored significantly higher on measures of intellectual functioning than portage group
					16 portage (8.5 h/week)		
Reed, Osborne and Corness	Brief report: relative effectiveness of different home-based behavioral approaches to early teach intervention	2007	Comparison Outcome study	Compare effects of high intensity vs. low intensity ABA on intellectual and educational functioning	14 DTT high intensity (30.4 h/week)	Intellect	High intensity group made greater gains in intellect and educational functioning
					13 low intensity (12.6 h/week)	Educational functioning	Low intensity did not show any gains in educational functioning

Remington, Hastings, Kovshoff, Espinosa, Jahr, Brown and Ward	Early intensive behavioral intervention: outcomes for children with autism and their parents after 2 years	2007	Comparison Outcome study	To evaluate the effects of DTT on mental age, intellect, language, adaptive and social interactions	23 DTT (25.6 h/week)	Intellect	DTT achieved significant improvements in mental age, intellectual functioning, language, adaptive, positive social interactions
						Language	
						Adaptive	
					21 control group (15.3 h/week)	Nonverbal communication	No significant difference in any area for control group
						Social interactions	
Cohen, Amerine-Dickens, and Smith	Early intensive behavioral treatment: replication of the UCLA model in a community setting	2006	Replication outcome study	Compare DTT with eclectic intervention on IQ, adaptive skills, receptive language and academic placement	21 DTT (35–40 h/week)	Intellect	DTT achieved higher scores on measures of IQ, adaptive functioning and receptive language. 17/21 DTT children transitioned to mainstream
						Language	
					21 control (eclectic: 35–40 h/week)	Adaptive	No significant difference for control group in any area. One child went to mainstream classroom
						Academic placement	

(continued)

Table 3.1 (continued)

Authors	Title	Year	Type of article	Purpose	Participant groups	Dependent variables	Summary of findings
Eldevik, Eikeseth, Jahr and Smith	Effects of low intensity behavioral treatment for children with autism and mental retardation	2006	Retrospective comparison outcome study	Compare DTT vs. eclectic intervention on IQ, language and communication	13 DTT (12.5 h/week)	Intellect	DTT achieved higher scores in IQ, language functioning and communication and showed less symptoms
					15 eclectic (12 h/week)	Language	No significant difference in IQ, adaptive or language skills in Eclectic group
						Adaptive	
Sallows and Graupner	Intensive behavioral treatment for children with autism: 4 year outcome and predictors	2005	Comparison outcome study	To compare the effects of clinic directed DTT and parent directed DTT	13: clinic directed (37.6 h/week)	Intellect	Both groups made similar gains on all outcome measures
					10: parent directed (31.6 h/week)	Language	
						Adaptive	
						Social	
						Academic	
Howard, Sparkman, Cohen, green and Stanislaw	A comparison of intensive behavior analytic and eclectic treatment for young children with autism	2005	Comparison outcome study	Compare effects of DTT and low intensity eclectic intervention on intellectual functioning, visual spatial skills, language and adaptive functioning	29 DTT (25–40 h/week)	Intellect	DTT significantly higher scores on all domains
					16 intensive eclectic (25–30 h/week)	Visual special skills	
					16 low-intensity eclectic (15 h/week)	Language	The two eclectic groups did not differ in outcomes
						Adaptive	

Eikeseth, Smith, Jahr and Eldevik	Intensive behavioral treatment at school for 4–7 year old children with autism: a 1-year comparison controlled study	2002	Comparison outcome study	To compare the outcomes of DTT and eclectic treatments on adaptive functioning, intellect, visual-spatial skills, and language	13 DTT (28 h/week)	Intellect	DTT group achieved better scores on measures of intellectual functioning, visual-spatial skills and language
					12 eclectic (29.1 h/week)	Visual-spatial skills	Eclectic group showed significantly better increases in adaptive functioning
						Language functioning	
						Adaptive skills	
Smith, Groen, and Wynn	Randomized trial of intensive early intervention for children with pervasive developmental disorder	2000	Randomized clinical control trial	To evaluate outcomes of DTT and parent delivered behavioral intervention on intellectual functioning, visual spatial-skills, language, academic functioning	15 DTT (24.5 h/week)		DTT group scored higher on measures of intellect, visual spatial skills, language and academics
					13 (15–20 h/week)		No difference between the two groups on adaptive skills or problem behavior
Sheinkopf and Siegel	Home-based behavioral treatment of young children with autism	1998	Comparison Outcome study	To evaluate effects of DTT on IQ and severity of symptoms	11 DTT (27 h/week, delivered by parents)	Intellect	DTT achieved significantly higher IQ scores and significantly lower scores on a measure of symptom severity
					11 TAU (11.1 h in school setting)	Symptom severity	TAU groups showed no significant change in IQ scores or symptom severity

(continued)

Table 3.1 (continued)

Authors	Title	Year	Type of article	Purpose	Participant groups	Dependent variables	Summary of findings
Smith, Eikeseth, Klevstrand, and Lovaas	Intensive behavioral treatment for preschoolers with severe mental retardation and pervasive developmental disorder	1997	Comparison Outcome study	To evaluate effects of high intensity DTT on IQ and expressive language skills	11 DTT (30 h/ week)	Intellect	DTT greater increases in IQ and expressive language
					10 control (low intensity ABA; 10 h/ week)	Expressive language	Average of 8 point IQ increase in DTT group, decrease of 3 IQ points in control group
Birnbauer and Leach	The Murdoch early intervention program after 2 years	1992	Comparison Outcome study	Evaluate effects of DTT on language and intellectual functioning	9 DTT (18.7 h/week)	Intellect	Significantly higher language and nonverbal IQ scores for children in DTT. 4 of the 9 DTT IQ scores within normal range
					5 NTC	Adaptive skills	None of the children in the NTC group scored in the normal range for IQ
						Language	

Codes: *EIBI* Early Intensive Behavioral Intervention, *TAU* treatment as usual, *NTC* no treatment control; unless otherwise specified, intervention was delivered by trained clinicians; hours per week are average, unless otherwise indicated

Table 3.2 Meta analyses and systematic reviews

Authors	Title	Year	Type of article	Number and type of studies	Summary of conclusions
Reichow	Overview of meta analyses on early intensive behavioral intervention for young children with autism spectrum disorders	2011	Overview of meta analyses	5 meta analyses	Four of five analyses concluded DTT was effective intervention for children with autism
Peters-Scheffer, Didden, Korzillius, and Sturmey	A meta analytic study on the effectiveness of comprehensive ABA-based early intervention programs for children with Autism Spectrum Disorders	2011	Meta-analysis	11 total	Experimental groups who received DTT outperformed the control groups on IQ, nonverbal IQ, language (expressive and receptive) and adaptive behavior
Makrygianni and Reed	A meta-analytic review of the effectiveness of behavioural early intervention programs for children with autistic spectrum disorders	2010	Meta-analysis	14 total	Behavioral programs are effective in improving intellectual functioning, language, communication and social skills of children with autism. A moderate to high effect was found for improving adaptive functioning.
Virues-Ortega	Applied behavior analytic intervention for autism in early childhood: Meta analysis, meta-regression and dose-response meta analysis of multiple outcomes	2010	Meta-analysis	22 total	Long term comprehensive ABA intervention leads to positive outcomes (with medium to large effects). Positive outcomes include increases in intellectual functioning, language development, acquisition of daily living skills and social functioning
Howlin and Magiati	Systematic review of early intensive behavioral interventions for children with autism	2009	Systematic review	11 total	DTT results in improved outcomes compared to control/other treatment groups

(continued)

Table 3.2 (continued)

Authors	Title	Year	Type of article	Number and type of studies	Summary of conclusions
Eldevik, Hastings, Hughes, Jahr, Eikeseth and Cross	Meta-analysis of early intensive behavioral intervention for children with autism	2009	Meta-analysis	34 total	DTT produces large to moderate effect sizes for changes in IQ and the Vineland adaptive behavior composite scores for children with ASD compared to no intervention controls and eclectic treatment models
				9 controlled designs with comparison or control group	
Eikeseth	Outcome of comprehensive psych-educational interventions for young children with autism	2009	Systematic review	25 total	DTT is considered well established
				20 (behavioral treatment)	ABA is demonstrated effective in enhancing global functioning in children with ASD and PDD-NOS
				3 (TEACHH)	
				2 (Colorado Health Sciences Project/The Denver Model)	TEACHH and the Denver Model are considered neither well established nor probably efficacious
Reichow and Wolery	Comprehensive synthesis of early intensive behavioral interventions for young children with autism based on the UCLA young autism project model	2009	Comprehensive synthesis (effect size analysis, descriptive analysis, meta-analysis)	14 total	DTT is an effective treatment for children with autism
					May not be effective for all children

Summary of the DTT Outcome Study Literature

Outcome studies allow a comparison of those who experience a particular intervention to those who do not (i.e., no intervention, an alternative intervention, less of the same intervention) on important measures of the effects of the interventions. In the outcome research on DTT, these measures typically involve intellectual functioning, adaptive skills, and other socially significant outcomes that are meaningful for children with autism and their families. DTT is often compared to a community available control (i.e., treatment as usual), eclectic approaches, or a less intensive amount of DTT.

Twenty-two total studies were reviewed here. Thirteen studies between 2000 and 2012 directly compared DTT to eclectic models or treatment as usual (Ben-Itzchak, Lahat, Burgin, & Zachor, 2008; Cohen, Amerine-Dickens, & Smith, 2006; Eikeseth, Klintwall, Jahr, & Karlsson, 2012; Eikeseth, Smith, Jahr, & Eldevik, 2002, 2007; Eldevik, Eikeseth, Jahr, & Smith, 2006; Eldevik, Hastings, Jahr, & Hughes, 2012; Fava et al., 2011; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Magiati, Charman, & Howlin, 2007; Remington et al., 2007; Sheinkopf & Siegel, 1998; Strauss et al., 2012), four studies compared higher intensity DTT (i.e., greater number of hours) to lower intensity DTT (i.e., lesser hours) (Downs, Conley-Downs, Fossum, & Rau, 2008; Reed, Osborne, & Corness, 2007a, 2007b; Smith, Eikeseth, Klevstrand, & Lovaas, 1997; Smith, Groen, & Wynn, 2000), two studies compared DTT to no treatment at all (Birnbrauer & Leach, 1993; Flanagan, Perry, & Freeman, 2012), one study compared clinic-directed versus parent-directed DTT (Sallows & Graupner, 2005) and two studies compared high intensity DTT, low intensity DTT, and a no-treatment control (Lovaas, 1987; Reed et al., 2007a, 2007b).

The combined results of these studies consistently show that children participating in high intensity DTT programs achieve significantly greater gains in intellectual functioning, adaptive skills, expressive and receptive language, visual spatial skills, social skills, nonverbal communication, and play skills. Additionally, these studies have shown that DTT results in greater reductions in symptom severity and behavioral problems and results in better academic placement. Some studies (e.g., Eikeseth et al., 2002; Smith et al., 2000; Strauss et al., 2012) have failed to show significant differences between DTT and other approaches/control groups on some variables (behavior problems, adaptive functioning, and parental stress). However, each of the aforementioned studies demonstrated that DTT is most efficacious on the majority of variables investigated. In a rare exception, Magiati et al. (2007) found similar outcomes for autism-specific nursery services and DTT on all measures examined (intellectual functioning, adaptive skills, language, play and symptoms of autism), with the exception that children receiving DTT scored higher on daily living skills. Taken together, this body of literature illustrates superior effects of DTT but also indicates that DTT should include a specific focus on adaptive behavior (e.g., self-care) in addition to the core curriculum that targets intellectual functioning and cognitive skills.

Summary of Meta-analyses/Systematic Reviews

Meta-analyses combine the results from different studies to identify commonalities in findings. The goal of a meta-analysis is to collect and synthesize research results and to allow a more extensive and standard statistical examination of the degree of effect of treatment across multiple independent research investigations. Results of studies are compared by creating a standard "effect size" metric (e.g., degree of change produced) that can be compared and synthesized across multiple evaluations. Systematic reviews are thorough research reviews on a particular topic, aimed at summarizing, synthesizing and identifying gaps in literature.

The systematic reviews and meta-analyses on DTT reviewed in this chapter had varied inclusion criteria. However, taken together, they represent a large analysis of the literature on DTT thus far. The overall results suggest that DTT can produce significant *increases* in intellectual skills (IQ, standardized test scores), cognitive development, language, adaptive and social skills and significant *decreases* in symptoms of autism, problem behavior, and amount of school support needed. It is reasonable to conclude that DTT is an effective intervention for all children with autism. This body of research indicates younger children achieve better outcomes. Older children with more impairment still make substantial gains, but they may not achieve typical IQ and adaptive skills. However, DTT provided to older and more impaired children ensures that they maintain their current level of functioning or achieve better functioning because functioning decreases over time without DTT. Moderately impaired children who receive DTT are highly likely to maintain their level of impairment or to improve to slightly impaired. In contrast, moderately impaired children who receive no intervention at all are likely to become significantly impaired as they age and the gap between their development and that of their same age peers enlarges. Finally, it should be noted that the specific characteristics of intervention delivery (e.g., level of procedural integrity, clinical oversight, training etc.) varied greatly across studies, suggesting we need to define more clearly what constitutes an ideal DTT programming model and identify what ultimately leads to successful outcomes.

Suggestions for Future Research

The existing evidence base suggests that the DTT model and common variations of DTT teaching procedures are highly effective for improving the outcomes of children with ASD. However, additional research is needed to further our understanding of factors that will ensure the best possible outcomes for all children. Despite the positive outcomes of large-scale studies, some children do not appear to benefit as much as others from structured, intensive DTT models. Variables that are likely to impact outcomes include the child's diagnosis and severity of autism; number of

treatment hours; duration of treatment; qualifications of the therapists and supervisors; methods of staff training; frequency of progress review; procedural variations of prompting and reinforcement; breadth or range of targets included in programs; strategies to promote generalization; and parental participation in therapy. These factors varied across the large-scale studies, often in unsystematic or unknown ways. Thus, further large-scale research is needed to explicitly explore the relationship between these potentially important variables and therapy outcomes. Results of studies that compare DTT to other comprehensive early intervention approaches, or that evaluate combinations of approaches, also would help parents and practitioners make decisions when selecting treatments.

A number of procedural refinements to DTT procedures (e.g., prompt fading methods, reinforcement schedules; task interspersal arrangements) have not been adequately examined or compared to alternative variations. In particular, systematic evaluation and comparison of strategies to promote generalization have been given surprising little attention in the DTT literature. The number of exemplars needed to promote generalization and the most effective way to select and combine existing generalization strategies should be evaluated in further research. Given that instruction is typically delivered by adults, particular consideration should be given to methods for promoting generalization from adults to same-age peers.

Further development and evaluation of alternatives to traditional BST for teaching staff and caregivers to implement DTT are needed to expand the accessibility of this therapy to those living in rural or remote areas. Self-instructional manuals, computer-based training, and remote coaching may reduce the costs associated with this therapeutic model and the need for expert trainers. Computer-based instruction that incorporates or simulates the components of traditional BST, particularly modeling combined with rehearsal plus feedback, have the greatest potential to be effective across individuals with diverse backgrounds and levels of experience.

Finally, structured DTT programming may be less successful than other instructional models for teaching certain skills. For example, limited information is available about the potential effectiveness of the DTT approach for teaching complex social and emotional responses, particularly those that may impact the likelihood of successful relationships at home, in the community, and on the job. Further research that explores the range of skills that may be successfully taught via this model (e.g., daily living skills; complex social skills), along with modifications to DTT programming or procedures that would increase the breadth of its outcomes, should be considered. As noted previously, DTT instruction is typically combined with a variety of ABA-based interventions, including less structured, more naturalistic instructional approaches (e.g., incidental teaching). Research on the most effective way to supplement DTT instruction with these other approaches could lead to further improvements in the long-term outcomes of early intervention for children with autism.

References

Alvero, A. M., Bucklin, B. R., & Austin, J. (2001). An objective review of the effectiveness and essential characteristics of performance feedback in organizational settings. *Journal of Organizational Behavior Management, 21*, 3–29.

Benavides, C. A., & Poulson, C. L. (2009). Task interspersal and performance of matching tasks by preschoolers with autism. *Research in Autism Spectrum Disorders, 3*, 619–929.

Ben-Itzchak, E., Lahat, E., Burgin, R., & Zachor, A. D. (2008). Cognitive, behavior and intervention outcome in young children with autism. *Research in Developmental Disabilities, 29*, 447–458.

Birnbrauer, J., & Leach, D. J. (1993). The Murdoch early intervention program after 2 years. *Behaviour Change, 10*, 63–74.

Carey, M. K., & Bourret, J. C. (2014). Effects of data sampling on graphical depictions of learning. *Journal of Applied Behavior Analysis, 47*, 1–16.

Catania, C. N., Almeida, D., Liu-Constant, B., & Digennaro, F. D. (2009). Video modeling to train staff to implement discrete-trial instruction. *Journal of Applied Behavior Analysis, 42*, 387–392.

Charlop, M. H., Kurtz, P. F., & Milstein, J. P. (1992). Too much reinforcement, too little behavior: Assessing task interspersal procedures in conjunction with different reinforcement schedules with autistic children. *Journal of Applied Behavior Analysis, 25*, 795–808.

Chiara, L., Schuster, J. W., Bell, J. K., & Wolery, M. (1995). Small-group massed-trial and individually-distributed-trail instruction with preschoolers. *Journal of Early Intervention, 19*, 203–217.

Cividini-Motta, C., & Ahearn, W. H. (2013). Effects of two variations of differential reinforcement on prompt dependency. *Journal of Applied Behavior Analysis, 46*, 640–650.

Cohen, H., Amerine-Dickens, M., & Smith, T. (2006). Early intensive behavioral treatment: Replication of the UCLA model in a community setting. *Developmental and Behavioral Pediatrics, 27*, 145–155.

Cummings, A. R., & Carr, J. E. (2009). Evaluating progress in behavioral programs for children with Autism spectrum disorders via continuous and discontinuous measurement. *Journal of Applied Behavior Analysis, 42*, 57–71.

Dib, N., & Sturmey, P. (2007). Reducing student stereotypy by improving teachers' implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 40*, 339–343.

Downs, A., Conley-Downs, R., Fossum, M., & Rau, K. (2008). Effectiveness of discrete trial teaching with preschool students with developmental disabilities. *Education and Training in Developmental Disabilities, 43*, 443–453.

Ducharme, J. M., & Feldman, M. A. (1992). Comparison of staff training strategies to promote generalized teaching skills. *Journal of Applied Behavior Analysis, 25*, 165–179.

Dunlap, G. (1984). The influence of task variation and maintenance tasks on the learning and affect of autistic children. *Renal of Experimental Child Psychology, 37*, 41–64.

Eikeseth, S. (2009). Outcome of comprehensive psycho-educational interventions for young children with autism. *Research in Developmental Disabilities, 30*, 158–178.

Eikeseth, S., Hayward, D., Gale, C., Gitlesen, J., & Eldevik, S. (2009). Intensity of supervision and outcome for preschool aged children receiving early and intensive behavioral interventions: A preliminary study. *Research in Autism Spectrum Disorders, 3*, 67–73.

Eikeseth, S., Klintwall, L., Jahr, E., & Karlsson, P. (2012). Outcome for children with autism receiving early and intensive behavioral intervention in mainstream preschool and kindergarten settings. *Research in Autism Spectrum Disorders, 6*, 829–835.

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2002). Intensive behavioral at school for 4-to-7 year-old children with autism treatment. *Behavior Modification, 26*, 49–68.

Eikeseth, S., Smith, T., Jahr, E., & Eldevik, S. (2007). Outcome for children with autism who began intensive behavioral treatment between ages 4 and 7: A comparison controlled study. *Behavior Modification, 31*, 264–278.

Eldevik, S., Eikeseth, S., Jahr, E., & Smith, T. (2006). Effects of low-intensity behavioral treatment for children with autism and mental retardation. *Journal of Autism and Developmental Disorders, 36*, 211–224.

Eldevik, S., Hastings, R. P., Hughes, J. C., Jahr, E., Eikeseth, S., & Cross, S. (2009). Meta- analysis of early intensive behavioral intervention for children with autism. *Journal of Clinical Child and Adolescent Psychology, 38*, 439–450.

Eldevik, S., Hastings, R. P., Jahr, E., & Hughes, J. C. (2012). Outcomes of behavioral intervention for children with autism in mainstream preschool settings. *Journal of Autism and Developmental Disorders, 42*, 210–220.

Eldevik, S., Ondire, I., Hughes, J. C., Grindle, C. F., Randell, T., & Remington, B. (2013). Effects of computer simulation training on in vivo discrete trial teaching. *Journal of Autism and Developmental Disabilities, 43*, 569–578.

Elliott, C., & Dillenburger, K. (2014). The effect of choice on motivation for young children on the autism spectrum during discrete trial teaching. *Journal of Research in Special Educational Needs*. doi:10.1111/1471-3802.12073.

Fava, L., Strauss, K., Valeri, G., D'Elia, L., Arima, S., & Vicari, S. (2011). The effectiveness of a cross-setting complementary staff-and parent mediated early intensive behavioral intervention for young children with ASD. *Research in Autism Spectrum Disorders, 5*, 1479–1492.

Fenske, E. C., Krantz, P. J., & McClannahan, L. E. (2001). Incidental teaching: A not-discrete-trial teaching procedure. In C. Maurice & G. Green (Eds.), *Making a difference: Behavioral intervention for autism* (pp. 75–82). Austin, TX: PRO-ED.

Fentress, G. M., & Lerman, D. C. (2012). A comparison of two prompting procedures for teaching basic skills to children with autism. *Research in Autism Spectrum Disorders, 6*, 1083–1090.

Flanagan, H. E., Perry, A., & Freeman, N. L. (2012). Effectiveness of large-scale community-based intensive behavioral intervention: A waitlist comparison study exploring outcomes and predictors. *Research in Autism Spectrum Disorders, 6*, 673–682.

Geiger, K. B., Carr, J. E., LeBlanc, L. A., Hanney, N. M., Polick, A. S., & Heinike, M. R. (2012). Teaching receptive discriminations to children with autism: A comparison of traditional and embedded discrete trial teaching. *Behavior Analysis in Practice, 5*, 49–59.

Grow, L. L., Carr, J. E., Kodak, T. M., Jostad, C. M., & Kisamore, A. N. (2011). A comparison of methods for teaching receptive labeling to children with autism spectrum disorders. *Journal of Applied Behavior Analysis, 44*, 475–498.

Grow, L., Kodak, T. M., & Carr, J. E. (2014). A comparison of methods for teaching receptive labeling to children with autism spectrum disorders: A systematic replication. *Journal of Applied Behavior Analysis, 47*, 600–605.

Grow, L., & LeBlanc, L. (2013). Teaching receptive language skills: Recommendations for instructors. *Behavior Analysis in Practice, 6*(1), 56–75.

Harris, S. L., & Weiss, M. J. (2007). *Right from the start: Behavioral intervention for young children with autism* (2nd ed.). Bethesda, MD: Woodbine House.

Hausman, N. L., Ingvarsson, E. T., & Kahng, S. (2014). A comparison of reinforcement schedules to increase independent responding in individuals with intellectual disabilities. *Journal of Applied Behavior Analysis, 47*, 155–159.

Hay-Hansson, A. W., & Eldevik, S. (2013). Training discrete trials teaching skills using videoconference. *Research in Autism Spectrum Disorders, 7*, 1300–1309.

Howard, J. S., Sparkman, C. R., Cohen, H. G., Green, G., & Stanislaw, H. (2005). A comparison of intensive behavior analytic and eclectic treatments for young children with autism. *Research in Developmental Disabilities, 26*, 359–383.

Howlin, P., Magiati, I., & Charman, T. (2009). Systematic review of early intensive behavioral interventions for children with autism. *American Association on Intellectual and Developmental Disabilities, 114*, 23–41.

Karsten, A. M., & Carr, J. E. (2009). The effects of differential reinforcement of unprompted responding on skill acquisition of children with autism. *Journal of Applied Behavior Analysis, 42*, 327–334.

Koegel, R. L., Dunlap, G., & Dyer, K. (1980). Intertrial interval duration and leaning in autistic children. *Journal of Applied Behavior Analysis, 13*, 91–99.

Komaki, J. L., Desselles, M. L., & Bowman, E. D. (1989). Definitely not a breeze: Extending an operant model of effective supervision to teams. *Journal of Applied Psychology, 74*, 522–529.

Lafasakis, M., & Sturmey, P. (2007). Training parent implementation of discrete-trial teaching: Effects on generalization of parent teaching and child correct responding. *Journal of Applied Behavior Analysis, 40*, 685–689.

Lang R., Werff, M., Verbeek, K., Didden, R., Davenport, K., Moore, M., … Lancioni, G. (2014). Comparison of high and low preferred topographies of contingent attention during discrete trial training. *Research in Autism Spectrum Disorders,* 8, 1279–1286.

Leaf, J. B., Alcalay, A., Leaf, J. A., Tsuji, K., Kassardjian, A., Dale, S., … Leaf, R. (2014). Comparison of most-to-least to error correction for teaching receptive labelling for two children diagnosed with autism. *Journal of Research in Special Educational Needs, 44*(3), 475–498. doi:10.1111/1471-3802.12067.

Leaf, J. B., Leaf, R., Taubman, M., McEachin, J., & Delmolino, L. (2014). Comparison of flexible fading to error correction for children with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 26*, 203–224.

Leaf, R., & McEachin, J. (1999). *A work in progress: Behavior management strategies and a curriculum for intensive behavioral treatment of autism*. New York, NY: DRL Books.

Leaf, J. B., Sheldon, J. B., & Sherman, J. A. (2010). Comparison of simultaneous prompting and no-no prompting in two-choice discrimination learning with children with autism. *Journal of Applied Behavior Analysis,* 43, 215–228.

Leaf, J. B., Tsuji, K. H., Lentell, A. E., Dale, S. E., Kassardjian, A., Taubman, M., … Oppenheim-Leaf, M. L. (2013). A comparison of discrete trial teaching implemented in a one-to-one instructional format. *Behavioral Interventions, 28*, 82–106.

LeBlanc, L. A., Parks, N., & Hanney, N. (2014). Early intensive behavioral intervention (EIBI): Current status and future directions. In J. Luiselli (Ed.), *Children and youth with Autism Spectrum Disorder (ASD): Recent advances and innovations in assessment, education, and intervention* (pp. 63–75). New York, NY: Oxford.

Lerman, D. C., Dittlinger, L. H., Fentress, G., & Lanagan, T. (2011). A comparison of methods for collecting data on performance during discrete trial teaching. *Behavior Analysis in Practice, 4*, 53–62.

Lerman, D. C., Tetreault, A., Hovanetz, A., Strobel, M., & Garro, J. (2008). Further evaluation of a brief, intensive teacher training model. *Journal of Applied Behavior Analysis, 41*, 243–248.

Libby, M. E., Weiss, J. S., Bancroft, S., & Ahearn, W. H. (2008). A comparison of most-to-least and least-to-most prompting on the acquisition of solitary play skills. *Behavior Analysis in Practice, 1*, 37–43.

Lockshin, S. B., Gillis, J. M., & Romanczyk, R. G. (2004). *Defying autism: Keeping your sanity and taking control*. New York, NY: DRL Books.

Loughrey, T. O., Betz, A. M., Majdalany, L. M., & Nicholson. (2014). Using instructive feedback to teach category names to children with autism. *Journal of Applied Behavior Analysis, 47*, 425–430.

Lovaas, O. I. (1981). *Teaching developmentally disabled children: The Me Book*. Baltimore, MD: University Park.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*, 3–9.

Lovaas, O. I. (2002). *Teaching individuals with developmental delays: Early intervention techniques*. Austin, TX: Pro-Ed.

MacDuff, G. S., Krantz, P. J., & McClannahan, L. E. (2001). Prompts and prompt-fading strategies for people with autism. In G. Maurice, G. Green, & R. Foxx (Eds.), *Making a difference: Behavioral intervention for autism* (pp. 37–50). Austin, TX: Pro-Ed.

Magiati, I., Charman, T., & Howlin, P. (2007). A two-year prospective follow-up study of community based early intensive behavioral intervention and specialist nursery provision for

children with autism spectrum disorders. *Journal of Child Psychology and Psychiatry, 48*, 803–812.

Majdalany, L. M., Wilder, D. A., Greif, A., Mathisen, D., & Saini, V. (2014). Comparing massed-trial instruction, and task interspersal to teach tacts to children with autism spectrum disorders. *Journal of Applied Behavior Analysis, 47*, 1–6.

Maurice, C. (1994). *Let me hear your voice: A family's triumph over autism*. New York, NY: Random House.

Maurice, C., Green, G., & Foxx, R. M. (2001). *Making a difference: Behavioral intervention for autism*. Austin, TX: Pro-Ed.

Maurice, C., Green, G., & Luce, S. (1996). *Behavioral intervention for young children with autism*. Austin, TX: PRO-ED.

May, R. J., Austin, J. L., & Dymond, S. (2011). Effects of a stimulus prompt display on therapists' accuracy, rate, and variation of trial type delivery during discrete trial teaching. *Research in Autism Spectrum Disorders, 5*, 305–316.

McGhan, A. C., & Lerman, D. C. (2013). An assessment of error-correction procedures for learners with autism. *Journal of Applied Behavior Analysis, 46*, 626–639.

McKenney, E. L. W., & Bristol, R. M. (2015). Supporting intensive interventions for students with autism spectrum disorder: Performance feedback and discrete trial teaching. *School Psychology Quarterly, 30*(1), 8–22. Advance online publication. http://dx.doi.org/10.1037/spq0000060.

Miltenberger, R. G. (2003). *Behavior modification: Principles and procedures*. Belmont, CA: Wadsworth Publishing.

Najdowski, A. C., Chilingaryan, V., Bergstrom, R., Granpeesheh, D., Balasanyan, S., Aguilar, B., & Tarbox, J. (2009). Comparison of data-collection methods in a behavioral intervention program for children with pervasive developmental disorders: A replication. *Journal of Applied behavior Analysis, 42*, 827–832.

North, S. T., & Iwata, B. A. (2005). Motivational influences on performance maintained by food reinforcement. *Journal of Applied Behavior Analysis, 38*, 317–333.

Nosik, M. R., Williams, W. L., Garrido, N., & Lee, S. (2013). Comparison of computer based instruction to behavior skills training for teaching staff implementation of discrete-trial instruction with an adult with autism. *Research in Developmental Disabilities, 34*, 461–468.

Olendick, D. L., & Pear, J. J. (1980). Differential reinforcement of correct responses to probes and prompts in picture-name training with severely retarded children. *Journal of Applied Behavior Analysis, 13*, 77–89.

Polick, A. S., Carr, J. E., & Hanney, N. M. (2012). A comparison of general and descriptive praise in teaching intraverbal behavior to children with autism. *Journal of Applied Behavior Analysis, 45*, 593–599.

Pollard, J. S., Higbee, T. S., Akers, J. S., & Brodhead, M. T. (2014). An evaluation of interactive computer training to teach instructors to implement discrete trials with children with autism. *Journal of Applied Behavior Analysis, 47*, 1–12.

Powers, M. D. (2001). *Children with autism: A parent's guide*. Bethesda, MD: Woodbine House.

Randall, T., Hall, M., Bizo, L., & Remington, B. (2007). DTkid: Interactive simulation software for training tutors of children with autism. *Journal of Autism and Developmental Disabilities, 37*, 637–647.

Reed, P., Osborne, L. A., & Corness, M. (2007a). Brief report: Relative effectiveness of different home-based behavioral approaches to early intervention. *Journal of Autism and Developmental Disorders, 37*, 1815–1821.

Reed, P., Osborne, L. A., & Corness, M. (2007b). The real-world effectiveness of early teaching interventions for children with autism spectrum disorder. *Exceptional Children, 73*, 417–433.

Reed, F. D. D., Reed, D. D., Baez, C. N., & Maguire, H. (2011). A parametric analysis of errors of commission during discrete-trial training. *Journal of Applied Behavior Analysis, 44*, 611–615.

Reichow, B. (2012). Overview of meta-analyses on early intensive behavioral intervention for young children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 512–520.

Reichow, B., & Wolery, M. (2009). Comprehensive synthesis of early intensive behavioral interventions for young children with autism based on the UCLA young autism project model. *Journal of Autism and Developmental Disorders, 39*, 23–41.

Reichow, B., & Wolery, M. (2011). Comparison of progressive prompt delay with and without instructive feedback. *Journal of Applied Behavior Analysis, 44*, 327–340.

Remington, B., Hastings, R. P., Kovshoff, H., Espinosa, F., Jahr, E., Brown, T., & Ward, M. (2007). Early intensive behavioral intervention: Outcomes for children with autism and their parents after two years. *American Journal on Mental Retardation*, *112*, 418–438.

Rodgers, T. A., & Iwata, B. A. (1991). An analysis of error-correction procedures during discrimination training. *Journal of Applied Behavioral Analysis, 24*, 775–781.

Sallows, G. O., & Graupner, T. D. (2005). Intensive behavioral treatment for children with autism: Four year outcome and predictors. *American Journal on Mental Retardation, 110*, 417–438.

Sarokoff, R. A., & Sturmey, P. (2004). The effects of behavioral skills training on staff implementation of discrete-trial teaching. *Journal of Applied Behavior Analysis, 37*, 535–538.

Schroeder, C. M., Schuster, J. W., & Hemmeter, M. L. (1998). Efficiency in programming for generalization: Comparison of two methods for teaching expressive labeling to preschoolers with developmental delays. *Journal of Developmental and Physical Disabilities, 10*, 109–131.

Sellers, T. P., Bloom, S. E., Samaha, A. L., Dayton, E., Lambert, J. M., & Keyl-Austin, A. A. (2013). Evaluation of some components of choice making. *Journal of Applied Behavior Analysis, 46*, 455–464.

Sheinkopf, S. J., & Siegel, B. (1998). Home-based behavioral treatment of young children with autism. *Journal of Autism and Development Disorders, 28*, 15–23.

Smith, T., Eikeseth, S., Klevstrand, M., & Lovaas, O. I. (1997). Intensive behavioral treatment for preschoolers with severe mental retardation and pervasive developmental disorder. *American Journal of Mental Retardation, 102*, 238–249.

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal of Mental Retardation, 105*, 269–285.

Smith, T., Mruzek, D. W., Wheat, L. A., & Hughes, C. (2006). Error correction in discrimination training for children with autism. *Behavioral Interventions, 21*, 245–263.

Soluaga, D., Leaf, J. B., Taubman, M., McEachin, J., & Leaf, R. (2008). A comparison of flexible prompt fading and constant time delay for five children with autism. *Research in Autism Spectrum Disorders, 2*, 753–765.

Stevens, C., Sidner, T. M., Reeve, S. A., & Sidener, D. W. (2011). Effects of behavior-specific and general praise, on acquisition of tacts in children with pervasive developmental disorders. *Research in Autism Spectrum Disorders, 5*, 666–669.

Stokes, T. F., & Baer, D. M. (1977). An implicit technology of generalization. *Journal of Applied Behavior Analysis, 10*, 349–367.

Strauss, K., Vicari, S., Valeri, G., D'Elia, L., Arima, S., & Fava, L. (2012). Parent inclusion in early intensive behavioral intervention: The influence of parental stress, parent treatment fidelity and parent-mediated generalization of behavior targets on child outcomes. *Research in Developmental Disabilities, 33*, 688–703.

Sundberg, M. L., & Partington, J. W. (1998). *Teaching language to children with autism or other developmental disabilities*. Pleasant Hill, CA: Behavior Analysts.

Taubman, M., Brierley, S., Wishner, J., Baker, D., McEachin, J., & Leaf, R. B. (2001). The effectiveness of a group discrete trial instructional approach for preschoolers with developmental disabilities. *Research in Developmental Disabilities, 22*, 205–219.

Taubman, M. T., Leaf, R. B., McEachin, J. J., Papovich, S., & Leaf, J. B. (2013). A comparison of data collection techniques used with discrete trial teaching. *Research in Autism Spectrum Disorders, 7*, 1026–1034.

Thiessen, C., Fazzio, D., Arnal, L., Martin, G. L., Yu, C. T., & Keilback, L. (2009). Evaluation of a self-instructional manual for conducting discrete-trials teaching with children with autism. *Behavior Modification, 33*, 360–373.

Thomas, B. R. (2013). Effects of conducting peer behavioral observations on the observer's correct use of discrete trial teaching procedures. *Research in Developmental Disabilities, 34*, 2143–2148.

Thomson, K., Martin, G. L., Arnal, L., Fazzio, D., & Yu, C. T. (2009). Instructing individuals to deliver discrete-trials teaching to children with autism spectrum disorders: A review. *Research in Autism Spectrum Disorders, 3*, 590–606.

Thomson, K. M., Martin, G. L., Fazzio, D., Salem, S., Young, K., & Yu, C. T. (2012). Evaluation of a self-instructional package for teaching tutors to conduct discrete-trials teaching with children with autism. *Research in Autism Spectrum Disorders, 6*, 1073–1082.

Tiger, J. H., Hanley, G. P., & Hernandez, E. (2006). An evaluation of the value of choice with preschool children. *Journal of Applied Behavior Analysis, 39*, 1–16.

Touchette, P. E., & Howard, J. S. (1984). Errorless learning: Reinforcement contingencies and stimulus control transfer in delayed prompting. *Journal of Applied Behavior Analysis, 17*, 175–188.

Vismara, L. A., Young, G. S., Stahmer, A. C., Griffith, E. M., & Rogers, S. J. (2009). Dissemination of evidence-based practice: Can we train therapists from a distance? *Journal of Autism and Developmental Disorders, 39*, 1636–1651.

Vladescu, J. C., Carroll, R., Paden, A., & Kodak, T. M. (2012). The effects of video modeling with voiceover instruction on accurate implementation of discrete-trial instruction. *Journal of Applied Behavior Analysis, 45*, 419–423.

Vladescu, J. C., & Kodak, T. M. (2013). Increasing instructional efficiency by presenting additional stimuli in learning trials for children with autism spectrum disorder. *Journal of Applied Behavior Analysis, 46*, 805–816.

Volkert, V. M., Lerman, D. C., Trosclair, N., Addison, L., & Kodak, T. (2008). An exploratory analysis of task-interspersal procedures while teaching object labels to children with autism. *Journal of Applied Behavior Analysis, 41*, 335–350.

Volkmar, F. R., & Wiesner, L. A. (2009). *A practical guide to autism: What every parent, family member, and teacher needs to know*. New York, NY: Wiley.

Wacker, D. P., Lee, J. F., Padilla Dalmau, Y. C., Kopelman, T. G., Lindgren, S. D., Kuhle, J., … Waldron, D. B. (2013a). Conducting functional communication training via telehealth to reduce the problem behavior of young children with autism. *Journal of Developmental and Physical Disabilities, 25*, 35–48.

Wacker, D. P., Lee, J. F., Padilla Dalmau, Y. C., Kopelman, T. G., Lindgren, S. D., Kuhle, J., … Waldron, D. B. (2013b). Conducting functional analyses of problem behavior via telehealth. *Journal of Applied Behavior Analysis, 46*, 1–16.

Waugh, R. E., Alberto, P. A., & Fredrick, L. D. (2011). Simultaneous prompting: An instructional strategy for skill acquisition. *Education and Training in Autism and Developmental Disabilities, 46*, 528–543.

Webber, J., & Scheuermann, B. (2008). *Educating students with autism: A quick start manual*. Austin, TX: Pro-Ed.

Worsdell, A. S., Iwata, B. A., Dozier, C. L., Johnson, A. D., Neidert, P. L., & Thomason, J. L. (2005). Analysis of response repetition as an error correction strategy during sight-word reading. *Journal of Applied Behavioral Analysis, 38*, 511–527.

Wunderlich, K. L., Vollmer, T. R., Donaldson, J. M., & Phillips, C. L. (2014). Effects of serial and concurrent training on acquisition and generalization. *Journal of Applied Behavior Analysis, 47*, 1–15.

Young, K. L., Boris, A. L., Thomson, K. M., Martin, G. L., & Yu, C. T. (2012). Evaluation of a self instructional package on discrete-trials teaching to parents of children with autism. *Research in Autism Spectrum Disorders, 6*, 1321–1330.