Behavioral Development Bulletin
2017, Vol. 22, No. 1, 6–22

1942-0722/17/$12.00 http://dx.doi.org/10.1037/bdb0000046

Infants at Risk of Autism and Developmental Disorders: Establishing Early Social Skills

Hayley Neimy
Shabani Institute—Center for Behavior Analysis and Language Development, Lakewood, California

Martha Pelaez
Florida International University

Jacqueline Carrow
FirstSteps for Kids, Inc., Hermosa Beach, California

Katerina Monlux
Stanford University

Jonathan Tarbox
FirstSteps for Kids, Inc., Hermosa Beach, California

In the present paper we discuss early markers of infants and children at risk of developing autism spectrum disorder (ASD) and other developmental disorders, and review studies that use operant contingencies to shape critical social skills in both typically and atypically developing infants. We emphasize the use of operant learning models to facilitate the early acquisition of infant social skills including eye contact, joint attention, vocal responding, and social referencing. We discuss research that has shown how specific contingencies of reinforcement can be implemented by caregivers to promote the development of their infants' social behaviors. The assumption is that by strengthening these early social repertoires, the severity of subsequent developmental problems can be lessened or mitigated in those infants who are identified as at risk.

Keywords: social skills, infants at risk, early intervention, autism, developmental disorders

Identifying the early markers of emerging autism spectrum disorder (ASD), and other developmental disorders in infants and toddlers has become of increased importance. In the past three decades, psychologists and physicians have been able to diagnose ASD at progressively earlier stages in a child's development, leading to highly effective early intensive behavior intervention programs that target the acquisition of behaviors, the development of language, and social skills deficits.

The core diagnostic criteria of ASD include persistent deficits in social communication and social interaction skills, including impairments in social-emotional reciprocity, reduced sharing of interests, failure to initiate or respond to social interactions, and deficits in nonverbal communication (American Psychiatric Association, 2013).

Currently, the average age of a child receiving an ASD diagnosis is 5 years old, however, deficits in social behaviors have been reported years prior to the child receiving an official diagnosis (e.g., Adrien et al., 1992; Dawson et

Editor's Note. Michael Lamport Commons served as the action editor for this article.—MLC

This article was published Online First January 23, 2017.

Hayley Neimy, Shabani Institute—Center for Behavior Analysis and Language Development, Lakewood, California; Martha Pelaez, Department of Leadership and Professional Studies, Florida International University; Jacqueline Carrow, FirstSteps for Kids, Inc., Hermosa Beach, California; Katerina Monlux, Stanford University; Jonathan Tarbox, FirstSteps for Kids, Inc.

Correspondence concerning this article should be addressed to Hayley Neimy, 4077 Tujunga Avenue #203, Studio City, CA 91604. E-mail: hayleymayneimy@gmail.com

al., 2004; Mitchell et al., 2006; Osterling & Dawson, 1994; Sterling et al., 2008; Talbott, Nelson, & Tager-Flusberg, 2015). Today, ASD can be reliably detected as early as 18 months of age (Baird, Cass, & Slonims, 2003; Baird et al., 2000; Robins et al., 2014), but possible early markers have even been identified at 6–12 months, including: nonresponsiveness to name, lack of spontaneous imitation, infrequent vocalizations and babbling, decreased pointing and showing, infrequent orienting to individual's faces, overfocus and perseveration on objects instead of others, minimal social smiles or facial affect, little-to-no eye contact or visual tracking, no joint attention and social referencing, rigidity and limitations in play and adaptive routines, minimal play and exploratory skills, and increased fussiness and disruptive behavior (Adrien et al., 1992; Baird et al., 2003; Field et al., 2010; Kiaei & Pelaez, 2011; Mitchell et al., 2006; Northrup & Iverson, 2015; Ozonoff et al., 2010, 2014; Patten et al., 2014; Rogers & Pennington, 1991; Young, Merin, Rogers, & Ozonoff, 2009; Zwaigenbaum et al., 2005).

Early detection of social behavioral deficits promotes earlier treatment and potentially improves outcomes for infants at risk, and for those exhibiting early warning signs of ASD and other developmental disorders (Dawson et al., 2012; Eikeseth, Smith, Jahr, & Eldevik, 2007; Eldevik et al., 2009; Howlin, 2003; McEachin, Smith, & Lovaas, 1993; Remington et al., 2007; Rogers & Pennington, 1991; Rogers et al., 2014; Smith, Groen, & Wynn, 2000). Intervening on these early social deficits place practitioners in an advantageous position to develop efficacious proactive treatments that can interrupt maladaptive response patterns while teaching more adaptive foundational repertoires. Early child development specialists have investigated how intervening on the core prerequisites to language and social skills during infancy postpones and/or mitigates the later onset expression of ASD (Rogers & Pennington, 1991; Rogers et al., 2014). They have begun to draw more consistent parallels between the importance of an infant displaying specific pivotal skills early in development, and the likelihood of later obtaining a diagnosis of ASD. Specifically, researchers frequently regard infant behaviors such as eye contact, vocalizations, pointing, joint attention, and social referencing as the hallmark prerequisite skills for developing strong social, cognitive, and language repertoires (e.g., Baron-Cohen et al., 1996; Dawson, 2013; Dawson et al., 2004; Howlin, 2003; Howlin, Mawhood, & Rutter, 2000; Pelaez, 2009; Sigman et al., 1999; Toth, Munson, Meltzoff, & Dawson, 2006; Venter, Lord, & Schopler, 1992). Their assumption is that addressing deficits in social and communication skills early during infancy can potentially decrease the likelihood that an infant will later be diagnosed with ASD, or at least mitigate the severity with which that individual's autism is expressed. From an operant learning perspective, if positive supports can be utilized early (e.g., reinforcement, prompting, shaping) one would hypothesize that an infant at risk of ASD and other developmental disorders could develop more closely along a typical trajectory, reducing the likelihood of later manifesting verbal and social deficits.

Therefore, the purpose of the present discussion is threefold. First, we summarize the literature on risk factors and identify early markers for developing ASD and other behavioral disorders among infants and children. Second, we review the literature on specific social skills consistently regarded during infancy and early childhood as fundamental prerequisites to the development of more complex social and communication skills: eye contact, vocalizations, joint attention, and social referencing. By identifying both the early behavioral markers of at risk infants, and the pivotal social skills necessary for acquiring more complex skills later in childhood, we can subsequently develop caregiver-implemented intervention packages targeting the acquisition of these relative social skill deficits. Third, we discuss the potential utility of empirically supported behavioral interventions and procedures to help both typically and atypically developing children acquire or improve these early social repertoires.

Infants and Children at Risk of Autism and Developmental Disorders

In recent years, research on early markers and precursors of ASD has expanded significantly and correlations have been found between a variety of infant behaviors and later diagnoses of ASD (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Ozonoff et al., 2014). In this section we review environmental behavioral

risk factors and some of the major research findings identifying at risk markers in each year of early child development. Though we acknowledge the significant influence of environmental prenatal and postnatal risk factors (e.g., parental characteristics and maternal diseases, teratogens, poor nutrition, alcohol, tobacco, harmful chemicals, and other environmental hazards), the main focus of this paper is on those observable behaviors of the infant and contingencies provided by the caregiver. The contributions of genetic and inheritable biological predisposition of ASD are well documented, and though the exact causes of ASD are not presently known, research supports the influence of both genetic and environmental systems (e.g., Happé, Ronald, & Plomin, 2006; Ronald, Happé, Price, Baron-Cohen, & Plomin, 2006). Our discussion focuses more specifically on the literature supporting operant methods that can shape early social skills of both typically and atypically developing infants, leaving to other forums the discussion of the genetic and biological determinants (Plomin, DeFries, Knopik, & Neiderhiser, 2016; Plomin, Shakeshaft, McMillan, & Trzaskowski, 2014).

Parental Characteristics

Researchers have investigated the role of various parental characteristics that may contribute to the development of at risk characteristics in infants and children (Field et al., 1998; Hart, Field, del Valle, & Pelaez-Nogueras, 1998; Pelaez, Field, Pickens, & Hart, 2008; Seymour, Giallo, Cooklin, & Dunning, 2015; Waller, Shaw, Forbes, & Hyde, 2015). For example, we know that parental conditions including maternal age, maternal nutrition, mental illness and psychopathology, substance abuse, maternal depression, maternal anxiety, stress, emotional inexpressiveness, negative mood, disengagement, anxious/avoidant interactions, unresponsiveness to infant cues, the authoritarian parenting style of depressed mothers, withdrawn/intrusive responses from parents, noncontingent responding, and other potential misplaced contingencies may influence the development of at risk behaviors (e.g., Bountress, & Chassin, 2015; Brennan, Hammen, Katz, & Le Brocque, 2002; Drash & Tudor, 2004; Field, 1992; Field et al., 1998; Graignic-Philippe et al., 2014; Hart et al., 1998; Jacobson & Jacobson, 2002; Lambert-Brown et al., 2015; Malphurs et al., 1996; Parfitt, Pike, & Ayers, 2013; Pelaez-Nogueras, Field, Cigales, Gonzalez, & Clasky, 1994; Pelaez, Field, et al., 2008; Pelaez, Virues-Ortega, & Gewirtz, 2011a, 2011b; Pelaez, Virues-Ortega, Field, Amir-Kiaei, & Schnerch, 2013; Pelaez, Virues-Ortega, & Gewirtz, 2012; Pelaez-Nogueras & Gewirtz, 1997; Pelaez-Nogueras, Gewirtz, et al., 1996; Seymour et al., 2015).

Our notion is not that parental behavior is the cause of developmental disorders, rather we strive to identify the ways in which the infant's environment can enhance or mitigate the later onset of undesirable developmental outcomes. Our notion is that the behaviors of the mother and child function as concurrent influences on each other and as contexts that support one another (Pelaez, 2002). The mother-child interaction is constantly evolving and depends on the bidirectional behavioral effects of multiple interacting variables (Novak & Pelaez, 2004; Pelaez et al., 2012).

Infant at Risk Characteristics

Early markers: 0–12 months. For decades, parents have reported observations detecting patterns of atypical behavior within the first year of their child's life (Kanner, 1943). Caregiver report and intake documentation aids in the identification of specific risk factors and early markers of ASD and other developmental disorders (Adrien et al., 1992; Osterling & Dawson, 1994; Talbott et al., 2015; Zwaigenbaum et al., 2005). For example, home videos of children with autism and typically developing children at 1 and 2 years of age revealed significantly lower levels of facial recognition, pointing, reaching, eye contact, gaze shifting, and joint attention when compared with typically developing children (Adrien et al., 1992; Osterling & Dawson, 1994; Young et al., 2009). The most indicative predictor of a later diagnosis of ASD has been the child's infrequent initiated "looks" to others (e.g., mother, father; Young et al., 2009). To identify behavioral markers of ASD, longitudinal studies comparing high risk (i.e., siblings of children diagnosed with ASD) and low risk infants have been conducted. These studies reported that infants at risk of developing ASD consistently displayed several atypical responses, including poor eye

contact, lack of visual tracking, disengagement of visual attention, failure to orient to name, minimal imitation skills, low social smiling, overreactivity, lack of social interest, poor affect, and limited expressive and receptive language (Ozonoff et al., 2010; Zwaigenbaum et al., 2005). Approximately 14,000 parents were assessed about their children's early signs and precursors of ASD through a 30-month period. Among the children later diagnosed with ASD when compared with those who did not receive a diagnosis, they found differences in the children's frequency of social initiations, variety of play skills, eye contact, exploratory behavior, and language development as early as 6 months of age. These early behavioral differences have been associated with the core diagnostic criteria of ASD, consisting of social, communicative, and play deficits (Bolton, Golding, Emond, & Steer, 2012).

A large body of literature shows that children with ASD consistently exhibit delays in early social behaviors that are necessary for typical language development. Specifically, infrequent vocalizations and babbling, decreased pointing and showing, infrequent orienting to individual's faces, stimulus over selectivity, perseveration on objects instead of others, minimal social smiles or facial affect, little-to-no eye contact or visual tracking, rigidity and limitations in adaptive routines, minimal play and exploratory skills, and increased fussiness and disruptive behavior can all be identified within the first year of life (Adrien et al., 1992; Baird et al., 2003; Bolton et al., 2012; Golarai, Grill-Spector, & Reiss, 2006; Lovaas, Koegel, & Schreibman, 1979; Osterling & Dawson, 1994; Ozonoff et al., 2014; Zwaigenbaum et al., 2005).

Early markers: 12–36 months. Children diagnosed with ASD tend to exhibit a significant decrease in developmental progress between the ages of 1 and 2 years (Landa & Garrett-Mayer, 2006; MacDonald, Parry-Cruwys, Dupere, & Ahearn, 2014). Specifically, typically developing children show a steady increase in skill acquisition, where at risk children have a much slower acquisition-rate trajectory (Ozonoff et al., 2014). As infants at risk of autism continue to grow physically, the discrepancy in their development as compared with typically developing children continues to increase and becomes more profound. To illustrate, Landa and Garrett-Mayer (2006) compared at risk infants (i.e., siblings of children with autism) with low risk infants by analyzing five scales including: (a) gross motor, (b) visual reception, (c) fine motor, (d) receptive language, and (e) expressive language. At 6 months, they found no significant differences between the two groups. However, at 14 months old, the differences between the two groups across all scales except for visual reception (i.e., perception abilities) were more salient. At 24 months, these delays persisted with differences in visual reception. Notably, the largest differences between the two groups were found in their communication skills (Landa & Garrett-Mayer, 2006).

More recently, Mayo, Chlebowski, Fein, & Eigsti (2013) retrospectively screened 119 children between 16 and 30 months who later developed ASD. Their measures included the Autism Diagnostic Observation Schedule (Lord et al., 2000; Lord, Rutter, DiLavore, & Risi, 2002), the Modified Checklist for Autism in Toddlers (Robins et al., 2014), and the Mullen Scales (Mullen, 1997), as well as the age the infant emitted their first words. Although acquiring language by age 5 is a strong indicator of later positive developmental outcomes with individuals with ASD, acquiring useful language by 24 months of age was the strongest indicator of positive developmental trajectories (Mayo et al., 2013).

In general, at risk infants may display a variety of delays in the areas of social and communication skill development. Moreover, these identified behavioral characteristics include prerequisite skills that aid in the acquisition of later foundational social and communicative behaviors. The early social indicators of developmental delays consist of: minimum eye contact, facial recognition, visual tracking, delayed joint attention, limited social initiations with caregivers, infrequent smiles, difficulty attending to stimuli, and limited exploratory motor behaviors (Lambert-Brown et al., 2015; Lord, 2015; Ozonoff et al., 2014; Pelaez & Novak, 2013; Pelaez et al., 2011a, 2011b, 2012; Rogers & Pennington, 1991; Rogers et al., 2014; Toth et al., 2006). Next, we discuss how operant-learning paradigms can offer effective tools for researchers in understanding the development of early social behavior.

Infant Operant Learning

Research has shown that early social learning begins once the newborn is exposed to the physical environment and begins to interact with the multitude of stimuli through sensory systems (i.e., seeing, hearing, smelling, tasting, and feeling; Lipsitt, 1967; May, Byers-Heinlein, Gervain, & Werker, 2011; Novak & Pelaez, 2004; Werner & Siqueland, 1978). An abundant amount of literature supports the finding that early intensive behavioral intervention can subsequently promote significant gains in cognitive, language, and social development (Dawson et al., 2012; Eikeseth et al., 2007; Eldevik et al., 2009; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005; Howard, Stanislaw, Green, Sparkman, & Cohen, 2014; Howlin, 2003; Lovaas, 1977; MacDonald et al., 2014; McEachin et al., 1993; Remington et al., 2007; Rogers & Pennington, 1991; Rogers et al., 2014). Since the 1970s, it has become increasingly more apparent that applied behavior analysis is an effective tool for significantly changing and improving behavior among children with ASD (Lovaas, 1977). By manipulating operant contingencies and through careful functional analysis, desired behavior change can occur. At the basis of applied behavior analysis is the notion that social behaviors can be under control of the stimuli that precede and follow it. In the decades since the initial Lovaas study (Lovaas, 1977), scientific advances have demonstrated that operant conditioning can be used effectively with infants as young as a couple of hours old (DeCasper & Fifer, 1980, DeCasper & Spence, 1986). In controlled settings, careful manipulations of contingencies have produced meaningful operant behavior change in infants such as: head lifting and turning, 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, crying, referencing, and imitating (Gewirtz & Peláez-Nogueras, 1991, 1992; Novak & Pelaez, 2004; Pelaez et al., 2011b, 2012; Pelaez-Nogueras & Gewirtz, 1997). A common outcome across most of these studies is that gains in the infant target behavior occurred as a function of the contingent presentation of reinforcing stimuli provided by the caregiver.

Identifying naturally occurring social reinforcers in the environment can be useful in promoting behavior change among infants (Drash & Tudor, 2004; Higbee & Pelaez-Nogueras, 1998; Schlinger, 1995). When researchers and clinicians identify both the factors that place an infant at risk and the relevant environmental antecedents and consequence conditions influencing the infant's behavior, treatment can be very effective at both a reactive and preventative level.

The development of early communication responses and language deficits have also been examined from a behavior analytic perspective. For example, according to Drash and Tudor (2004) the development of ASD can also be viewed as a series of displaced contingencies of verbal and social emotional behaviors that occur within the initial three years of life (Drash & Tudor, 2004). If a lack of verbal behavior among infants may be partially due to misplaced reinforcement contingencies, then teaching parents behavioral strategies to evoke and maintain verbal responses effectively should aid in increasing that child's verbal repertoire. Increasing the infant's foundational skill set increases that child's potential for developing more complex verbal and language skills in later childhood (Pelaez & Novak, 2013; Williams, & Garbarini, 2015).

Results of existing research on at risk behavior characteristics has demonstrated that social and language skills in infancy and early childhood are critical prerequisites for acquiring more complex repertoires (Benasich & Tallal, 2002; Dawson et al., 2004; Dawson, 2013; Falk, 2004; Northrup & Iverson, 2015; Novak & Pelaez, 2004; Oller, Eilers, Neal, & Cobo-Lewis, 1998; Oller, Eilers, Neal, & Schwartz, 1999; Toth et al., 2006). The research has also delineated that specific types of social and language skills deficits are consistently observed among children with ASD, thus pointing to the potential for researchers and practitioners to train those pivotal skills during infancy and early childhood.

In sum, operant conditioning and behavioral principles have provided an empirically validated model for demonstrating the learned basis of early infant social skills (Gewirtz & Peláez-Nogueras, 1992; Pelaez et al., 2011a, 2011b, 2012). In our present analysis, we identify behavioral cusps that involve prerequisite skills

for learning more complex language and social behaviors Specifically, in the following section we focus on those pivotal social skills that are necessary for typical development and that, when missing, they become early markers for ASD and developmental disorders. We show how operant procedures have been used effectively to promote them. These skills, discussed in the remainder of the paper, include: eye contact, vocalizations, joint attention, and social referencing (Bruinsma, Koegel, & Koegel, 2004; Dawson et al., 2004; Pelaez & Novak, 2013; Toth et al., 2006).

Establishing Pivotal Infant Social Skills

Vocalizations

Early infant preverbal vocalizations are precursors to the later onset development and emergence of language in childhood (Benasich & Tallal, 2002; Falk, 2004; Oller et al., 1998; Oller et al., 1999). Behavioral research emphasizes the role of maternal vocal stimulation in facilitating the development of language in typically developing children. Often in the natural environment, caregivers initiate and respond to their infant's vocalizations with either: (a) imitative sounds (i.e., vocal imitation), or (b) words or short sentences delivered with a high pitch and forced intonation (i.e., motherese speech; Brand, Baldwin, & Ashburn, 2002; Fernald, 1985). Vocal imitation has been frequently referenced in the early literature as a way to facilitate language acquisition in atypically developing young children, suggesting that the acquisition of varied functional speech is potentially mediated by strengthening generalized vocal imitation skills (Baer & Deguchi, 1985; Guess, Sailor, & Baer, 1976; Lovaas, 1977; Risley & Wolf, 1967). Imitation deficits have long been considered a "universal" characteristic of young children with autism (Field et al., 2010; Rogers & Pennington, 1991). The development of vocal imitation may be enhanced by parental contingent imitation of the child's vocalizations (Masur & Olson, 2008; Pelaez et al., 2011a, 2011b; Poulson, Kymissis, Reeve, Andreatos, & Reeve, 1991).

Behaviorists assert that early vocalizations, among typically and atypically developing infants, can potentially be increased by directly manipulating contingencies in the environment, such as various forms of social reinforcement (Masur & Olson, 2008; Pelaez et al., 2011a, 2011b; Rheingold, Gewirtz, & Ross, 1959). Researchers continue to focus on identifying and understanding these environmental social variables and social reinforcers that promote increased preverbal language during parent face-to-face interaction (Franklin et al., 2014; Koegel, Singh, Koegel, Hollingsworth, & Bradshaw, 2014). Specifically the social contingencies that aid in increasing infant vocalizations include: (a) touch and physical stimulation (Gewirtz, & Pelaez-Nogueras, 2000; Jean, Stack, & Arnold, 2014; Pelaez-Nogueras et al., 1997; Peláez-Nogueras, Field, Hossain, & Pickens, 1996), (b) motherese and infant-directed speech (Bendixen & Pelaez, 2010; Pelaez et al., 2011a, 2011b), and (c) maternal vocal imitation (Masur & Olson, 2008; Pelaez et al., 2011a, 2011b; Poulson, 1984; Poulson et al., 1991). In what follows we describe some of the experimental manipulations that utilize forms of social reinforcement to increase the emission of infant vocalizations.

We report here a recent replication and an extension of Pelaez and colleagues (2011a). We utilized similar methodology to contrast the effects of contingent and noncontingent motherese and vocal imitation using a parent-training model with a typically developing infant (female; 11 months old). During treatment sessions, contingent on the emission of target infant vocalizations, the caregiver was instructed to either: (a) provide a motherese-type statement directed toward their infant, or (b) vocally imitate the infant emitted vocalizations. We used a noncontingent control condition (yoked reinforcement schedule) to confirm the efficacy of both forms of treatment as a type of contingent social reinforcement. Results (Figure 1.) illustrate the cumulative number of vocalizations emitted across all conditions and thus far suggest that contingent vocal imitation is the most effective social reinforcer for increasing the overall frequency of vocalizations, when compared with baseline and other treatment and control conditions.

Taking all the studies together, one can conclude that specific forms of social reinforcement (e.g., contingent vocal imitation and motherese speech) can be manipulated, as part of a social-reinforcement operant learning paradigm, to maximize the acquisition of preverbal skills in

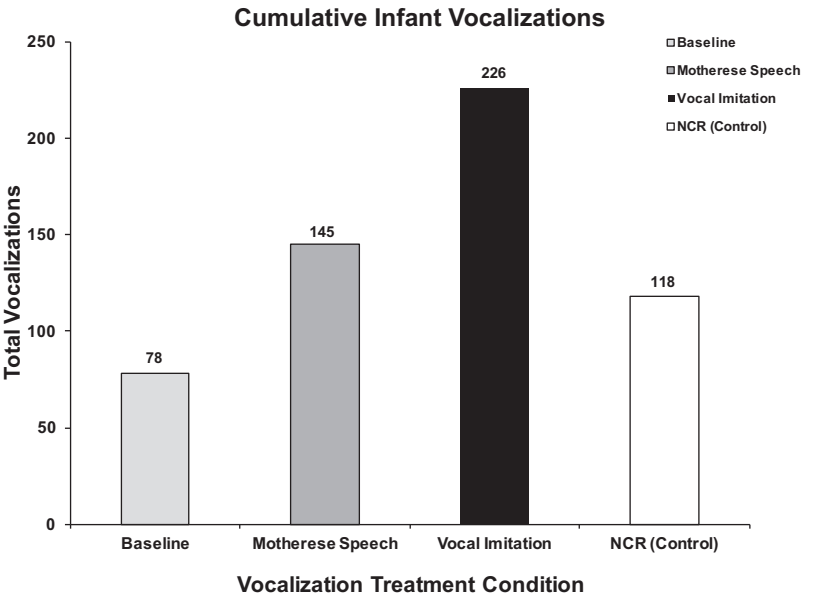

Figure 1. Infant vocalization graph illustrating cumulative number of vocalizations emitted by a typically developing infant (female; 11 months old) across aggregated treatment sessions: (a) baseline, (b) contingent motherese speech, (c) contingent vocal imitation, and (d) noncontingent motherese speech and vocalizations.

both typically, and atypically, developing infants and children.

In sum, considering that the majority of an infant's social opportunities are spent interacting with their caregivers, systematic parent-training procedures that focus on these specific forms of contingent vocal stimulation may: (a) increase the rate of vocalizations in their infants; (b) provide bolstering effects for preventing the later onset of various behavioral, social, emotional, and language disorders, including possibly the severity of ASD; and (c) ultimately facilitate the development of more complex language in later childhood.

Eye Contact

Eye contact is one of the earliest and most rudimentary behaviors an infant acquires, and is crucial for the development of skills required to build social communicative behaviors (e.g., joint attention and social referencing). Among infants at risk of ASD, poor eye contact is consistently among the hallmark features later associated with a formal diagnosis (Baird et al., 2003; Jones, & Klin, 2013). Specifically, research has found that children with ASD tend to orient to the mouth region over another individual's eyes (Klin & Jones, 2008; Klin, Shultz, & Jones, 2015), as well as orient to nonsocial stimuli in the environment that may compete for discriminated attention with the social stimuli (e.g., toys, plants, clocks; Lohaus et al., 2006; Sasson & Touchstone, 2014). A consistent environment plays a critical role in learning and developing social behaviors and therefore the role of environmental contingencies is integral to the development of eye contact among both typically and atypically developing children.

Parental use of positive reinforcement in the form of touch, emotional expressions, motherese speech, and contingent vocal imitation and infant-directed speech has been used to promote eye contact in typically developing infants (Kaplan, Sliter, & Burgess, 2007; Pelaez et al., 2011a, 2012). For example, Pelaez, Gewirtz, and colleagues (1996) developed a synchronized reinforcement procedure, consisting of simultaneous motherese speech (e.g., verbal praise), smiling, and gentle touch. They compared synchronized reinforcement, with and

without touch, to increase eye contact among typically developing infants. Findings suggested that the addition of touch served as an effective reinforcer to increase eye contact and positive affect in typically developing infants. (Pelaez-Nogueras, Gewirtz, et al., 1996). Further, in an earlier study, Pelaez-Nogueras, Gewirtz, and colleagues (1996), found that physical touch serves as a powerful reinforcer for increasing eye contact among infants with depressed mothers (Peláez-Nogueras, Field, et al., 1996). Compared with infants of nondepressed mothers, they found that infants of depressed mothers made more consistent eye contact following the introduction of touch during sessions. The evidence is that a synchronized reinforcement procedure that includes gentle touching, smiling, and cooing to the infant while he or she is making eye contact can aid in teaching infants socially significant behaviors.

Pilot data for the replication and extension of Pelaez-Nogueras, Gewirtz, and colleagues (1996) study with a typically developing infant (female; 4 months old) are depicted in Figure 2, and indicate the efficacy of an operant contingency paradigm for acquiring increased eye contact of an infant during face-to-face caregiver interactions. Specifically, a form of behavioral skills training (BST; Parsons, Rollyson, & Reid, 2012) was used to teach caregivers how to provide forms of synchronous reinforcement contingent on infant-initiated and sustained eye contact with the caregiver in the natural home environment. Using an ABAB-withdrawal design, our preliminary results suggest that contingent synchronous reinforcement increases infant eye contact, and is an effective social reinforcer for establishing and maintaining increased durations of appropriate eye contact.

Joint Attention

Joint attention is commonly defined as one's ability to use eye contact and gestures to both initiate and respond to bids of sharing objects

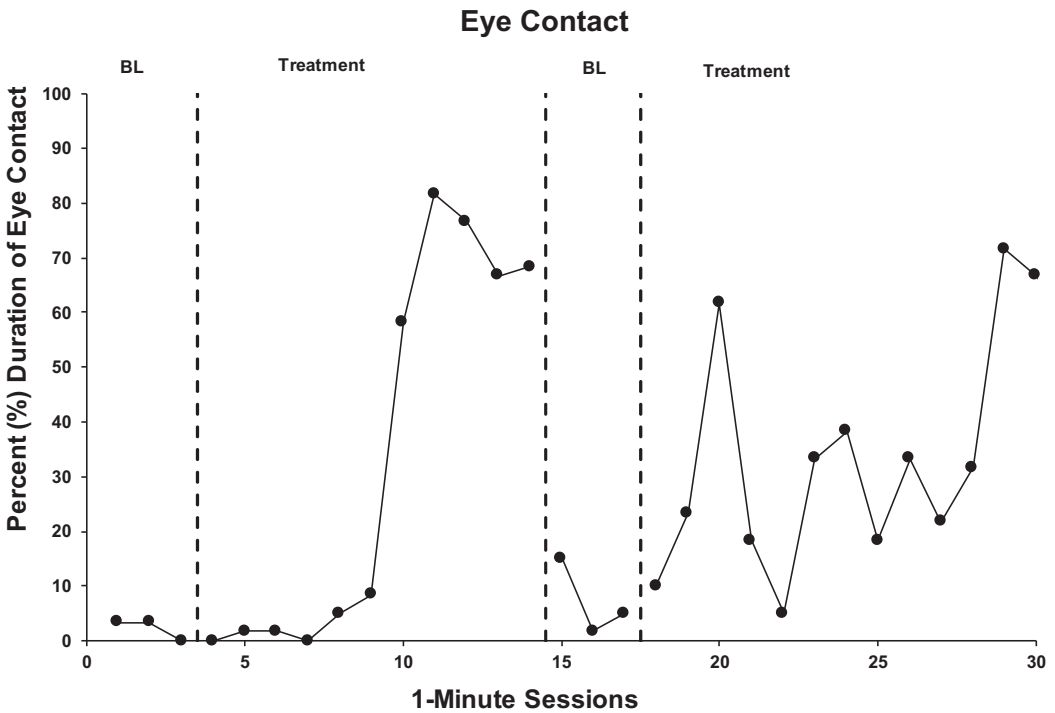

Figure 2. Eye contact graph illustrating overall percentage of a typically developing infant's (female; 4 months old) time spent engaged in eye contact with caregiver. Treatment procedures included the use of contingent synchronous reinforcement from caregiver as a social reinforcer for sustained eye contact during a 1-min face-to-face interaction.

and/or experiences with other individuals socially (Carpenter, Nagelle, Tomasello, Butterworth, & Moore, 1998; Mundy, 1995; Morales et al., 2000; Sigman & Kasari, 1995). Instances of joint attention provide the foundation for an infant's knowledge about the social and nonsocial world, and help establish early preverbal and communication skills between the child and their caregiver (Adamson, Bakeman, Deckner, & Romski, 2009; Holth, 2005; Isaksen & Holth, 2009; Morales et al., 2000; Sigman & Kasari, 1995; Toth et al., 2006). In the past three decades, researchers have reported that infants with ASD, language disorders, and other developmental delays display either impairments or an overall absence in joint attending skills from an early age (Lewy & Dawson, 1992; McArthur & Adamson, 1996; Morales et al., 2000; Mundy, 1995; Mundy et al., 2007; Mundy, Sigman, & Kasari, 1994; Sigman, Mundy, Sherman, & Ungerer, 1986). Understanding how joint attention skills develop throughout the course of childhood could potentially provide insight toward developing effective prevention and treatment.

Functional analyses and behavioral strategies, such as differential reinforcement, shaping, and prompting within joint attention training (i.e., teaching a chain of behaviors consisting of attending to another person's gestures and/or vocalizations, another stimulus, and then shifting gaze back to the person) have been effective with both typically and atypically developing children. Joint attention procedures have been examined among children with ASD by systematically teaching initiations and responses to bids for attention (Whalen & Schreibman, 2003). Further, Taylor and Hoch (2008) examined joint attention skills in three young children with ASD and found that when treatment included the use of systematic prompting, adult visual indicators, and socially mediated reinforcement (e.g., social interaction), all three children were able to respond to the caregiver's bids for joint attention and make accompanying comments (Taylor & Hoch, 2008). Additionally, when other behavioral components were included to treatment, like conditioned social contingencies and modeling procedures, children with autism were able to both initiate and respond to bids for joint attention (Isaksen & Holth, 2009). Finally, the use of contingency analyses for identifying the specific reinforcing consequences associated with joint attention skills were evaluated (e.g., adult-generated reinforcers, adult assistance during play, and adult facial expressions (Dube, MacDonald, Mansfield, Holcomb, & Ahearn, 2004; Macdonald et al., 2006). Overall findings illustrate the appropriate integration of behavior analytic concepts (e.g., functional analyses) in identifying the discriminative and reinforcing functions of specific classes of relevant stimuli within the joint attention training paradigm. These studies demonstrate the efficacy of utilizing an operant-based approach for teaching joint attention skills to both typically and atypically developing children.

Social Referencing

Joint attention serves as a precursor to a variety of social behaviors, most notably social referencing (Cornew, Dobkins, Akshoomoff, McCleery, & Carver, 2012; Dube et al., 2004; Holth, 2005; Schlinger, 1995). However, though joint attention and social referencing are similarly comprised of gaze shifting and infant attending responses, it is the discrimination of the relevant social stimuli (i.e., caregiver facial expressions as cues) that serves as a fundamental component in understanding referencing as a more complex social skills during infancy (Pelaez et al., 2013). Behaviorally, social referencing has been argued to be a form of discriminative learning shaped during early mother-child interactions. In the context of ambiguity, the infant references the mother's cues (typically her facial expressions) to determine how to behave in the unknown context; the learning of infant social referencing has been established via conditional discrimination (Gewirtz & Peláez-Nogueras, 1992; Pelaez et al., 2012, 2013). During a referencing episode, an ambiguous object signals the eye gaze shift of an infant toward another person, whose facial, vocal, and gestural cues may then signal a subsequent infant response (Pelaez, 2012).

Operant methodology, in the development of social referencing, has been examined extensively between caregivers (typically mothers) and their infants and young children (Brim, Townsend, DeQuinzio, & Poulson, 2009; DeQuinzio, Poulson, Buffington Townsend, & Taylor, 2015; Gewirtz & Peláez-Nogueras, 1992; Pelaez, 2009; Pelaez et al., 2012, 2013).

Pelaez (2013) has argued that there is a social-emotional component to this skill, evidenced by the second partner in the dyad responding to the stimulus. As such, parental characteristics and infant temperament can also influence the delivery of social referencing. Pelaez and colleagues (2013) evaluated infant-parent dyads of depressed mothers and their infants. Infants as young as one year of age demonstrated limited social referencing skills toward their depressed parent's facial expressions and vocalizations. Through a brief operant learning paradigm, parents were able to increase the frequency of their infant's correct responding to positive and negative demonstrations of social referencing (i.e., reaching toward stimuli that were preceded by positive facial affect, and absence of approaching stimuli preceded by fearful facial affect) (Pelaez et al., 2013).

Our pilot data for the replication and extension of Pelaez and colleagues' (2012, 2013) studies with a typically developing infant are depicted in Figure 3. Specifically, we taught a caregiver to implement procedures similar to those used by Pelaez (2009) using BST (Parsons et al., 2012) in the natural environment. Overall, our participant (female; 1 year 11 months old) showed mastery and successful generalization of the referencing skill across treatment environments as compared to baseline levels for both positive and negative facial affect cues. Treatment procedures required various modifications to ensure caregiver fidelity (e.g., decrease inadvertent prompting of particular elements of the social referencing episode), and lead to minor changes to individualize the protocol to the participant's needs and acquisition style.

Conclusion

In this paper we have illustrated various empirically supported procedures, and discussed how operant-learning paradigms can facilitate the ac-

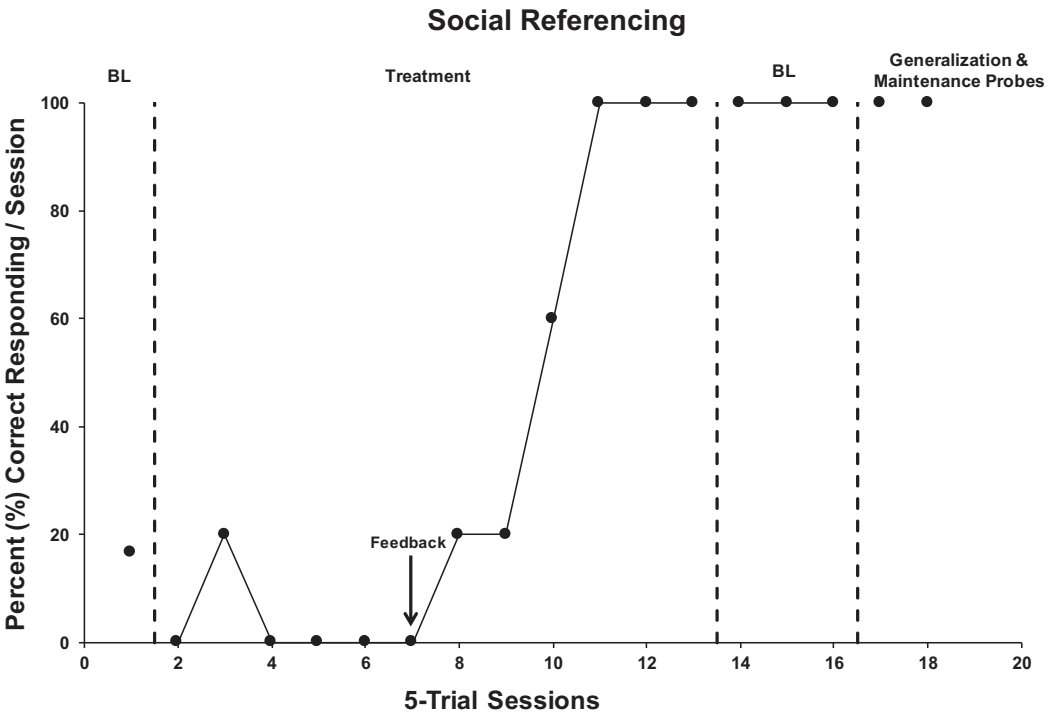

Figure 3. Social referencing graph illustrating accuracy in a typically developing child's (female; 1 year, 11 months old) approaching responses to ambiguous stimuli based on referencing caregiver's facial expressions, combined across (a) positive trials, and (b) negative trials. Treatment included the use of delayed prompting, blocking, redirection, and differential reinforcement for correct responding. Generalization probes were targeted in noninstructional settings.

quisition of eye contact, vocalizations, joint attention, and social referencing among both typically developing children and infants and children at risk for the development of ASD and other developmental disorders. From a behavioral and learning theory perspective, addressing the environmental variables and contingencies that influence a child's propensity to be at risk during infancy provides both a pragmatic and optimistic approach to effective treatment. When considering the increasing rates of ASD diagnoses worldwide, intervening on the precursor deficits that appear early during infancy can potentially: (a) decrease the likelihood that an infant will subsequently receive a diagnosis of ASD or another developmental disorder, (b) mitigate the severity of undesirable behavioral characteristics expressed in a given child, and (c) strengthen the early social and language repertoires of that infant. We provided behavioral models that show how infant social skills emerge and how we as behavior analysts can enable parents and caregivers to promote these skills systematically in their own natural environment.

An operant approach to the development of early infant social skills can possibly prevent faulty notions of reification, or, in other words, avoid using circular logic to explain why or why not an infant is engaging in a given skill (Pelaez, 2002; Pelaez-Nogueras, 1992; Schlinger, 1995). Our assumption is that when caregivers know how to closely "tune in" to their own behavior, their infant's behavior, and the environmental variables they control, they may be more likely to try the interventions discussed. Though the expression of various developmental disorders such as ASD are highly influenced by genetics and biological environmental factors, we emphasize that the transactional relationship between an infant and his or her learning environment can be effectively manipulated. And we conclude that the examination of specific contingencies that routinely occur between caregiver and infant can lead us to make positive changes in our interventions designed to teach infants early social skills.

Our current program of research was established to implement the operant learning principles and techniques reported in the literature. As part of our early intervention program with infants at risk of ASD and other developmental disorders, we are presently replicating and expanding findings obtained by previous researchers with respect to the pivotal social skills that include eye contact, vocalizations, joint attention, and social referencing skills. Our plan is to also include in our research program the infant development of tacts, mands, and early forms of imitation. We conduct research using single subject methodology designs in order to identify how behavioral procedures that involve caregiver's cues and contingencies can best be used to improve the development of these social and communication skills at the individual level. Our goal is to develop a comprehensive treatment package that uses combinations of various behavioral procedures, while designing protocols that are customizable without compromising treatment integrity to meet the unique developmental characteristics and needs of a given infant at risk or toddler diagnosed with ASD. Research will then need to proceed to longer-term, outcome-level analyses that evaluate how such treatment packages affect the developmental trajectories of atrisk infants into early and school-age childhood. Considering that the research and procedures reported here seem to be effective in the acquisition and/or maintenance of early infant social skills (e.g., eye contact, vocalizations, joint attention, and social referencing), and potentially lessen the likelihood that an infant develops along an atypical trajectory, we recommend dissemination and further research in the domains of operant approaches to intervening on early markers of infants at risk of ASD and other developmental disorders.

References

Adamson, L. B., Bakeman, R., Deckner, D. F., & Romski, M. (2009). Joint engagement and the emergence of language in children with autism and Down syndrome. *Journal of Autism and Developmental Disorders, 39,* 84–96. http://dx.doi.org/10.1007/s10803-008-0601-7

Adrien, J. L., Perrot, A., Sauvage, D., Leddet, I., Larmande, C., Hameury, L., & Barthelemy, C. (1992). Early symptoms in autism from family home movies. Evaluation and comparison between 1st and 2nd year of life using I. B. S. E. scale. *Acta Paedopsychiatrica: International Journal of Child & Adolescent Psychiatry, 55,* 71–75.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed., pp. 50–59). Arlington, VA: Author.

Baer, D. M., & Deguchi, H. (1985). Generalized imitation from a radical-behavioral viewpoint. In S. Reiss & R. R. Bootzin (Eds.), *Theoretical issues in behavior therapy* (pp. 179–217). New York, NY: Academic Press.

Baird, G., Cass, H., & Slonims, V. (2003). Diagnosis of autism. *British Medical Journal, 327,* 488–493. http://dx.doi.org/10.1136/bmj.327.7413.488

Baird, G., Charman, T., Baron-Cohen, S., Cox, A., Swettenham, J., Wheelwright, S., & Drew, A. (2000). A screening instrument for autism at 18 months of age: A 6-year follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry, 39,* 694–702. http://dx.doi.org/10.1097/00004583-200006000-00007

Baron-Cohen, S., Cox, A., Baird, G., Swettenham, J., Nightingale, N., Morgan, K., . . . Charman, T. (1996). Psychological markers in the detection of autism in infancy in a large population. *The British Journal of Psychiatry, 168,* 158–163. http://dx.doi.org/10.1192/bjp.168.2.158

Benasich, A. A., & Tallal, P. (2002). Infant discrimination of rapid auditory cues predicts later language impairment. *Behavioural Brain Research, 136,* 31–49. http://dx.doi.org/10.1016/S0166-4328(02)00098-0

Bendixen, M. I., & Pelaez, M. (2010). Effects of contingent maternal imitation vs. contingent motherese speech on infant canonical babbling. In M. S. Plathotnik, S. M. Nielsen, & D. M. Pane (Eds.), *Proceedings of the Ninth Annual College of Education & G. S. N. Research Conference* (pp. 2–6). Miami, FL: Florida International University.

Bolton, P. F., Golding, J., Emond, A., & Steer, C. D. (2012). Autism spectrum disorder and autistic traits in the Avon Longitudinal Study of Parents and Children: Precursors and early signs. *Journal of the American Academy of Child & Adolescent Psychiatry, 51,* 249–260.e25. http://dx.doi.org/10.1016/j.jaac.2011.12.009

Bountress, K., & Chassin, L. (2015). Risk for behavior problems in children of parents with substance use disorders. *American Journal of Orthopsychiatry, 85,* 275–286. http://dx.doi.org/10.1037/ort0000063

Brand, R., Baldwin, D., & Ashburn, L. (2002). Evidence for 'motionese': Modifications in mothers' infant-directed action. *Developmental Science, 5,* 72–83. http://dx.doi.org/10.1111/1467-7687.00211

Brennan, P. A., Hammen, C., Katz, A. R., & Le Brocque, R. M. (2002). Maternal depression, paternal psychopathology, and adolescent diagnostic outcomes. *Journal of Consulting and Clinical Psychology, 70,* 1075–1085. http://dx.doi.org/10.1037/0022-006X.70.5.1075

Brim, D., Townsend, D., DeQuinzio, J. A., & Poulson, C. (2009). Analysis of social referencing skills among children with autism. *Research in Autism Spectrum Disorders, 3,* 942–958. http://dx.doi.org/10.1016/j.rasd.2009.04.004

Bruinsma, Y., Koegel, R. L., & Koegel, L. K. (2004). Joint attention and children with autism: A review of the literature. *Mental Retardation and Developmental Disabilities Research Reviews, 10,* 169–175. http://dx.doi.org/10.1002/mrdd.20036

Carpenter, M., Nagell, K., Tomasello, M., Butterworth, G., & Moore, C. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63,* 1–143. http://dx.doi.org/10.2307/1166214

Cornew, L., Dobkins, K. R., Akshoomoff, N., McCleery, J. P., & Carver, L. J. (2012). Atypical social referencing in infant siblings of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42,* 2611–2621. http://dx.doi.org/10.1007/s10803-012-1518-8

Dawson, G. (2013). Early intensive behavioral intervention appears beneficial for young children with autism spectrum disorders. *The Journal of Pediatrics, 162,* 1080–1081. http://dx.doi.org/10.1016/j.jpeds.2013.02.049

Dawson, G., Jones, E. J., Merkle, K., Venema, K., Lowy, R., Faja, S., . . . Webb, S. J. (2012). Early behavioral intervention is associated with normalized brain activity in young children with autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 51,* 1150–1159. http://dx.doi.org/10.1016/j.jaac.2012.08.018

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28,* 479–485. http://dx.doi.org/10.1023/A:1026043926488

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology, 40,* 271–283. http://dx.doi.org/10.1037/0012-1649.40.2.271

DeCasper, A. J., & Fifer, W. P. (1980). Of human bonding: Newborns prefer their mothers' voices. *Science, 208,* 1174–1176. http://dx.doi.org/10.1126/science.7375928

DeCasper, A. J., & Spence, M. J. (1986). Prenatal maternal speech influences newborns' perception of speech sounds. *Infant Behavior & Development, 9,* 133–150. http://dx.doi.org/10.1016/0163-6383(86)90025-1

DeQuinzio, J. A., Poulson, C., Buffington Townsend, D., & Taylor, B. (2015). Social referencing and children with autism. *The Behavior Analyst, 39,* 1–13.

Drash, P. W., & Tudor, R. M. (2004). An analysis of autism as a contingency-shaped disorder of verbal behavior. *Analysis of Verbal Behavior, 20,* 5–23.

Dube, W. V., Macdonald, R. P., Mansfield, R. C., Holcomb, W. L., & Ahearn, W. H. (2004). Toward a behavioral analysis of joint attention. *The Behavior Analyst, 27,* 197–207.

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. http://dx.doi.org/10.1177/0145445506291396

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. http://dx.doi.org/10.1080/15374410902851739

Falk, D. (2004). Prelinguistic evolution in early hominins: Whence motherese? *Behavioral and Brain Sciences, 27,* 491–503. http://dx.doi.org/10.1017/S0140525X04000111

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior & Development, 8,* 181–195. http://dx.doi.org/10.1016/S0163-6383(85)80005-9

Field, T. (1992). Infants of depressed mothers. *Development and Psychopathology, 4,* 49–66. http://dx.doi.org/10.1017/S0954579400005551

Field, T., Nadel, J., Diego, M., Hernandez-Reif, M., Russo, K., Vchulek, D., . . . Siddalingappa, V. (2010). Children with autism are more imitative with an imitative adult than with their parents. *Early Child Development and Care, 180,* 513–518. http://dx.doi.org/10.1080/03004430802090570

Field, T. M., Scafidi, F., Pickens, J., Prodromidis, M., Pelaez-Nogueras, M., Torquati, J., . . . Kuhn, C. (1998). Polydrug-using adolescent mothers and their infants receiving early intervention. *Adolescence, 33,* 117–143.

Franklin, B., Warlaumont, A. S., Messinger, D., Bene, E., Nathani Iyer, S., Lee, C. C., . . . Oller, D. K. (2014). Effects of parental interaction on infant vocalization rate, variability, and vocal type. *Language Learning and Development, 10,* 279–296. http://dx.doi.org/10.1080/15475441.2013.849176

Gewirtz, J. L., & Peláez-Nogueras, M. (1991). The attachment metaphor and the conditioning of infant separation protests. In J. L. Gewirtz & W. M. Kurtines (Eds.), *Intersections with attachment* (pp. 123–144). Hillsdale, NJ: Erlbaum.

Gewirtz, J. L., & Peláez-Nogueras, M. (1992). Social referencing as a learned process. In S. Feinman (Ed.), *Social referencing and the social construction of reality in infancy* (pp. 151–173). New York, NY: Plenum Press. http://dx.doi.org/10.1007/978-1-4899-2462-9_7

Gewirtz, J. L., & Pelaez-Nogueras, M. (2000). Infant emotions under the positive-reinforcer control of caregiver attention and touch. In J. C. Leslie & D. Blackman (Eds.), *Issues in experimental and applied analyses of human behavior* (pp. 271–291). Reno, NV: Context Press.

Golarai, G., Grill-Spector, K., & Reiss, A. L. (2006). Autism and the development of face processing. *Clinical Neuroscience Research, 6,* 145–160. http://dx.doi.org/10.1016/j.cnr.2006.08.001

Graignic-Philippe, R., Dayan, J., Chokron, S., Jacquet, A. Y., & Tordjman, S. (2014). Effects of prenatal stress on fetal and child development: A critical literature review. *Neuroscience and Biobehavioral Reviews, 43,* 137–162. http://dx.doi.org/10.1016/j.neubiorev.2014.03.022

Guess, D., Sailor, W., & Baer, D. (1976). *Functional speech and language training for the severely handicapped*. Austin, TX: Pro-Ed.

Happé, F., Ronald, A., & Plomin, R. (2006). Time to give up on a single explanation for autism. *Nature Neuroscience, 9,* 1218–1220. http://dx.doi.org/10.1038/nn1770

Hart, S., Field, T., del Valle, C., & Pelaez-Nogueras, M. (1998). Depressed mothers' interactions with their one-year-old infants. *Infant Behavior & Development, 21,* 519–525. http://dx.doi.org/10.1016/S0163-6383(98)90024-8

Higbee, T. S., & Pelaez-Nogueras, M. (1998). Reinforcer identification in infants. *Behavioral Development Bulletin, 7,* 10–14. http://dx.doi.org/10.1037/h0100519

Holth, P. (2005). An operant analysis of joint attention skills. *Journal of Early and Intensive Behavior Intervention, 2,* 160–175. http://dx.doi.org/10.1037/h0100311

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. http://dx.doi.org/10.1016/j.ridd.2004.09.005

Howard, J. S., Stanislaw, H., Green, G., Sparkman, C. R., & Cohen, H. G. (2014). Comparison of behavior analytic and eclectic early interventions for young children with autism after three years. *Research in Developmental Disabilities, 35,* 3326–3344. http://dx.doi.org/10.1016/j.ridd.2014.08.021

Howlin, P. (2003). Can early interventions alter the course of autism? *Novartis Foundation Symposium, 251,* 250–259.

Howlin, P., Mawhood, L., & Rutter, M. (2000). Autism and developmental receptive language disorder—A follow-up comparison in early adult life. II: Social, behavioural, and psychiatric outcomes. *Journal of Child Psychology and Psychiatry, 41,* 561–578. http://dx.doi.org/10.1111/1469-7610.00643

Isaksen, J., & Holth, P. (2009). An operant approach to teaching joint attention skills to children with autism. *Behavioral Interventions, 24,* 215–236. http://dx.doi.org/10.1002/bin.292

Jacobson, J. L., & Jacobson, S. W. (2002). Effects of prenatal alcohol exposure on child development. *Alcohol Research & Health, 26,* 282–286.

Jean, A. D., Stack, D. M., & Arnold, S. (2014). Investigating maternal touch and infants' self-regulatory behaviours during a modified face-to-face still-face with touch procedure. *Infant and Child Development, 23,* 557–574. http://dx.doi.org/10.1002/icd.1870

Jones, W., & Klin, A. (2013). Attention to eyes is present but in decline in 2–6-month-old infants later diagnosed with autism. *Nature, 504,* 427–431. http://dx.doi.org/10.1038/nature12715

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217–250.

Kaplan, P. S., Sliter, J. K., & Burgess, A. P. (2007). Infant-directed speech produced by fathers with symptoms of depression: Effects on infant associative learning in a conditioned-attention paradigm. *Infant Behavior & Development, 30,* 535–545. http://dx.doi.org/10.1016/j.infbeh.2007.05.003

Kiaei, A. Y., & Pelaez, M. (2011). Hidden communication deficits in children with autism and early behavioral interventions. In M. S. Plathotnik, S. M. Nielsen, & D. M. Pane (Eds.), *Proceedings of the Tenth Annual College of Education and Graduate Student Network Research Conference* (pp. 101–108). Miami, FL: Florida International University.

Klin, A., & Jones, W. (2008). Altered face scanning and impaired recognition of biological motion in a 15-month-old infant with autism. *Developmental Science, 11,* 40–46. http://dx.doi.org/10.1111/j.1467-7687.2007.00608.x

Klin, A., Shultz, S., & Jones, W. (2015). Social visual engagement in infants and toddlers with autism: Early developmental transitions and a model of pathogenesis. *Neuroscience and Biobehavioral Reviews, 50,* 189–203. http://dx.doi.org/10.1016/j.neubiorev.2014.10.006

Koegel, L., Singh, A., Koegel, R., Hollingsworth, J., & Bradshaw, J. (2014). Assessing and improving early social engagement in infants. *Journal of Positive Behavior Interventions, 16,* 69–80. http://dx.doi.org/10.1177/1098300713482977

Lambert-Brown, B. L., McDonald, N. M., Mattson, W. I., Martin, K. B., Ibañez, L. V., Stone, W. L., & Messinger, D. S. (2015). Positive emotional engagement and autism risk. *Developmental Psychology, 51,* 848–855. http://dx.doi.org/10.1037/a0039182

Landa, R., & Garrett-Mayer, E. (2006). Development in infants with autism spectrum disorders: A prospective study. *Journal of Child Psychology and Psychiatry, 47,* 629–638. http://dx.doi.org/10.1111/j.1469-7610.2006.01531.x

Lewy, A. L., & Dawson, G. (1992). Social stimulation and joint attention in young autistic children. *Journal of Abnormal Child Psychology, 20,* 555–566. http://dx.doi.org/10.1007/BF00911240

Lipsitt, L. P. (1967). Learning in the human infant. *Early behavior: Comparative and developmental approaches* (pp. 225–247). New York, NY: Wiley.

Lohaus, A., Keller, H., Lissmann, I., Ball, J., Borke, J., & Lamm, B. (2006). Eye contact and social contingency experiences from 3 to 6 months of age and their relation to the detection of non-social contingencies. *European Journal of Developmental Psychology, 3,* 388–401. http://dx.doi.org/10.1080/17405620600605323

Lord, C. (2015). Infant autism: Parents' role in ameliorating risk? *The Lancet Psychiatry, 2,* 112–113. http://dx.doi.org/10.1016/S2215-0366(14)00146-1

Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Jr., Leventhal, B. L., DiLavore, P. C., . . . Rutter, M. (2000). The Autism Diagnostic Observation Schedule-generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30,* 205–223. http://dx.doi.org/10.1023/A:1005592401947

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (2002). *Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services.

Lovaas, O. I. (1977). *The autistic child: Language development through behavior modification*. New York, NY: Irvington.

Lovaas, O. I., Koegel, R. L., & Schreibman, L. (1979). Stimulus overselectivity in autism: A review of research. *Psychological Bulletin, 86,* 1236–1254. http://dx.doi.org/10.1037/0033-2909.86.6.1236

MacDonald, R., Anderson, J., Dube, W. V., Geckeler, A., Green, G., Holcomb, W., . . . Sanchez, J. (2006). Behavioral assessment of joint attention: A methodological report. *Research in Developmental Disabilities, 27,* 138–150. http://dx.doi.org/10.1016/j.ridd.2004.09.006

MacDonald, R., Parry-Cruwys, D., Dupere, S., & Ahearn, W. (2014). Assessing progress and outcome of early intensive behavioral intervention for toddlers with autism. *Research in Developmental Disabilities, 35,* 3632–3644. http://dx.doi.org/10.1016/j.ridd.2014.08.036

Malphurs, J., Field, T., Larraine, C., Pickens, J., Pelaez-Nogueras, M., Yando, R., & Bendell, D. (1996). Altering withdrawn and intrusive interaction behaviors of depressed mothers. *Infant Mental Health Journal, 17,* 152–160. http://dx.doi.org/10.1002/(SICI)1097-0355(199622)17:2<152::AID-IMHJ5>3.0.CO;2-S

Masur, E. F., & Olson, J. (2008). Mothers' and infants' responses to their partners' spontaneous action and vocal/verbal imitation. *Infant Behavior &*

Development, 31, 704–715. http://dx.doi.org/10.1016/j.infbeh.2008.04.005

May, L., Byers-Heinlein, K., Gervain, J., & Werker, J. F. (2011). Language and the newborn brain: Does prenatal language experience shape the neonate neural response to speech? *Frontiers in Psychology, 2,* 222.

Mayo, J., Chlebowski, C., Fein, D. A., & Eigsti, I. M. (2013). Age of first words predicts cognitive ability and adaptive skills in children with ASD. *Journal of Autism and Developmental Disorders, 43,* 253–264. http://dx.doi.org/10.1007/s10803-012-1558-0

McArthur, D., & Adamson, L. B. (1996). Joint attention in preverbal children: Autism and developmental language disorder. *Journal of Autism and Developmental Disorders, 26,* 481–496. http://dx.doi.org/10.1007/BF02172271

McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation, 97,* 359–372.

Mitchell, S., Brian, J., Zwaigenbaum, L., Roberts, W., Szatmari, P., Smith, I., & Bryson, S. (2006). Early language and communication development of infants later diagnosed with autism spectrum disorder. *Journal of Developmental and Behavioral Pediatrics, 27,* S69–S78. http://dx.doi.org/10.1097/00004703-200604002-00004

Morales, M., Mundy, P., Delgado, C. E., Yale, M., Messinger, D., Neal, R., & Schwartz, H. K. (2000). Responding to joint attention across the 6- through 24-month age period and early language acquisition. *Journal of Applied Developmental Psychology, 21,* 283–298. http://dx.doi.org/10.1016/S0193-3973(99)00040-4

Mullen, E. M. (1997). *Mullen Scales of Early Learning*. Los Angeles, CA: Western Psychological Services.

Mundy, P. (1995). Joint attention and social-emotional approach in children with autism. *Development and Psychopathology, 7,* 63–82. http://dx.doi.org/10.1017/S0954579400006349

Mundy, P., Block, J., Delgado, C., Pomares, Y., Van Hecke, A. V., & Parlade, M. V. (2007). Individual differences and the development of joint attention in infancy. *Child Development, 78,* 938–954. http://dx.doi.org/10.1111/j.1467-8624.2007.01042.x

Mundy, P., Sigman, M., & Kasari, C. (1994). Joint attention, developmental level, and symptom presentation in autism. *Development and Psychopathology, 6,* 389–401. http://dx.doi.org/10.1017/S0954579400006003

Northrup, J. B., & Iverson, J. M. (2015). Vocal coordination during early parent-infant interactions predicts language outcome in infant siblings of children with autism spectrum disorder. *Infancy, 20,* 523–547. http://dx.doi.org/10.1111/infa.12090

Novak, G., & Pelaez M. (2004). *Child and adolescent development: A behavior systems approach*. Thousand Oaks, CA: Sage.

Oller, D. K., Eilers, R. E., Neal, A. R., & Cobo-Lewis, A. B. (1998). Late onset canonical babbling: A possible early marker of abnormal development. *American Journal on Mental Retardation, 103,* 249–263. http://dx.doi.org/10.1352/0895-8017(1998)103<0249:LOCBAP>2.0.CO;2

Oller, D. K., Eilers, R. E., Neal, A. R., & Schwartz, H. K. (1999). Precursors to speech in infancy. *Journal of Communication Disorders, 32,* 223–245. http://dx.doi.org/10.1016/S0021-9924(99)00013-1

Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders, 24,* 247–257. http://dx.doi.org/10.1007/BF02172225

Ozonoff, S., Iosif, A. M., Baguio, F., Cook, I. C., Hill, M. M., Hutman, T., . . . Young, G. S. (2010). A prospective study of the emergence of early behavioral signs of autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 49,* 256–266.e.2.

Ozonoff, S., Young, G. S., Belding, A., Hill, M., Hill, A., Hutman, T., . . . Iosif, A. M. (2014). The broader autism phenotype in infancy: When does it emerge? *Journal of the American Academy of Child & Adolescent Psychiatry, 53,* 398–407.e2. http://dx.doi.org/10.1016/j.jaac.2013.12.020

Parfitt, Y., Pike, A., & Ayers, S. (2013). The impact of parents' mental health on parent-baby interaction: A prospective study. *Infant Behavior & Development, 36,* 599–608. http://dx.doi.org/10.1016/j.infbeh.2013.06.003

Parsons, M. B., Rollyson, J. H., & Reid, D. H. (2012). Evidence-based staff training: A guide for practitioners. *Behavior Analysis in Practice, 5,* 2–11.

Patten, E., Belardi, K., Baranek, G. T., Watson, L. R., Labban, J. D., & Oller, D. K. (2014). Vocal patterns in infants with autism spectrum disorder: Canonical babbling status and vocalization frequency. *Journal of Autism and Developmental Disorders, 44,* 2413–2428. http://dx.doi.org/10.1007/s10803-014-2047-4

Pelaez, M. (2002). Causes of behavior development and contextual variables. *Behavioral Development Bulletin, 11,* 9–16. http://dx.doi.org/10.1037/h0100485

Pelaez, M. (2009). Joint attention and social referencing in infancy as precursors of derived relational responding. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding: Applications for learners with autism and other*

developmental disabilities (pp. 63–78). Oakland, CA: New Harbinger.

Pelaez, M., Field, T., Pickens, J. N., & Hart, S. (2008). Disengaged and authoritarian parenting behavior of depressed mothers with their toddlers. *Infant Behavior & Development, 31,* 145–148. http://dx.doi.org/10.1016/j.infbeh.2007.06.002

Pelaez, M., & Novak, G. (2013). "Hidden" skills and deficits in the emergence of autism. *European Journal of Behavior Analysis, 14,* 87–96.

Pelaez, M., Virues-Ortega, J., Field, T. M., Amir-Kiaei, Y., & Schnerch, G. (2013). Social referencing in infants of mothers with symptoms of depression. *Infant Behavior & Development, 36,* 548–556. http://dx.doi.org/10.1016/j.infbeh.2013.05.003

Pelaez, M., Virues-Ortega, J., & Gewirtz, J. L. (2011a). Reinforcement of vocalizations through contingent vocal imitation. *Journal of Applied Behavior Analysis, 44,* 33–40. http://dx.doi.org/10.1901/jaba.2011.44-33

Pelaez, M., Virues-Ortega, J., & Gewirtz, J. L. (2011b). Contingent and noncontingent reinforcement with maternal vocal imitation and motherese speech: Effects on infant vocalizations. *European Journal of Behavior Analysis, 12,* 277–287.

Pelaez, M., Virues-Ortega, J., & Gewirtz, J. L. (2012). Acquisition of social referencing via discrimination training in infants. *Journal of Applied Behavior Analysis, 45,* 23–36. http://dx.doi.org/10.1901/jaba.2012.45-23

Pelaez-Nogueras, M. (1992). Recurrent issues in the study of behavior development: Metamodels. *Behavioral Development, 1,* 3–5.

Pelaez-Nogueras, M., Field, T., Cigales, M., Gonzalez, A., & Clasky, S. (1994). Infants of depressed mothers show less "depressed" behavior with their nursery teachers. *Infant Mental Health Journal, 15,* 358–367.

Pelaez-Nogueras, M., Field, T., Gewirtz, J. L., Cigales, M., Gonzales, A., Sanchez, A., & Richardson, S. C. (1997). The effects of systematic stroking versus tickling and poking on infant attention and affective behavior. *Journal of Applied Developmental Psychology, 18,* 169–177. http://dx.doi.org/10.1016/S0193-3973(97)90034-4

Pelaez-Nogueras, M., Field, T. M., Hossain, Z., & Pickens, J. (1996). Depressed mothers' touching increases infants' positive affect and attention in still-face interactions. *Child Development, 67,* 1780–1792. http://dx.doi.org/10.2307/1131731

Pelaez-Nogueras, M., & Gewirtz, J. (1997). The context of stimulus control in behavior analysis. In D. M. Baer & E. M. Pinkston (Eds.), *Environment and Behavior* (pp. 30–42). Boulder, CO: Westview Press.

Pelaez-Nogueras, M., Gewirtz, J. L., Field, T., Cigales, M., Malphurs, J., Clasky, S., & Sanchez, A. (1996). Infants' preference for touch stimulation in face-to-face interactions. *Journal of Applied Developmental Psychology, 17,* 199–213. http://dx.doi.org/10.1016/S0193-3973(96)90025-8

Plomin, R., DeFries, J. C., Knopik, V. S., & Neiderhiser, J. M. (2016). Top 10 replicated findings from behavioral genetics. *Perspectives on Psychological Science, 11,* 3–23. http://dx.doi.org/10.1177/1745691615617439

Plomin, R., Shakeshaft, N. G., McMillan, A., & Trzaskowski, M. (2014). Nature, nurture, and expertise. *Intelligence, 45,* 46–59. http://dx.doi.org/10.1016/j.intell.2013.06.008

Poulson, C. L. (1984). Operant theory and methodology in infant vocal conditioning. *Journal of Experimental Child Psychology, 38,* 103–113. http://dx.doi.org/10.1016/0022-0965(84)90021-3

Poulson, C. L., Kymissis, E., Reeve, K. F., Andreatos, M., & Reeve, L. (1991). Generalized vocal imitation in infants. *Journal of Experimental Child Psychology, 51,* 267–279. http://dx.doi.org/10.1016/0022-0965(91)90036-R

Remington, B., Hastings, R. P., Kovshoff, H., degli Espinosa, F., Jahr, E., Brown, T., . . . Ward, N. (2007). Early intensive behavioral intervention: Outcomes for children with autism and their parents after two years. *American Journal on Mental Retardation, 112,* 418–438. http://dx.doi.org/10.1352/0895-8017(2007)112[418:EIBIOF]2.0.CO;2

Rheingold, H. L., Gewirtz, J. L., & Ross, H. W. (1959). Social conditioning of vocalizations in the infant. *Journal of Comparative and Physiological Psychology, 52,* 68–73. http://dx.doi.org/10.1037/h0040067

Risley, T., & Wolf, M. (1967). Establishing functional speech in echolalic children. *Behaviour Research and Therapy, 5,* 73–88. http://dx.doi.org/10.1016/0005-7967(67)90001-0

Robins, D. L., Casagrande, K., Barton, M., Chen, C. M., Dumont-Mathieu, T., & Fein, D. (2014). Validation of the Modified Checklist for Autism in Toddlers, Revised with Follow-up (M-CHAT-R/F). *Pediatrics, 133,* 37–45. http://dx.doi.org/10.1542/peds.2013-1813

Rogers, S., & Pennington, B. (1991). A theoretical approach to the deficits in infantile autism. *Development and Psychopathology, 3,* 137–162. http://dx.doi.org/10.1017/S0954579400000043

Rogers, S. J., Vismara, L., Wagner, A. L., McCormick, C., Young, G., & Ozonoff, S. (2014). Autism treatment in the first year of life: A pilot study of infant start, a parent-implemented intervention for symptomatic infants. *Journal of Autism and Developmental Disorders, 44,* 2981–2995. http://dx.doi.org/10.1007/s10803-014-2202-y

Ronald, A., Happé, F., Price, T. S., Baron-Cohen, S., & Plomin, R. (2006). Phenotypic and genetic over-

lap between autistic traits at the extremes of the general population. *Journal of the American Academy of Child & Adolescent Psychiatry, 45,* 1206–1214. http://dx.doi.org/10.1097/01.chi.0000230165.54117.41

Sasson, N. J., & Touchstone, E. W. (2014). Visual attention to competing social and object images by preschool children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44,* 584–592. http://dx.doi.org/10.1007/s10803-013-1910-z

Schlinger, H. D., Jr. (1995). *A behavior analytic view of child development*. New York, NY: Springer Science & Business Media. http://dx.doi.org/10.1007/978-1-4757-8976-8

Seymour, M., Giallo, R., Cooklin, A., & Dunning, M. (2015). Maternal anxiety, risk factors and parenting in the first post-natal year. *Child: Care, Health and Development, 41,* 314–323. http://dx.doi.org/10.1111/cch.12178

Sigman, M., & Kasari, C. (1995). Joint attention across contexts in normal and autistic children. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development* (pp. 189–204). Hillsdale, NJ: Erlbaum.

Sigman, M., Mundy, P., Sherman, T., & Ungerer, J. (1986). Social interactions of autistic, mentally retarded and normal children and their caregivers. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 27,* 647–656. http://dx.doi.org/10.1111/j.1469-7610.1986.tb00189.x

Sigman, M., Ruskin, E., Arbeile, S., Corona, R., Dissanayake, C., Espinosa, M., . . . Zierhut, C. (1999). Continuity and change in the social competence of children with autism, Down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development, 64,* 1–114.

Smith, T., Groen, A. D., & Wynn, J. W. (2000). Randomized trial of intensive early intervention for children with pervasive developmental disorder. *American Journal on Mental Retardation, 105,* 269–285. http://dx.doi.org/10.1352/0895-8017(2000)105<0269:RTOIEI>2.0.CO;2

Sterling, L., Dawson, G., Webb, S., Murias, M., Munson, J., Panagiotides, H., & Aylward, E. (2008). The role of face familiarity in eye tracking of faces by individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 38,* 1666–1675. http://dx.doi.org/10.1007/s10803-008-0550-1

Talbott, M. R., Nelson, C. A., & Tager-Flusberg, H. (2015). Diary reports of concerns in mothers of infant siblings of children with autism across the first year of life. *Journal of Autism and Developmental Disorders, 45,* 2187–2199. http://dx.doi.org/10.1007/s10803-015-2383-z

Taylor, B. A., & Hoch, H. (2008). Teaching children with autism to respond to and initiate bids for joint attention. *Journal of Applied Behavior Analysis, 41,* 377–391. http://dx.doi.org/10.1901/jaba.2008.41-377

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders, 36,* 993–1005. http://dx.doi.org/10.1007/s10803-006-0137-7

Venter, A., Lord, C., & Schopler, E. (1992). A follow-up study of high-functioning autistic children. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 33,* 489–507. http://dx.doi.org/10.1111/j.1469-7610.1992.tb00887.x

Waller, R., Shaw, D. S., Forbes, E. E., & Hyde, L. W. (2015). Understanding early contextual and parental risk factors for the development of limited prosocial emotions. *Journal of Abnormal Child Psychology, 43,* 1025–1039. http://dx.doi.org/10.1007/s10802-014-9965-7

Werner, J. S., & Siqueland, E. R. (1978). Visual recognition memory in the preterm infant. *Infant Behavior and Development, 1,* 79–94. http://dx.doi.org/10.1016/S0163-6383(78)80011-3

Whalen, C., & Schreibman, L. (2003). Joint attention training for children with autism using behavior modification procedures. *Journal of Child Psychology and Psychiatry, 44,* 456–468. http://dx.doi.org/10.1111/1469-7610.00135

Williams, G., & Garbarini, S. E. (2015). *The chronology of acquisition of primary verbal operants on the continuum of language development*. Paper presented at the 26th Annual Convention of the New York State Association for Behavior Analysis (NYSABA), Albany, NY.

Young, G. S., Merin, N., Rogers, S. J., & Ozonoff, S. (2009). Gaze behavior and affect at 6 months: Predicting clinical outcomes and language development in typically developing infants and infants at risk for autism. *Developmental Science, 12,* 798–814. http://dx.doi.org/10.1111/j.1467-7687.2009.00833.x

Zwaigenbaum, L., Bryson, S., Rogers, T., Roberts, W., Brian, J., & Szatmari, P. (2005). Behavioral manifestations of autism in the first year of life. *International Journal of Developmental Neuroscience, 23,* 143–152. http://dx.doi.org/10.1016/j.ijdevneu.2004.05.001

Received July 20, 2016
Revision received October 9, 2016
Accepted October 12, 2016 ■