Early Interventions for Infants at Risk of Autism Spectrum Disorder

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Abstract A plethora of research in early evidence-based behavior-analytic interventions consistently yield promising outcomes for teaching young children diagnosed with autism spectrum disorder (ASD) a variety of social, adaptive, behavioral, and functional skills. Given the promising results of previous basic experimental research with infants, we examine here the application of behavior-analytic interventions specifically designed for infants at risk of ASD. The present chapter first provides an overview of the various early markers, indicators, and behavioral characteristics reliably observed in infants, which are later associated with a diagnosis of ASD in early childhood. We review relevant content areas in the realm of infant social behavioral development from a behavior-analytic perspective, including the development of attachment, fears, precursors to language and social communication, like eye contact, vocalizations, joint attention, and social referencing. In this process, we also emphasize the unique role of the infant's environment as a dynamic variable influencing the development of these various skills and provide general behavioral strategies derived from evidence-based behavior-analytic interventions with typically developing infants. Other nonbehavioral mainstream, eclectic, and emerging evidence-based approaches are offered as well. Lastly, we delineate guidelines and recommend ethical considerations when developing behavioral interventions for infants at risk, while outlining specific codes in the Professional and Ethical Compliance Code for Behavior Analysts. These recommendations include the responsibilities and competency of the practitioner, appropriate assessment procedures, identifying and defining goals, arranging the environment, designing methodology, and developing intervention and treatment specifics. Overall, our chapter illustrates how early behavior-analytic interventions can effectively establish pivotal social behavioral phenomena among infants at risk of ASD within their natural environment.

Keywords infants · at risk · autism spectrum disorder · applied behavior analysis · early intervention

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The extensive body of research accrued in the last 30 years in early behavior interventions is evidence of the great advancement and efficacy of behavior-analytic principles to treat young children diagnosed with autism spectrum disorder (ASD) and other developmental disorders (e.g., Eldevik et al. 2009; Eldevik et al. 2012; Howard et al. 2005, 2014; Lovaas 1987; MacDonald et al. 2014; Virués-Ortega 2010). Early behavioral interventions have been very useful in treating a wide array of issues observed among infants at risk of developmental problems. The targeted problems have included the reduction of behavioral excesses, the treatment of behavioral deficits, and the teaching of core foundational cusps and other pivotal social and communication skills, like eye contact, vocalizations, joint attention, tacting, naming, social referencing, and perspective taking. It is well documented that, the earlier a child receives early intensive behavior interventions, the greater the gains made (Howard et al. 2014; MacDonald et al. 2014). For those children who receive services at an earlier age, as compared to older children, these behavioral gains are not only significant, but they also maintain and generalize for longer periods (MacDonald et al. 2014).

One inconsistency in the literature, however, is the definition of *early*. How early should one intervene? Generally speaking, early intervention services are typically provided following a formal ASD diagnosis, and as such, services often become diagnosis contingent (i.e., between 2-5 years of age). In general, the age for intervention varies and depends on when the earliest markers of ASD are identifiable. The appearance of these markers often results in referral to pediatricians and clinical psychologists for a formal diagnosis, which typically includes the administration of the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord et al. 2012). The formal diagnosis helps the parents secure reimbursement for intervention services. On average, children receive formal ASD diagnoses at approximately 5 years of age (Baird et al. 2003) although in many circumstances, observable deficits, behavioral markers, and characteristics associated with a later onset diagnosis of ASD are observed months and even years prior to the diagnosis.

Presently, assessment and diagnostic procedures are sensitive enough to detect and diagnose ASD as early as 18 months of age (Baird et al. 2003; Ozonoff et al. 2010; Rogers and Pennington, 1991; Zwaigenbaum et al. 2005, 2015), and some behavioral markers of ASD are noticeable as early as 6 to 12 months of age (Landa and Garrett-Mayer, 2006; Ozonoff et al. 2014). These early indicators and pre-ASD characteristics, among other parental, genetic, and environmental factors, place an infant "at risk" of ASD and/or other developmental (e.g., Tourette's syndrome), behavioral (e.g., attention-deficit and hyperactivity), social (e.g., selective mutism), emotional (e.g., attachment problems), and intellectual disorders (e.g., global learning and language delays). Considering the existing evidence with children already diagnosed with ASD and other developmental disorders, the delivery of early interventions based on the application of behavior-analytic principles to infants at risk, seems both appropriate and necessary, in particular, as a form of preventive intervention. In fact, research results by Bradshaw et al. (2015) encourage the suitability of evidence-based behavioral interventions with children younger than 24 months of age. Today, we know that treatments based on behavior-analytic

procedures and techniques are applicable to prevention prior to an ASD diagnosis (Bradshaw et al. 2015; Zwaigenbaum et al. 2005, 2015).

The objectives of the present chapter are to: (a) provide an overview of the *markers, indicators,* and/or behavioral *characteristics* of infants who are considered "at risk" of ASD and other behavioral and social issues; (b) outline specific *content areas* of infant social behavioral milestones and development from a behavior-analytic perspective (i.e., attachment, fears, and social communication) while reviewing the research on interventions and *applications of behavior analysis* to typically and atypically developing infants; (c) discuss both *behavior-analytic and mainstream interventions* for promoting infant social behavioral health; and (d) offer *best practice guidelines*, including specific environmental arrangements and ethical considerations when developing behavior-analytic interventions for at risk infants.

Behavioral Characteristics and Markers of Infants at Risk

The definition of *at risk* varies across disciplines, professions, and geographical states, which affects the implementation of specific regulations (e.g., IDEA). A wide range of factors place a child at risk of ASD. These factors reported in the literature include a child's neurodevelopment, genetic disorders, environmental contexts, and the presence of specific problematic behavior or the absence of specific social skills. Often, an infant considered at risk is one who begins to show developmental delays as a result of various medical or physiological issues at birth (e.g., low birth weight, low APGAR scores, prematurity, respiratory distress, infection, brain hemorrhage, lack of oxygen, or other physical trauma at birth – see Fig. 1).

Fig. 1 An example of a premature, 32-week gestational age, neonate with low birth weight (3 pounds 4 oz.)

An infant may also be considered at risk if he/she has had a history of genetic disabilities or abnormalities (e.g., developmental disabilities, genetic disorders); in-utero exposure to specific environmental factors (e.g., maternal disease or viruses, poor nutrition, alcohol, tobacco and narcotic use, and exposure to other toxic chemicals); and/or has a history of specific parental behavioral interactions (e.g., parental neglectfulness, physical or verbal abuse, maternal depression, parental stress, emotional inexpressiveness, noncontingent responding, unresponsiveness, apathy, and authoritarian parenting styles) (Boutress and Chassin 2015; Hart et al. 1998; Neimy et al. 2017; Novak and Pelaez 2004; Pelaez et al., in review).

When an infant has a specific genetic, physical, and/or medical condition, that child is also considered at risk, irrespective of having a more formal diagnosis (e.g., cerebral palsy, blindness, and/or visual impairment, Down's syndrome, and Fragile X syndrome). As such, many of these infants receive targeted early intervention services provided by specialists who primarily intervene focusing on ameliorating those medical or diagnostic-specific symptoms.

Infants at risk may not meet any of the above criteria, yet, they may be experiencing an at-risk environment (e.g., siblings of a child with ASD) (Neimy et al. 2020). Given that ASD is phenomenological in nature, and research is still being conducted to determine the specific influence of a single or many genetic or chromosomal features, the environment that an infant develops within seems to play a significant role in the expression and manifestation of the various characteristics of the disorder itself (Drash and Tudor 2004). For example, misplaced, intrusive, and/or inappropriate reinforcement contingencies for various social and communicative infant behaviors provided by parents and/or caregivers may inadvertently reinforce maladaptive patterns of responding that can be symptomatic of ASD (Neimy et al. 2017). As such, several observable responses of an infant may be indicative that they are at risk of later developing social, behavioral, or language problems (Osterling and Dawson 1994).

Harris (2003) and Harris and Glasberg (2003) offer guides for parents on the topic of siblings of children with ASD and delineate practical and age-appropriate steps for how parents should prepare lessons for teaching their children about ASD. It is important for parents to learn how to help their young children form a relationship with their sibling with ASD. For example, when the typical infant wants to play with her sibling with ASD and smiles, she often can end up being ignored, given that her sibling may lack the necessary play and social skills to reciprocate. At other times, a sibling with ASD might display tantrums, cry, or become aggressive with the typical young child – all relatively aversive contexts – and the social attempts of the young sibling may undergo punishment or extinction. In situations like this, without an early intervention and monitoring program in place, it can be difficult for the neurotypical child to develop a healthy, constructive, and positive relationship with the sibling with ASD. Also, there is the potential for the subsequent generalization of these skill deficits to other relationships (e.g., peers) and other environments (e.g., school).

Within the first year of life, many of the observable *markers* of an "at risk infant" most commonly include: (a) infrequent initiated and sustained eye contact; (b)

limited visual eye tracking, pointing, and joint attention; (c) lack of responsiveness and orienting to name; (d) limited smiling; (e) over-reactivity and fussiness; (f) minimal vocal behavior; (g) difficulty in referencing social cues; (h) lack of imitative skills; and (i) limited interest or motivation to engage socially and play with others (Baird et al. 2003; Neimy et al. 2017; Ozonoff et al. 2010; Pelaez et al. 2013; Zwaigenbaum et al. 2005, 2015). These social behavioral deficits could then impede the future development of other important social repertoires, like those behavioral skills that are essential for children's communication and social interaction (e.g., perspective taking and empathy). For example, some behavioral cusps can involve those social behaviors that provide the learner with extensive opportunities to contact novel reinforcers, environments, and contingencies, and subsequently generalize across new or related behaviors. Interventions that focus on helping infants establish these behavioral cusps, as early as possible, are of utmost priority. In many cases, these infants at risk would be eligible to receive early behavior intervention services.

Many of today's treatment services stem from a wide array of disciplines and professional fields, and thus yield significant variability in the quality and type of applied therapeutic services delivered (i.e., occupational therapy, speech and language therapy, cognitive behavioral therapy, and acceptance and commitment (ACT) therapy). With this in mind, behavior analysts should stay focused on employing behavior–analytic principles within the context of early infant individualized interventions, prioritizing the acquisition of social behavioral cusps that the infant at risk is lacking.

Early Milestones of Social Behavior in Infants

The nature and quality of interactions between infants and parents, and how these interactions influence various aspects of child development, have long been a source of interest and research across related, but conceptually differing fields (e.g., Ainsworth 1979; Gewirtz and Pelaez-Nogueras 1996; Schlinger Jr 1995). This interest has resulted in different forms and approaches to infant intervention. Traditionally, the learning of infant social and communicative behaviors has been understood through the lens of developmental psychology (e.g., Shaffer and Kipp 2012), where historically, developmental psychologists have been considered the experts in the realm of social, emotional, and cognitive development of infants and young children. However, when we analyze the theories formulated by developmental psychologists, often there is a lack of consistency and uniformity. Developmental psychologists tend to operate under the pretense of hypothetico-deductive constructs that commonly are proposed as the cause of various social, emotional, cognitive, and communicative deficits as a function of "stages of development" – this notion of stages as a causal variable of the child's skills has been rejected by behavior analysts (e.g., Pelaez et al. 2008a, b; Pelaez and Monlux 2020;

Schlinger Jr 1995). A stage is considered only as a distant variable that organizes behavior, but a stage is not causal for the development of any behaviors discussed below.

Another concern with mainstream developmental psychologists' approach is that they frequently explain the expression of infant observable milestones and behaviors as a function of their chronological *age* (Baer 1970). Many developmental researchers have used age as an independent variable or as a grouping variable. In this way, age has served as the foundation for the "stage-like" manner within which behavior and language is thought to unfold. But for behavior analysts, infant development should deemphasize the ontogenic and idiosyncratic influences of genetics, and focus mainly on the specific behavior-response relations and on describing, predicting, and understanding infant behavior as a result of individualized environmental contingencies (Gewirtz and Pelaez-Nogueras 1992; Pelaez, 2002). Parsimoniously, the infant's age may more appropriately speak to the collective number of 3 and 4-term contingencies, on a macro level, that the infant has directly experienced for each unique social behavior. Also, from the behavioral approach, the critical phenomena under study should include the origins, early acquisition, and progression of complex social behaviors, like those denoting attachment and separation anxiety, acquisition of fears, and sibling jealousy (Gewirtz and Pelaez-Nogueras 1990, 1991, 1993). In the following section, we discuss these social phenomena in relation to development with both typically and atypically developing infants.

Specifically, in the next section, we elaborate on the social behavioral milestones that are of extreme importance for healthy early infant development: *attachment, fears, early language skills* (e.g., mands, vocalizations, and echoics), *eye contact, joint attention,* and *social referencing*. Our emphasis is that these social, communicative, and behavioral cusps are integral for the subsequent development of more complex behaviors later during childhood and adolescence (Novak and Pelaez 2004).

Attachment Patterns

Theories of attachment have included developmental, ethological, and clinical perspectives (Ainsworth 1979; Bowlby 1969; Gewirtz and Pelaez-Nogueras 1990) and have suggested that a biological propensity of attachment to a parent figure develops early. Ultimately, an attachment pattern evolves as a function of that figure removing or reducing the likelihood of threatening consequences. Mother-infant interactions are largely reciprocal, but attachment bonds are thought to be established based on the infant's innate "need" for safety, security, and protection. The dynamic interplay between infant and parent results in an overarching "system" of attachment. This attachment system is said to influence the development and acquisition of other behaviors due to the specific *style* of that attachment. The behaviors denoting a mother-child attachment style include: (a) signaling and approaching parents (b)

infant crying, (c) smiling, (d) babbling, and (e) clinging (after the ensuing separation). Through a closer analysis of the etiology of these behaviors, we see that attachment theorists have associated these various behaviors largely as a function of innate, internal processes that unfold due to the infant's development and unique temperament, in conjunction with the style of interaction with their parent (i.e., mother). These researchers have suggested that the quality of attachment is often a function of the separation protests resulting from parent provided contingencies during the departures and/or separations from the infant (Gewirtz and Pelaez-Nogueras 1991; Schaffer and Emerson 1964). The behavior patterns that denote an attachment style have been analyzed using operant conditioning principles (Gewirtz and Pelaez-Nogueras 1991). These patterns of child and mother interactions correspond with overarching styles of attachment that are defined by Ainsworth and colleagues using four different categories: (a) *secure attachment*, (b) *avoidant attachment*, (c) *anxious attachmen*t, and (d) *disorganized attachment* – the latter three categories collectively represent aspects of what has been named by Ainsworth and followers as an *insecure* attachment style.

The science of behavior analysis has continued studying dyadic parent-child behavior interactions and redefining patterns as those previously characterized as attachment (Patterson and Gullion 1971; Rutter et al. 2009). In general, attachment styles are typically considered stably aligned with one's social environment, yet still changeable. Attachment interaction styles may alter as a function of specific environmental contexts (e.g., poverty, early adverse childhood experiences, parental withdrawal, and other global life stressors). While previously conceived as an internal construct, the behavioral-attachment or behavioral systems perspective, illustrates dynamic changes by person-environmental interactions and transactions (Novak and Pelaez 2004; Rutter et al. 2009). Infant behaviors associated with specific types of attachment, such as separation protests denoting *insecure* attachment, are considered to be a function of the loss of a potent reinforcer (i.e., absence of parents and parental extinction), and as such, attachment is not a "thing" an infant possesses, but a behavioral style that develops as a function of a specific history of reinforcement contingencies (Gewirtz and Pelaez-Nogueras 1991).

Gewirtz and Pelaez-Nogueras (1990, 1991, 2000) demonstrated experimentally that infant separation protests can be problematic and are established and maintained like any other operant behavior. When parental attention is provided contingent on the infant separation protests, these separation responses increase and are shown probabilistically depending on the parent providing reinforcement (e.g., the mother's contingent attention and warm hugs upon reunion with her infant increases the probability of the next separation protests).

Some developmental research has noted that young children with ASD and their parents are at a heightened risk for developing an insecure attachment style, which may lend itself to infants at risk of ASD. However, these data are still relatively inconclusive and variable (Hattigan et al. 2011; McKenzie and Dallos 2017). From a behavioral perspective, an insecure attachment style may also result from inconsistent or misplaced parental contingencies during other important interactions, like feeding opportunities (e.g., breast and bottle feeding), that interfere with the

operant/respondent conditioning processes. It is these dynamic pairing processes that may help establish the parent (or any immediate caregiver) as a potent social reinforcer (Gewirtz and Pelaez 1992). For example, when a parent/caregiver is feeding their infant, the parent/caregiver's voice, physical appearance, smell, and touch (hypothesized neutral stimuli) are all being simultaneously paired with the delivery of milk (unconditioned reinforcer), and as such, may become part of a collective conditioned reinforcement system.

Given that children already diagnosed with ASD are often less responsive to, and motivated by, social contingencies, it is likely that not only are parents potentially less inclined to respond to the subtle communicative cues of the infant at risk of ASD, but that, in turn, their infant does not initiate and/or reciprocate interactions in ways that the parents/caregivers may expect (Van IJzendoorn et al. 2007). As such, parents/caregivers may inadvertently, unknowingly, and/or incorrectly reinforce crying and other undesirable behaviors (i.e., infant's behavior being maintained on an intermittent schedule of reinforcement). From this view, early behavioral interventions focus on establishing early interactions that promote replacement behaviors and a secure "attachment" between the infant and the parent/caregiver. Parents and all relevant caregivers should be taught to differentially respond to both the emerging pro-social behaviors or "engagement cues" (e.g., eye contact, vocalizations, and reaching responses) of their infants on a consistent reinforcement schedule.

Fear Development

Historically, classic experiments within behavioral psychology have illustrated the operant nature of the development of fearful behavior (Watson and Rayner 1920), suggesting that fear responses are conditioned and learned as a result of specific histories of conditioning. "Stranger anxiety" has been viewed as a developmental milestone in the literature, emerging around approximately 6 to 7 months of age. Reliably, behavioral studies have demonstrated that fear responses are similar to those responses that are emitted during "stranger anxiety" episodes (e.g., infant crying, gazing away, and clinging to parent) and that these behaviors result as a function of the reinforcers being delivered by parents for that class of functionally equivalent responses (Gewirtz and Pelaez-Nogueras 2000).

Researchers have evaluated phenomena like infant fear of the dark and fear of strangers. From their studies it has become increasingly clear that infant differences in how these "anxieties" and fears are established are largely a result of how those infant responses are shaped by their parents/caregivers. Parsimonious explanations and systematic analyses of the acquisition of fear of strangers and the conditioning of infant fear of the dark have been provided by behavior analysts using prompting and shaping procedures (Gewirtz and Pelaez-Nogueras 1992, 2000; Novak and Pelaez 2004). For example, in one experiment, Gewirtz, Pelaez and collaborators (Lum Lock et al. 1999) compared and examined how 9-month-old infants learned

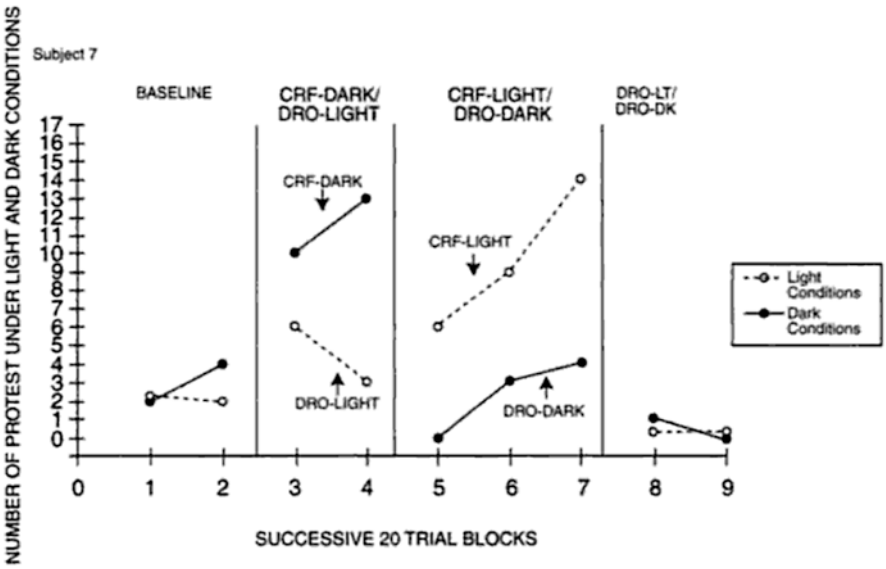

Fig. 2 Illustrates maternal responding to infant protests during two different treatment conditions (CRF vs. DRO) (Gewirtz and Pelaez-Nogueras 2000)

to approach or avoid a confederate female stranger depending on the unique discriminative and reinforcing stimuli provided by the mother. Their results, similar to studies on fear of the dark, suggest that behaviors denoting fear of strangers in real-life settings is significantly influenced and related to operant conditioning processes where reinforcement contingencies are intentionally or unintentionally provided by the primary parent (i.e., mother hugging and consoling) (see Fig. 2).

Given that fear is a learned operant response, one could ask, how do these fears develop and how do they manifest among infants at risk, and can they be evaluated systematically in relation to the environment (i.e., contingency analysis, parametric analysis, and observations)? With toddlers and very young children, a parent's own anxious and fearful behaviors are often the target of intervention, ensuring that their behaviors do not inadvertently reinforce fearful responses of their children through negative reinforcement contingencies (e.g., Aktar et al. 2014). Additionally, other research has demonstrated that both fears and phobias are often more prevalent among children with ASD, and may be more unusual, atypical, or uncommon than those fears displayed by neurotypically developing children (e.g., noises, specific environments, shadows, features of stimuli, and mechanical objects) (Lyndon et al. 2015). Similar to the research discussed above with neurotypically developing infants, and to the studies that treat fears among children diagnosed with ASD, we believe behavior-analytic interventions can be effective.

Behavior analysts can reduce fear responses of infants at risk using behavior-analytic principles and operant conditioning procedures (e.g., shaping, differential reinforcement, systematic desensitization, habituation, and gradual extinction),

while ensuring that parents/caregivers are trained to respond differentially to the infant's behavior (e.g., differential reinforcement of other behaviors (DRO), differential reinforcement of alternative behaviors (DRA), and differential reinforcement of low rates of behaviors (DRL)).

Language and Communication

The emergence and etiology of language is among the most controversial topics in the understanding of human behavior (Chomsky 1965; Skinner 1957). Generally speaking, we can distinguish between a *topographical/structural* approach and a *functional* approach to the development of language. According to developmental linguists, the topographical development of language historically unfolds relative to age sequences, beginning with early cooing around 3–6 weeks of age, babbling, echolalic babbling, and complex vocables emerging between 3 and 12 months of age, and first words typically emerging around 12–15 months old (Oller et al. 1999). However, these developmental norms do not account for the specific role of the environment and its potential influence in shaping the emergence of these early approximations to language. More recently, developmental theorists have promoted a social interactional view of language, which is now more widely accepted (e.g., Golinkoff et al. 2015; Vihman 2017) and discards the conception of an internal developmental system in the absence of behavior-environment interactions (Gottlieb 1991; Lerner 1991). Behavior analysts were among the frontrunners in this more modern approach to the conceptualization of language "development" (Novak and Pelaez 2004; Pelaez et al., in review). Further, the functional approach to language asserts that early vocalizations are shaped into native-language sounds and words through a combination of both automatic and social reinforcement. Vocalizations are verbal behavior, which like any other learned operant behavior is acquired as a function of the differential reinforcement provided by the environment (Esch et al. 2009; Novak and Pelaez 2004; Schlinger Jr, 1995; Shillingsburg et al. 2015; Sundberg et al. 1996).

Moerk's (1986) analysis suggested that there is ample evidence that the environment, mediated in particular by the parent, shapes the child's language. The high intensity of repetitions of words, modeling, and the frequent feedback provided by parents (e.g., reinforcement) shape their child's vocal responses. Critically important data were provided by Hart and Risley (1995) showing that young children have an enormous amount (i.e., millions of repetitions and words) of language spoken to them at home. But those children who were exposed to language on a more consistent basis and heard more repetitions from their parents (i.e., millions vs. thousands of repetitions of words and sentences), showed a larger vocabulary in later in childhood than those children with less exposure (Hart and Risley 1995).

Mands Among the earliest forms of communication is crying. An infant cry can be conceptualized from the functional approach as a verbal operant, or more specifically,

Fig. 3 Infant crying likely serves as a mand; a request for the parent/caregiver to meet the infant's needs (feeding, changing, attention, and sleep)

as a *mand.* The infant's mand is controlled by some relative state of deprivation (i.e., establishing or abolishing operations), and may serve as a request for the parent/caregiver's attention to meet the infant's needs (e.g., hunger). The parent/caregiver then subsequently reinforces the infant's mand by providing specific reinforcement in return (e.g., feeding, changing, physical touch, and sleep) (Pelaez-Nogueras and Gewirtz 1997) (see Fig. 3).

As the infant continues to contact reinforcement for engaging in vocal and other verbal behavior (i.e., symbolic gestures) as they develop, topographies of communication become more refined and begin to approximate more complex verbal responses (i.e., babbling and first words). Thus, as previously noted, the early development of language is likely only related to time and chronology in that it may speak to average histories of reinforcement (i.e., cumulative reinforcement contingencies contacted), and the individual behaviors observed across infants suggests idiosyncrasies in these specific environmental interactions.

Vocalizations A behavioral approach to verbal behavior accounts more for the role of automatic and social reinforcement in how and when infant vocalizations are expressed within their developmental trajectory. Specifically, infant vocalizations occur in part because they are contacting internal automatic reinforcement contingencies (e.g., proprioceptive sensations on the infant's vocal cords and mouth, and the audible sound produced by vocalizing). In other words, the vocalizations emitted by the infant "feel good" and as such, the infant continues to produce similar sounds in the future. At some point in the infant's learning history, those earliest vocalizations initially maintained by automatic contingencies, contact social reinforcement contingencies provided by the parents/caregivers (e.g., smiles, vocal attention, and physical touch) and as such, become dually maintained by forms of both automatic and social reinforcement (Baer and Deguchi 1985; Schlinger Jr 1992, 1995; Sundberg et al. 1996).

Motherese Speech and Vocal Imitation The parent's vocal behavior, through pairing with other primary reinforcers, has been shown to be an incredibly effective reinforcer for promoting typically developing infant's vocalizations, but only when delivered in the appropriate temporal sequence. Specifically, researchers have investigated and compared parent's *motherese speech in* relation to parent's *vocal imitation*, in both contingent and noncontingent paradigms (Neimy et al. 2017, 2020; Pelaez et al. 2011a, b). Results consistently demonstrated that infants prefer contingent social reinforcement, with idiosyncratic differences in preference for both motherese speech and vocal imitation (see Figs. 4 and 5) (Bendixen and Pelaez 2010; Neimy et al. 2017, 2020; Pelaez et al. 2011a, b, 2018).

Other researchers have similarly demonstrated that operant procedures can be effectively applied to promote the emergence and increased frequency of vocalizations in children diagnosed with ASD (Esch et al. 2009; Shillingsburg et al. 2015), however often additional reinforcement systems (i.e., edibles and tangibles) and/or procedures (i.e., stimulus-stimulus pairing) are necessary (Miguel et al. 2002; Shillingsburg et al. 2015).

Further, recent research has also demonstrated that parental vocal imitation, when used as a reinforcer for infant vocalizations, not only promotes increased rates of vocalizations, but establishes the emergence of early echoic repertoires. Specifically, the vocal imitation provided by the parent for the infant's vocalizations serves as both a reinforcer and a discriminative stimulus (SD) for the infant to continue vocalizing/echoing, and illustrates among the first vocal "conversations" or

Fig. 4 Parent's vocalizations in the form of vocal imitation and motherese speech function as conditioned reinforcers early in the development of infant vocal responses

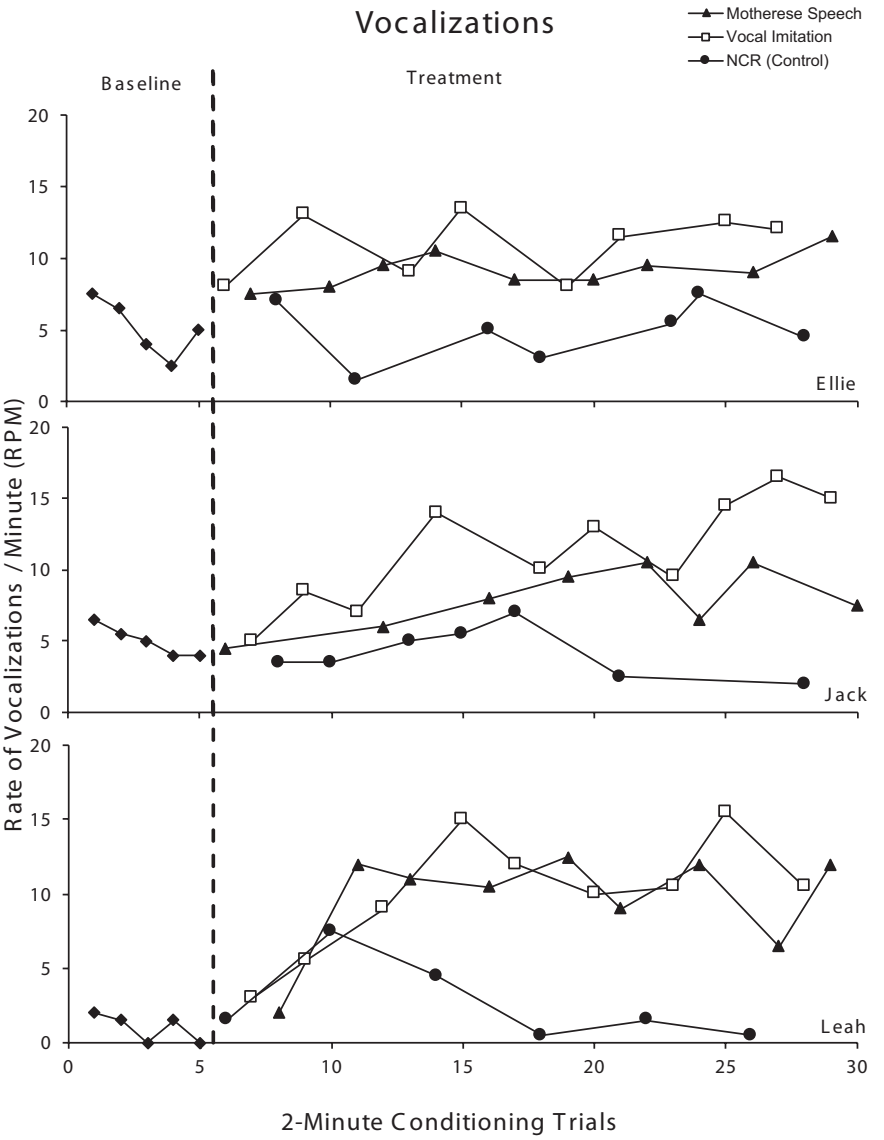

Fig. 5 Graph illustrating the rate of vocalizations emitted during behavior-analytic parent-led interventions with three infants at risk of ASD (Neimy et al. 2020)

"back-and-forth" interactions observed among infants and their parents. This has now been investigated and demonstrated in both typically and atypically developing infants (Neimy et al. 2020; Pelaez et al. 2018).

Eye Contact

A variety of integral operant responses emerge during early infancy, including: head turning, "rooting," high-amplitude sucking, visual and auditory tracking, orienting, gazing away, kicking, crawling, smiling, laughing, grasping, touching, reaching for an object, moving away, vocalizing, grimacing, protesting, tacting, naming, crying, referencing, and imitating (Gewirtz and Pelaez-Nogueras 1990, 1991, 1992; Hulsebus 1973; Novak and Pelaez 2004; Ohr and Fagen 1994; Pelaez et al. in review; Pelaez et al. 2011b; Pelaez-Nogueras and Gewirtz 1997; Poulson and Nunes 1988). Among the most critical and integral skills that an infant acquires right after birth is eye contact with others (see Figs. 6 and 7).

Eye contact is crucial for the development of more complex social skills later in infancy, like joint attention and social referencing. Infants will often display reliable eye contact and can begin discriminating facial features within the first few weeks of life. However, infants at risk have been found to orient and more frequently allocate their eye gaze to nonsocial stimuli (e.g., toys, objects, and textures) or inaccurate social stimuli (e.g., parent's/caregiver's mouth movements) vs critical social stimuli (i.e., parent's/caregiver's eyes and facial expressions) (Jones and Klin 2013; Klin, Shultz, & Jones, 2015).

In the past 50 years, a breadth of literature has demonstrated the efficacy of early behavior-analytic interventions that teach eye contact in children diagnosed with ASD and other disabilities. These behavioral interventions vary from client to client, but typically include the delivery of some kind of identified conditioned or unconditioned reinforcer contingent on specified eye contact response criteria (i.e.,

Figs. 6 and 7 Parents/caregivers establishing eye-contact during face-to-face interactions. Around 2–3 months, infants begin scanning faces; they become fixated on the parent's/caregiver's eyes, where they can then receive important social information. Infants later diagnosed with ASD exhibited decline in eye fixation from 2–6 months of age (Jones and Klin 2013)

initiated instances of eye contact, total duration of eye contact, fluency with responding, orienting to name, and controlled gaze shifting). Some studies have investigated the acquisition of eye contact among young infants (Pelaez-Nogueras et al. 1996a). Researchers have found that with typically developing infants, contingent positive reinforcement consisting of combined forms of physical touch, positive facial affect (e.g., smiling), and infant-directed speech (i.e., motherese speech) can be used to promote increased infant initiated instances and duration of eye contact with their parent/caregiver (Pelaez-Nogueras et al. 1996a; Pelaez-Nogueras et al. 1997). These developmental behavior analysts have coined this combined reinforcement package *synchronized reinforcement*, which has been successfully used to promote eye contact with infants of mothers who both were, and were not, diagnosed with depression (see Fig. 8) (Pelaez-Nogueras et al. 1996a, b).

We should note that infants at risk of ASD who display lower levels of eye contact and a higher frequency of gazing away may similarly benefit from interventions within the natural environment delivered by parents/caregivers that reinforce appropriate and increased eye contact (Neimy et al. 2017; Pelaez and Monlux 2018).

Fig. 8 Synchronized reinforcement, which includes physical touch, provided by the parent/caregiver can serve as a powerful reinforcer for infants and improve infant's social development. Research has showed that the duration and initiations of infant eye contact increases when parents/caregivers provide physical touch contingent on their infant's eye contact

Joint Attention

We have defined joint attending operationally, given that differing disciplines have conceptualized *joint attention* inconsistently (i.e., some as an innate phenomenon) (Mundy et al. 2007). From a behavior-analytic approach, joint attention consists of a discrete chain of individual behaviors, specifically when an infant: (a) shifts their eye gaze to/between objects to (b) their parent/caregiver, as an initiation or a response, in order to (c) obtain social reinforcement and develop stimulus-stimulus relations about their world around them (see Fig. 9) (Dube et al. 2004; Monlux et al. 2019; Pelaez and Monlux 2018). Infants initiate and/or respond to joint attention instances by looking at, pointing at, showing, sharing, or engaging with objects, then shift their eye gaze to their parent/caregiver, who may often provide forms of generalized conditioned reinforcement (e.g., social praise, nodding, and smiling) as part of a shared social experience. During these shared experiences, the infant joint attention response contacts both unconditioned (i.e., parent's/caregiver's face) and conditioned (e.g., parent's/caregiver's facial expressions) social reinforcers, and as such, these repertoires are strengthened in the future (Pelaez and Monlux 2018, 2020).

Considering the social nature of the exchange, joint attention has been examined extensively among ASD populations and is a hallmark deficit observed in those children. Diagnosed with ASD (DeQuinzio et al. 2016; Isaksen and Holth 2009; Taylor and Hoch 2008). These exchanges are typically maintained by the social interaction that follows, and could be considered a form of mand for attention to "share an experience" with their parent/caregiver. Given the limited potency of

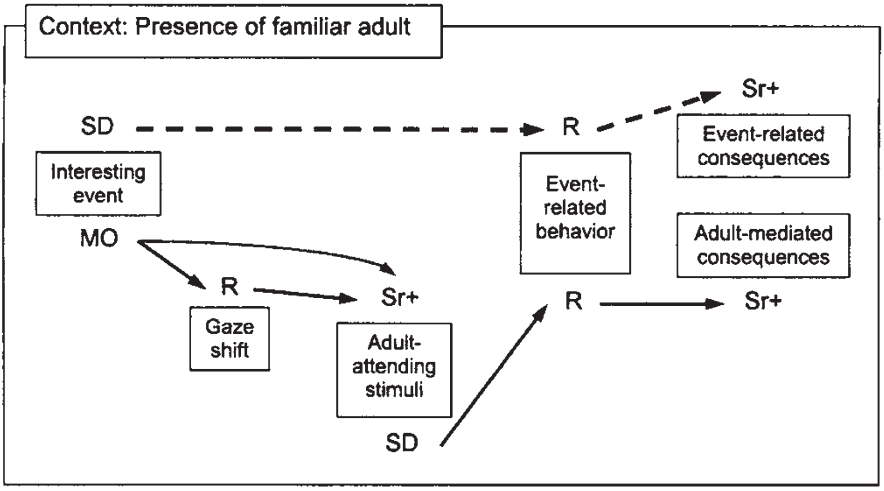

Fig. 9 Contingency diagram of the behavioral components of the joint attention sequence (Dube et al. 2004)

social reinforcers for individuals with ASD, it is not surprising that these repertoires are often lacking.

A breadth of studies over the past two decades have consistently demonstrated that joint attention skills can be taught using systematic combinations of shaping, prompting, and differential reinforcement (Holth, 2005; Isaksen and Holth 2009; Monlux et al. 2019b; Taylor and Hoch 2008). Interventions with infants at risk of ASD and other disabilities attempt to facilitate the emergence of joint attention to mitigate the likelihood of future deficits (e.g., over-selectivity and/or discrimination issues resulting in failure to acquire social referencing) and strengthen pivotal foundational repertoires or cusps (Pelaez and Monlux 2020; Pelaez and Novak 2013).

Social Referencing

A critical skill that may mediate the development of many prosocial and/or maladaptive behaviors is the infant's ability to read the social cues and facial expressions of parents/caregivers when presented with novel, unfamiliar, or vague stimuli. *Social referencing* has been similarly discussed by developmental psychologists as a conceptual skill that is "prewired," and emerges within the chronology of development, however developmental behaviorists have also demonstrated that similar to attachment and fear, social referencing is acquired like any other learned operant (Gewirtz and Pelaez-Nogueras 1991; Pelaez et al. 2012). Specifically, Pelaez and collaborators have shown that social referencing is a complex behavior chain made up of joint attention skills, where infants orient and shift their eye gaze to specific social stimuli (e.g., parent's/caregiver's facial expressions) following the presentation of novel stimuli, in an attempt to understand how to respond (i.e., approach following positive signaling, or avoid following negative signaling) (Pelaez et al. 2012) (see Fig. 10).

Behavior analysts have studied social referencing in both typically developing infants and infants at risk of ASD and developmental delays. Researchers have conditioned novel stimulus cues (e.g., parents/caregivers emitting specific gestures/hand signals) in the presence of ambiguous stimuli. In the presence of these cues, they taught infants to discriminate whether to approach or avoid the ambiguous stimulus based on the presentation of the parent's/caregiver's cues (i.e., SDs). This was done in a direct response to developmental psychologists conventionalizing social referencing as an innate ability that unfolds developmentally. The infants reliably acquired the skill using combinations of prompting, shaping, and reinforcement procedures, which demonstrated that parent's/caregiver's facial expression can become conditioned SDs (cues) that either signal reinforcement or an aversive consequence for engaging in approaching responses (Pelaez et al. 2012, 2013). This was the first concrete evidence for the learning theory of social referencing, illustrating that this behavioral skill sequence was something that could successfully be taught.

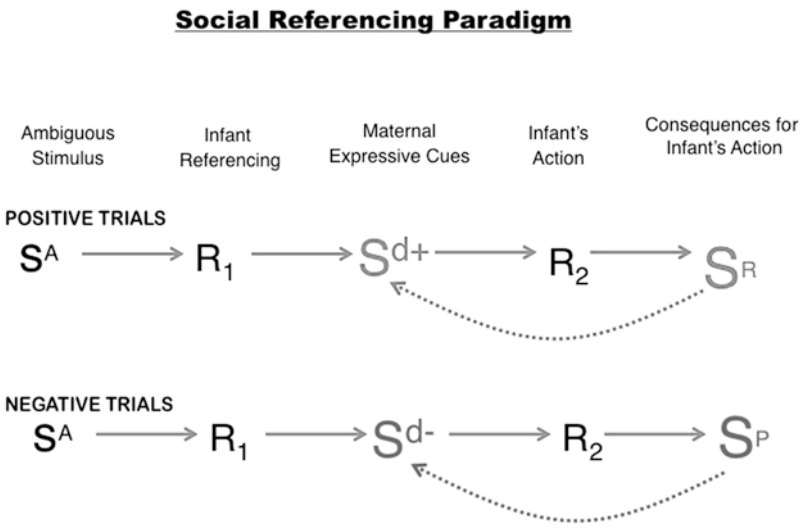

Fig. 10 Illustration of the different behavioral components of the operant-learning social referencing paradigm (Pelaez 2009)

For children with ASD, social referencing has been effectively taught using the principles of behavior analysis as part of early behavior intervention programs (Brim et al. 2009; DeQuinzio et al. 2016). As such, early behavior intervention research on social referencing with infants at risk of ASD and other developmental disabilities has yielded some initial promising results. Social referencing needs to be prioritized and systematically programmed for those infants at risk who lack these social repertoires. Targeting this complex social behavior chain as part of an early intervention program will establish the infant's referencing repertoires and fluency in effectively responding to the nonvocal verbal behavior and emotions exhibited by others. In other words, the learning of joint attending and social referencing skills are essential for infant's understanding and interpreting the emotions of others, and ultimately may play a role in more complex social skills, like perspective taking (Monlux et al. 2019b; Pelaez and Monlux 2018, 2020).

Behavior-Analytic and Mainstream Interventions for Infants at Risk

The behavioral and mainstream interventions discussed in this chapter follow the application of early behavioral principles through behavioral skills training (BST) (Parsons et al. 2012). We focus primarily on the parent and/or any immediate caregivers as the agent of change, and use evidence-based treatment approaches to address various skill and behavioral deficits during infancy (Patterson and Gullion

1971). Depending on the concerns faced, one can choose from a wide array of interventions available to a broad scope of multidisciplinary practitioners. In general, the majority of early intervention services for infants are administered by nurses, speech language pathologists, occupational therapists, physical therapists, psychologists, and their respective interns/assistants. However, focus should continue to become more centered on the training of the infant's parents/caregivers, either directly in vivo, and/or using telehealth or remote models, given their relative success with other populations (Monlux et al. 2019a; Tsami et al. 2019; Wacker et al. 2013). These services are most commonly provided for infants who have preexisting diagnoses (e.g., Down's syndrome and cerebral palsy) or specific medical fragilities (e.g., low birth weight, prematurity, and feeding issues). For infants at risk of ASD and some other genetic disorders (e.g., Fragile X), however, infant development services may be granted to qualifying families depending on their specific state-wide or federal regulations and/or medical insurance benefits, but these services may or may not include behavior analysts. The lack of involvement of behavior analysts, at least in the United States, may be largely a function of funding sources and limitations of the Board Certified Behavior Analyst (BCBA) credential. Given that the majority of services for applied behavior-analytic therapy are funded either via the state (e.g., regional centers) or through state-specific insurance mandates (e.g., government and private health insurance), behavior analysts have been limited in the populations they can feasibly serve.

Our professional governing body, the Behavior Analyst Certification Board (BACB 2014) does not provide licensure, only a certification – a limitation that may hinder involvement of behavior analysts across settings and populations outside of ASD in general. Conversely, there are several states that do have regulating licensing boards for behavior analysts, and as such, the intervention services afforded to both infants at risk of ASD and other developmental disorders by behavioral providers vary significantly ("Licensure and Regulation of Behavior Analysts" n.d.).

These focused support early interventions for infants are often conceptually different than our early behavioral interventions models. As we have seen, behavior-analytic researchers have investigated many of the behavioral phenomena lacking in infants at risk of ASD and other disabilities. Specifically, as previously mentioned, interventions delivered by specialists and parents/caregivers that focus on establishing social behavioral cusps, like eye contact and gaze shifting, vocalizations, joint attention, and social reinforcement, are paramount as the foundation for the development of more complex social and language skills in later childhood (Neimy et al. 2017; Novak and Pelaez 2004; Pelaez and Monlux 2019, 2020).

Extensive literature reviews suggest that best practices for interventions for children under the age of 2 years old who are at risk for ASD and other developmental disabilities, should be based on the principles of behavior analysis (Zwaigenbaum et al. 2015). In general, early intervention models that use specific principles of behavior analysis can be applied to not only treat the core deficits of ASD and developmental disabilities, but a myriad of other social, emotional, and behavior deficits and/or excesses observed in infants. In addition to the early intensive behavior interventions (EIBI) curricula, early infant interventions may be based on

applied behavior analysis (ABA), but at a reduced dosage, duration, and/or intensity. We can target a variety of specific social (e.g., joint attention, social referencing, and eye contact), behavioral (e.g., separation protests, noncompliance, and latching), and language skills (e.g., vocalizations, echoics, mands, and tacts) with a moderate rate of intervention. Often, moderate ABA interventions are parent-/caregiver-directed or include extensive parental/caregiver involvement in both brief and extended treatment models.

In general, an early behavioral intervention that focuses on dyadic parent–child interactions is crucial to establishing generative repertoires during early infancy and childhood. Similar naturalistic behavior-analytic interventions that have been successful in treating those specific characteristics of ASD may be similarly applied and adapted to infants at risk of ASD (LeBlanc et al. 2006). Specifically, interventions typically conducted within the natural home environment of the infant could incorporate *Incidental Teaching* (Charlop-Christy and Carpenter 2000; Hart and Risley 1968; McGee et al. 1999), *Naturalistic Environment Teaching (NET)* (Sundberg and Partington 1998), *Applied Verbal Behavior (AVB)* (Sundberg and Michael 2001) and other ABA-based *Naturalistic Teaching Strategies (NATS)* (Charlop-Christy et al. 1999) to teach skills and promote generalization. Further, these type of interventions can include more standard parent/caregiver management training (Parsons et al. 2012; Patterson and Gullion 1971) or modifying the environmental context and setting in a more structured format (Kohlhoff and Morgan 2014).

Specific components or aspects of behavior-analytic treatment are often incorporated into mainstream interventions, in conjunction with other procedures grounded in cognitive, clinical, and/or developmental psychology. Further, the vernacular and description of treatment that is utilized may be adjusted to more appropriately match the consumers (i.e., minimizing behavior-analytic terms and jargon). Collectively, these *eclectic* approaches and procedures may demonstrate overall efficacy as a package when evaluated, yet the underlying function or specific catalyst of change is partially unknown due to the use of correlational statistical inference instead of isolating treatment variables and demonstrating functional relationships, experimental control, and strong internal validity (i.e., component analysis may be necessary to identify the "active" ingredient of the treatment package). However, there are ongoing discussions and updates within the scientific community about how the term "evidence" may best be characterized and defined in efforts to best publicize those treatments that are in fact effective and have a significant impact overall (Kazdin 2015; Tolin et al. 2015).

Many of the emerging evidence-based eclectic procedures may in fact be effective due to the behavior-analytic principles included in treatment (i.e., contingent reinforcement, extinction, and shaping) (Howard et al. 2004; Schlinger Jr 1992, 1995). We should note that some of these approaches, like *Pivotal Response Training (PRT)* and *Parent Child Interaction Therapy (PCIT)* have strong behavior-analytic roots and incorporate significantly more aspects of applied behavior analysis within the context of their intervention approaches. As a result, these mainstream eclectic

interventions are difficult to tease apart and formally define as either meeting or not-meeting a pure behavior-analytic criterion for treatment.

Early Start Denver Model (ESDM) (Rogers and Dawson 2010; Rogers, Dawson, & Vismaea 2012) is another well-known emerging evidence-based eclectic intervention for young toddlers between the ages of 12–48 months old diagnosed with and/or at risk for ASD, based on the principles of developmental psychology and applied behavior analysis. The intervention is focused on addressing key domains of development, including imitation, communication, social, cognitive, motor, adaptive behavior, and play, all delivered by parents and therapists in a positive play-based and relationship-focused format. ESDM focuses on building a positive relationship, contrives teaching opportunities within natural play and normalized routine activities, and utilizes play to promote social interactions and communication skills. ESDM therapy is often delivered across home, clinic, and school settings, in either one-to-one and/or group settings. A critical component of ESDM is parental involvement; therapists will recruit participation of parents during sessions to ensure strategies and treatment approaches are adopted outside of direct sessions.

Parent–Child Interaction (PCI) Feeding and Teaching Scales (Kelly et al. 2003; Oxford et al. 2016). The PCI scales (formerly NCAST Feeding and Teaching Scales) are both a valid and reliable assessment and intervention guide for measuring specific observable parent–child interaction behaviors in the context of feeding and/or teaching situations. The PCI scales are among the most frequently used tools for identifying early patterns of social dysfunction and/or maladaptive interactions between infant and parent behaviors, and subsequently establish treatment programs targeting deficits observed during the scales. Using a blend of both cognitive and developmental approaches, there are also specific behavioral components that are targeted within the context of the PCI Feeding Scales that emphasize important aspects of infant-parent social interaction that occurs during breastfeeding, nursing, and feeding.

The components of an early behavior-analytic PCI intervention include: (a) contingent vocal responding; (b) contingent social reinforcement; (c) noncontingent attention; (d) differential reinforcement of other and alternative behaviors (DRO and DRA schedules); and (e) response redirection. During feeding opportunities, parents are encouraged to maintain an "en-face" position (i.e., face-to-face with direct aligned eye contact with the infant), respond to their infants when they make eye contact or vocalizations, talk to their infants both contingently and noncontingently, vary their tone and prosody of speech, provide positive and conversational statements to their infant, allow their infant to touch and explore the source of food (e.g., breast or bottle), immediately respond to and help redirect the infant's distress responses and disengagement cues (i.e., lateral gaze aversion, swiping, pushing away, and crying), and provide touch and vary the motion given to their infant during the interaction (i.e., stroking, massaging, swaying, and bouncing).

From a behavior-analytic perspective, these various contingent responses of the parent during the delivery of such a potent primary reinforcer (i.e., food) may

establish the parent's social behaviors as a source of reinforcement and stimulus control. That is, the parent's various social behaviors become a conditioned reinforcer for the infant's behaviors, while promoting the learning of the earliest social skills of the infant (e.g., eye contact, gaze shifting, social referencing, vocalizations, and appropriately terminating feeding) (Pelaez-Nogueras and Gewirtz 1997).

Parent Child Interaction Therapy (PCIT) (Kohlhoff and Morgan 2014; Lieneman et al. 2017; McNeil and Hembree-Kigin, 2010) is an evidence-based treatment for young toddlers to establish positive social-emotional relationships between parent–child dyads. PCIT is based on the developmental theory of parenting, attachment theory, social learning, and uses specific behavioral techniques (i.e., DRO, DRA, and contingent social reinforcement) to promote "secure attachment" through authoritative parenting style. This includes teaching parents to focus on boundary setting and healthy levels of follow through and consistency in responding to their toddlers. In general, PCIT is delivered via parents, and "coached" by a therapist using a "bug-in-the-ear" device within a clinic setting, allowing the therapist to provide moment-to-moment feedback and guidance on how to manage the child's behavior. PCIT is generally conducted across two treatment phases, in anywhere from 12–20 sessions, depending on the unique dyad. Phase one focuses on establishing warm positive relations between parents and their children, prioritizing the reduction of tantrums, hyperactivity, negative attention-seeking behavior, and parental frustration/over-reactivity, and increase secure attachment styles, attention span, self-esteem, and pro-social interactions and communication behaviors. Phase two of treatment focuses on managing and decreasing more challenging behaviors like aggression, destruction, and defiance, increasing compliance with functional, household, and academic requests, promoting positive behavior around others in public, and establishing strategies for parents/caregivers to remain calm and confident while managing these behaviors consistently and effectively.

Pivotal Response Treatment (PRT) (Koegel and Koegel 2006). PRT is similar in essence to Incidental Teaching, however its curricula as a package is still an emerging evidence-based treatment for children with ASD. PRT focuses on increasing a child's motivation to learn, self-monitoring of behaviors, and initiating social interaction and communication with others. The *pivotal skills* serve as a foundational behavioral cusp, that allow the child to learn a wide array of skills by contacting naturally occurring reinforcers. PRT targets specific pivotal areas including motivation, responding to multiple different cues, self-management of disruptive and self-stimulatory behaviors, and increased social, communication, and academic skills through natural reinforcement contingencies within the child's natural environment. Treatment can include an average of 25 hours per week, and is delivered by an interventionist in a play-based format, with learning opportunities and trials generally initiated by the child. The treatment goals are individualized and tailored to meet the unique goals and needs of the child within their natural environment, and focuses on six segments across language, play, and social skills during both unstructured and structured interactions.

Guidelines for Developing Behavior-Analytic Interventions for Infants at Risk

Any behavior-analytic intervention for infants at risk needs to be aligned with the *dimensions of applied behavior analysis* delineated by Baer et al. (1968). Specifically, infant behaviors selected for intervention need to be observable and measurable *(behavioral)*, the goals and behaviors identified are socially significant in that they warrant intervention *(applied*), the treatment procedures are formalized into step-by-step protocols *(technological)*, the interventions are grounded in behavior-analytic research and are evidence-based in nature *(conceptually systematic)*, the experimental methods utilized demonstrate functional relations between selected independent and dependent variables *(analytic)*, the intervention systematically programs for generalization across behaviors, individuals (i.e., parents and any/all immediate caregivers), and settings *(generality),* and the results of the interventions demonstrate overall efficacy and positive outcomes *(effective).*

Additionally, for behavior analysts specifically, working with at risk infants and their families presents several considerations to ensure procedures are being reliably upheld ethically; these are vulnerable populations that require extra care, sensitivities, and protections, and as such, careful attention to specific assessment methods, environmental arrangements, use of specific intervention methods, and experimental design considerations, in relation to specific BACB *Professional and Ethical Compliance Code for Behavior Analysts* (BACB, 2014) topics, warrants further discussion (Diekama 2009).

I. **Practitioner's Competency and Responsibilities** *(BACB Professional & Ethical Compliance Codes 1.02, 1.03, 2.01 & 2.02).*

Behavior analysts have not been consistently trained to work with infants in applied or clinical settings, or work amongst the common disciplinary team affiliated with infant intervention services. Practicing behavior analysts are most commonly working with young children, adolescents, and adults with ASD and other developmental and intellectual disabilities. In general, nurses, doctors, early childhood educators, psychologists, speech language pathologies, occupational therapists, and physical therapists frequently interact with infants. As such, before beginning assessments or interventions with infants at risk, behavior analysts will need to ensure they receive supervision, mentorship, and hands-on training from individuals who work with these infant populations prior to providing any form of services accordingly. Further, behavior analysts will likely need to complete additional course work in the areas of child development, early education, and developmental psychology.

A good behavior analyst should be fluent in child development and the typical developmental phenomena and research that have been discussed here (e.g., attachment, fear acquisition). Also, a behavior analyst interested in child development should know about how different theoretical perspectives have informed us on child development (e.g., Novak and Pelaez (2004; Schlinger Jr 1992, 1995). Behavior

analysts need to familiarize themselves with the research literature on infant behavior and development. These studies discussed here have been published mainly in developmental journals and have served as a historical basis for how behavior-analytic procedures have evolved (e.g., *Infancy, Child Development, Journal of Child Psychology & Psychiatry*). More importantly, behavior analysts must familiarize themselves with the research literature on early interventions with children with ASD and the results of the meta-analysis conducted (Virués-Ortega 2010). It is important for emerging behavior analysts to shadow and be supervised by practitioners who work directly with infant at risk populations, such that they have direct hands-on experience on assessment and treatment as part of their supervised experience hours necessary for pursuing or maintaining certification.

When testing and conducting interventions with infant populations, particularly those at risk, it is important to consider the vulnerability of the home environment across all the indirect consumers one interacts with. The parents/caregivers are likely under significant amounts of stress, may be battling with mental health issues, and may need additional support and consultation to better manage the behavioral contingencies of their infant. A focus on integrating appropriate "*bedside manner*" and various "*soft-skills*" (e.g., empathic listening, validation, flexibility, patience, and open-mindedness) is an essential component of *building rapport* with indirect consumers during the initial stages of developing the intervention (Taylor et al. 2018). The BCBA is responsible to all parties affected by the services provided, and as such, these early interventions with infants need to be sensitive to all parties involved.

When considering the fragile and vulnerable nature of infants born with a developmental problem, particularly those at risk because of medical complications and/or physiological and biological concerns, it may be necessary to *maintain ongoing collaboration* and/or *consistent consultation* with medical professionals (e.g., pediatrician, nurse physician, and medical specialists) to rule out any and all possible medical or physiological issues that may be emerging as behavioral symptoms. Furthermore, outside collaboration with medical professionals, can help us ensure that the vulnerable infant is also receiving coordinated specialized services from other providers (i.e., speech pathology, occupational therapy, and physical therapy). With this in mind, behavior analysts continue to act and serve the infant as part of a multidisciplinary team and will benefit from collaborative partnerships that include working closely with practitioners who have experience working with neonates and infants with developmental problems (e.g., NICU specialized pediatricians, nurses, lactation consultants, midwives, child clinical psychologists, developmental psychologists, physical therapists, occupational therapists, and speech and language pathologists).

II. **Assessment Procedures** *(BACB Professional & Ethical Compliance Codes 3.01-3.04).*

Following obtaining all necessary consent, when working with infants at risk of ASD, developmental disabilities, or other social-behavioral disorders, behavior-analytic assessment procedures need to be adapted to address the given concerns

presented by the vulnerable at risk infant. These assessments would not include any kind of formal diagnostics, but would include components of a *functional behavior assessment (FBA)* including, *indirect assessments/interviews* with all relevant immediate stakeholders, *descriptive assessments* and direct observations of the infant's behavior and interactions within the natural environment (e.g., duration of eye contact during interactions with parent/caregiver, frequency of vocalizations during play, and latency to fussiness during "tummy time"), gathering *baseline data* on specific skill and/or behavior deficits (e.g., vocalizations, gaze shifting, eye contact, joint attention, and social referencing) and excesses (e.g., crying, separation protests, avoidance and disengagement cues, and fear responses), and conducting *contingency or experimental functional analyses* to identify the putative maintaining variables for those specific behavioral excesses.

The use of standardized normative assessments may also be used as part of the indirect and descriptive assessments to corroborate anecdotal information provided by parents/caregivers, and help guide the development of skill-based goals. Specifically, these assessments may include: (a) *Adaptive Behavior Assessment System, Third Edition* (ABAS-3; Harrison and Oakland 2015; (b) *Assessment of Basic Language and Learning Skills – Revised* (ABLLS-R; Partington 2006); (c) *Developmental Profile, Third Edition* (DP-3; Alpern et al. 2007); (d) *Early Social Communication Scales* (ESCS; Mundy et al. 2003; (e) *Modified Checklist for Autism in Toddlers Revised with Follow-Up* (M-CHAT-R/F; Robins et al. 2014); (f) *Verbal Behavior Milestones Assessment and Placement Program* (VB-MAPP; Sundberg 2008); and (g) *Vineland*, *Third Edition* (Vineland-3; Sparrow et al. 2017). Each of these aforementioned assessments can be conducted by behavior analysts or trained school psychologists with infants from birth onwards. Normative developmental assessments can provide an additional information and help us measure progress throughout the course of treatment. BCBAs may need to seek additional training and mentorship from practitioners and specialized psychologists who are fluent on these assessments in order to successfully interpret and integrate the results into ongoing assessment reports, which serve as a basis for decision-making throughout the course of treatment. The obtained assessment results should be formally prepared (i.e., assessment report) and reviewed with parents/caregivers and all other immediate indirect consumers, using language and visual displays of data like graphs that effectively and easily helps us evaluate and explain findings (with minimal behavior-analytic jargon).

Additionally, indirect and direct *preference assessments* may also need to be incorporated into these early interventions to identify the infant's preferred stimuli and potential reinforcers to incorporate during treatment. This may involve interviews with parents/caregivers and/or directly observing the infant interacting with different tangibles (e.g., rattles, high contrast stimuli, cause-and-effect toys, and mobiles), activities (e.g., "tummy time", rocking/swaying, listening to songs, music, or books delivered by the parent/caregiver) and/or forms of social interaction (e.g., peek-a-boo, tickles, massage, hugs, and kisses).

III. **Identifying and Defining Goals** *(BACB Professional & Ethical Compliance Codes 4.03 & 4.05).*

The selection of goals needs to be tempered, balanced, prioritized, and weighed in relation to the goals of the family and other relevant stakeholders, considering their unique and diverse sociocultural beliefs, economic supports, and the overall acceptability of procedures and goals (i.e., *social validity*). Collaboration is critical to ensure parental participation, satisfaction, and ongoing treatment involvement (Zwaigenbaum 2015). Specifically, behavior analysts may use informal open–ended interviews in conjunction with the results of more standardized assessments to identify socially significant and relevant behavioral goals to address within the context of the intervention. These goals may include increasing infant social behaviors like eye contact, smiles, vocalizations, gaze shifting, oral motor, fine, and gross motor imitation, and promoting "tummy time" and the development of motor movements. They also may include parent-specific goals, like shaping infant self-feeding behavior, guidance with breast/bottle feeding, establishment of safe sleep environments and sleeping routines, identifying and responding to infant cues (i.e., hunger, engagement, and disengagement), and assistance with other adaptive daily living routines (e.g., bathing) (Figs. 11 and 12).

Similar to any other behavioral intervention plan with older children, infant behavior goals should be objectively delineated and defined such that ongoing data collection and visual inspection and analysis of graphs allows for data-based decisions as a function of client progress. The intervention established for the infant needs to focus on addressing *observable and measurable gains* in specific skill deficits and/or excesses related to their identified developmental issues. The intervention needs to focus on addressing the core social and behavioral deficits (i.e., the lack of developmental cusps) and on attempting to mitigate the gap in

Figs. 11 and 12 Interventions to teach an infant self-feeding responses and infant–parent engagement during sustained "tummy time" practice

functioning across domains (e.g., social, emotional, communication, adaptive, leisure, and cognitive skills) as quickly as possible.

IV. **Arranging the Environment** *(BACB Professional & Ethical Compliance Code 4.06 & 4.07).*

Working with infants at risk can present many challenges that can make delivery of early behavioral interventions services quite difficult. Specifically, considerations like the *time and duration of sessions*, *environmental distractions*, and providing *sufficient breaks* may be necessary. Specifically, infants often have varied sleeping and feeding schedules, and as such, sessions should be scheduled when the infant is well-rested and fed to prevent any potential problematic behavior that may interfere with or confound the progress made within treatment. Further, it is important to consider the overall duration of sessions, and to keep the teaching trials brief (i.e., 1–5 min maximum) and/or embedding teaching opportunities into naturally occurring contexts within the infant's natural environment. The behavior analyst must ensure, before every intervention, that the environment is set up for the infant's learning and success. For example, the use of appropriate seating arrangements (i.e., high-chair) that limit any potential distractions during treatment is necessary. The interventionist should allow the infant to have access to highly preferred items or edibles, ensure that no dangerous or unsafe items are within proximity, and that the infant has opportunities to take breaks frequently (i.e., playing and having snacks).

V. **Single-Subject Experimental Designs Considerations** *(BACB Professional and Ethical Compliance Code 4.09).*

Aside from general logistics of a treatment session, other specific design decisions need to be considered. Single-subject experimental designs have long been the preferred methodology of behavior analysts because they allow for the identification of functional relations between the dependent and independent variables at the individual level, where the subject serves as his/her own control (Kazdin 2011). In applied (nonexperimental) interventions, we recommend minimizing the use of reversal/withdrawal designs (ABAB) to reduce some of the potential negative side effects of removing treatment for too long (i.e., extinction effects) and to avoid the absence of effective treatment in place. The practitioner should opt for the use of *multiple–baseline designs, alternating designs,* and *changing-criterion designs* whenever possible, all of which still allow for replication and verification effects.

Always keep in mind that behavioral interventions require that we obtain parental consent for participation and also institutional review board (IRB) permission, including a training certification for the interventionist. The practitioner should protect the rights, welfare, and well-being of infant participants and follow the highest ethical standards for conducting human research. In particular, when conducting interventions with infants at risk, the behavior analyst must adhere to the ethical principles outlined by federal and state funding agencies. These ethical guidelines include *protecting humans from any possible harm* and also by making efforts to *secure their well-being* and *confidentiality of results*. Also, the practitioner should ensure they are employing a *sound research design*, *maintaining scientific*

integrity, and determining the *practical implications* of the work. One must ensure that the research and/or intervention in place contribute to generalizable knowledge and is worth conducting for the social significance of the potential outcomes.

VI. **Intervention/Treatment Specifications** *(BACB Professional & Ethical Compliance Code 4.01 & 4.08).*

With respect to the actual implementation of the intervention, we must keep in mind that infants are incredibly delicate beings, and require special protections and safety measures to ensure procedures are being conducted in the most ethical manner possible. One must always use the *least restrictive procedures* and means to produce meaningful behavioral change. Behavior analysts can establish observable and measurable criteria together with the parent/caregiver. Based on preliminary assessments of the infant's and parent's/caregiver's behavioral interactions and the surrounding environment, we can design our intervention and establish the criteria for when to initiate and terminate procedures. We must ensure that the infant is content during treatment sessions and have clear criteria for the termination of any procedures (e.g., consistent infant crying or protesting for longer than 30–45 seconds or based on parental level of comfort).

Further, we recommend that behavior intervention procedures be carried out by the parent/caregiver directly, and that interventions be primarily conducted in a parent-training format. Given that infants will spend the majority of their time interacting with their parents and other immediate caregivers, teaching these indirect consumers to implement the various treatment procedures may help ensure generality and maintenance of procedures outside of therapy sessions. As briefly mentioned previously, the use of in vivo BST has been demonstrated to be an effective method for training parents/caregivers to implement behavior-analytic procedures with their infants (Neimy et al. 2017, 2020). The use of telehealth and remote training sessions may also be warranted and applicable when providing services to families in remote locations, to minimize reactivity or any unwanted effects of the therapist's presence, and for the potential conveniences associated with avoiding scheduling conflicts, transportation issues, presence of health-concerns (e.g., illness), and reducing the costs and effort associated with participation (Tsami et al. 2019).

As such, the behavior-analytic interventions selected should primarily focus on the use of reinforcement contingencies provided by the parent/caregiver during social interaction, like the use of *modeling*, *prompting*, *shaping* via *DRA* and/or *DRO*. *Least-to-most* or *most-to-least* methods of prompting are often individualized based on the unique needs of each infant. The use of parent/caregiver modelling is integral for facilitating the acquisition of a myriad of pivotal social skills that are prerequisites for more complex social development (e.g., eye contact, vocalizations, joint attention, naming, manding, social referencing, imitation, play behaviors, and pointing/gesturing – see Fig. 13).

Also, we recommend focusing on the *reduction of problematic behavior* (e.g., excessive crying, avoidant social behaviors, and stereotypic behaviors). Extensive baselines and any periods of prolonged extinction should be avoided and replaced with more naturalistic interactions with parents/caregivers using DRA and DRO

Fig. 13 The outcome of early behavioral interventions is healthy infant social behavior (e.g., eye contact, smiling, vocalizing, pointing, referencing, and playing)

procedures (i.e., reinforcement for replacement and other behaviors) whenever possible. Targeting replacement behaviors is preferable as shown in some of the studies reported earlier in this chapter, where DRO and DRA are typically used instead of extinction. Keep in mind that extinction, time out, and other negative punishment procedures often produce other concomitant undesirable infant behaviors (e.g., anger, frustration, and emotional distress) (Gewirtz and Pelaez-Nogueras 1992).

Taken collectively, the principles of ABA have been effectively used to establish pivotal skills among infants at risk of ASD, developmental disabilities, and other social, emotional, and cognitive behavioral disorders, across a variety of different intervention procedures. While historically mainstream developmental and cognitive psychologists have dominated the literature on interventions, the research by behavior analysts illustrated in this chapter offers a direct application of behavior-analytic principles and intervention methodologies to conceptualize important infant phenomena, like attachment, fear acquisition, language development, joint attention, and social referencing. In this chapter, we have emphasized the importance of early behavioral interventions and evidence-based treatments in addressing critical early social-learning phenomena. We illustrated applications of ABA principles and techniques to establish social skills that are critical precursors and cusps for healthy development, in particular for infants at risk of ASD. The early interventions for infants at risk of ASD we discussed here focus both on the prevention and mitigation of behavioral and social skills deficits in later childhood.

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