Early Communication Development in Infants at High and Low Genetic Risk for Autism Spectrum Disorders: An Examination of Communication Spontaneity

Shanna L. Alvarez

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Reading Committee
Annette M. Estes, Co-chair
James Mazza, Co-chair
Elizabeth Sanders
Patricia Dowden
Ilene Schwartz
Stephen Dager, GSR

University of Washington

Abstract

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Shanna Alvarez

Chairs of the Supervisory Committee:

Annette Estes, PhD

James Mazza, PhD

Social communication impairment is one of the key diagnostic features of ASD, with communication deficits being the earliest symptom reported by most parents of children with ASD (Filipek et al., 1999; Landa & Garrett-Meyer, 2006). From differences in babble (Trevarthen & Daniel, 2005; Yirmiya, et al., 2006) and gesture inventories (Landa et al., 2007; Wetherby et al., 1998) to delayed onset or atypical development of verbal language (Luyster, 2009) and social-communication deficits (Landa et al., 2007; Wetherby, 1998; Zwaigenbaum, 2005), children with ASD present with a unique profile of early communication behaviors. One aspect of early communication development that has received limited attention is communication spontaneity (CS). CS has been conceptualized as the level of environmental support required for a child to initiate a communication act (Carter, Hotchkis & Cassar, 1996). While CS has been discussed as an important aspect of communication, additional research is needed to better understand CS's nature (i.e., how CS changes over time) and relevance (i.e., relationship to other developmental domains) in typically developing children as well as children with developmental disabilities such as ASD. Given the limitations of retrospective report, prospective studies are necessary to determine if early risk signs are related to later development of ASD or broader autism phenotype (BAP) features.

The purpose of the present study was to examine CS in a cohort of infants at high and low genetic risk for ASD at 12 and 24 month of age.. Results indicated that CS is associated with existing measures of language and social communication. A specific component of CS which captures how a child responds to direct communication prompts (CS-SP-Direct Prompts), was found to be particularly associated with outcomes, including ADOS diagnostic group and symptom severity. In contrast, children's CS during Free Play conditions or in response to non-social prompts was not significantly related to ASD outcomes. These findings suggest that previous discussions of potential differences in CS may be better conceptualized as differences in Social Prompt Responsiveness. At 12 months of age, CS-SP-Direct Prompts differentiated ASD from NonASD children and uniquely predicted both diagnostic group and ASD symptom severity. CS-SP-Direct Prompts may also be associated with the broader autism phenotype, though differences may not become clear until 24 months of age in high risk (HR), NonASD siblings. Results from the present study suggest that structured measurement of Social Prompt Responsiveness is possible and may contribute important information regarding a child's social-communication development, particularly in monitoring infants at high genetic risk for ASD. Findings also provide support for the social salience framework of ASD and its application to early communication development.

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DEDICATION

To my parents…

whose sacrifices and unyielding enthusiasm made Dra. Alvarez possible.

No hay mal que por bien no venga.

Chapter 1: Introduction

As research into the nature and treatment of Autism Spectrum Disorders (ASD) has increased, it has become clear that early identification and intervention leads to outcomes far better than historically believed possible for affected individuals (Dawson & Osterling, 1997; Harris & Weiss, 1998; Sheinkopf & Siegel, 1998). Children who enter programs at younger ages make greater gains than those who enter programs at older ages (Harris & Handleman, 2000; Sheinkopf & Siegel, 1998). Contemporary behavioral interventions for children under age 3, such as the Early Start Denver Model and Pivotal Response Training, have reported significant improvements in IQ, adaptive behavior, and autism symptoms compared to control group comparisons (Corsello, 2005; Dawson et al., 2009). Given the impact of early identification and treatment, there is a large body of research aiming to identify developmental differences in infancy and early childhood in children that go on to receive a diagnosis of ASD (Osterling & Dawson, 1994; Ozonoff et al., 2011; Saint-Georges et al., 2011; Werner & Dawson, 2005). This proposed study aimed to contribute to the field's current understanding of early indicators of ASD.

Section 1 of this study will review the definition, prevalence and the evidence for early indicators of ASD. Converging evidence from various research methodologies have established the presence of ASD symptoms in the first two years of life (Chawarska et al., 2007; Landa & Garrett-Mayer, 2006; Mars, Mauk & Dowrick, 1998; Osterling & Dawson, 1994; Saint-Georges et al., 2011; Zwaigenbaum et al., 2005). In retrospective parent report studies, researchers have collected developmental histories from parents whose children have already been diagnosed ASD to identify developmental differences present prior to diagnosis (Chawarska et al., 2007). In retrospective home video analysis, researchers have examined early home videos (e.g., first birthday party recordings) of children already diagnosed with ASD to identify characteristics that differentiate children with ASD from unaffected children (Mars, Mauk & Dowrick, 1998; Osterling & Dawson, 1994; Saint-Georges et al., 2011; Werner & Dawson, 2005).

Another method of identifying early signs of ASD is to study infant siblings of children with ASD. Given the heritable nature of ASD, these high-risk (HR) siblings of children with ASD are at higher genetic risk for developing ASD themselves (Ozonoff et al., 2011). Thus, development is monitored and assessed prospectively, prior to the emergence of ASD symptoms. When siblings are diagnosed with ASD, the prospectively gathered developmental data from these infants may be compared to unaffected infants to determine developmental differences present early in life. Through the prospective study of infant siblings, unique developmental profiles have been identified in high-risk infants that go on to develop ASD (Goldring, Thompson & Rogers, S., 2008; Landa & Garrett-Mayer, 2006; Ozonoff et al., 2008; Zwaigenbaum et al., 2005). In addition, developmental differences have been identified in infant siblings who do *not* develop ASD, but present with broader autism phenotype (BAP) features. The BAP is milder but qualitatively similar features associated with ASD (Bernier, Gerdts, Munson, Dawson & Estes, 2012; Dawson et al., 2007; Messinger et al., 2013; Ozonoff et al., 2005, 2008; Toth, Dawson, Meltzoff, Greenson & Fein, 2007; Yirmiya et al., 2006; Zwaigenbaum et al., 2007). A greater understanding of the early developmental profiles of ASD and BAP will allow access to early intervention for both groups, regardless of diagnostic outcome.

In the next section of this study, early communication development in typically developing (TD) and ASD populations will be reviewed. Impaired communication has been identified as a feature of both BAP and ASD (Goldberg et al., 2005; Toth et al., 2007).

Communication impairment is one of the key diagnostic features of ASD and is the earliest symptom reported by most parents of children with ASD (Filipek et al., 1999; Landa & Garrett-Meyer, 2006). Moreover, one of the strongest predictors of long-term outcomes for children with ASD is the acquisition of spoken communication (Stone & Yoder, 2001;Toth et al., 2006). From differences in babble (Trevarthen & Daniel, 2005; Yirmiya, et al., 2006) and gesture inventories (Landa et al., 2007; Wetherby et al., 1998) to delayed onset or atypical development of verbal language (Luyster, 2009) and social-communication deficits (Landa et al., 2007; Wetherby, 1998; Zwaigenbaum, 2005), children with ASD present with a unique profile of early communication behaviors.

One aspect of early communication development that has received limited attention is communication spontaneity (CS). CS has been conceptualized as the level of environmental support required for a child to initiate a communication act (Carter, Hotchkis & Cassar, 1996). CS has been described as an important aspect of functional communication (Carr & Kolingsky, 1983; Charlop, Schreibman & Thibodeau, 1985; Carter, 2002). Spontaneous communication allows individuals control over the instigation and termination of interactions rather than relying on a communication partner to determine these aspects of an interaction (Jones & Feeley, 2007; Reichle & Johnston, 1999). In addition, if spontaneity is limited, an individual's personal needs may not be met until those needs are obvious to others in their environment, resulting in reduced independence and potential frustration or discomfort (Potter & Whittaker, 2001). In fact, promoting spontaneity of communication in children with ASD has been suggested as a priority for early intervention programs (Woods & Wetherby, 2003). While CS has been discussed as an important aspect of communication, additional research is needed to better understand CS's nature (i.e., how CS changes over time) and relevance (i.e., relationship to other developmental domains) in typically developing children as well as children with developmental disabilities such as ASD. Diminished CS may be an aspect of the social-communication profile of children with ASD. If so, additional research will aid in the development of appropriate assessment tools and interventions.

This dissertation will examine early communication development of infants at high and low genetic risk for ASD as they transition from presymbolic to symbolic stages of communication. Specifically, receptive and expressive language, social-communication and communication spontaneity will be examined in a cohort of infants at high and low genetic risk for ASD at 12 and 24 months of age. The dissertation begins with a review of the literature in Autism Spectrum Disorders and early communication development. Next, specific research questions and hypotheses are proposed, followed by the methods, statistical analyses, and results. The dissertation concludes with a discussion of the findings in the context of the literature, along with limitations to the study, and directions for future research. It is hoped that an increased understanding of communication spontaneity will contribute to the body of research on normative communication development as well as the social-communication profiles in children at-risk for ASD.

Chapter 2: Literature Review

Leo Kanner first described autism in 1943, in a classic article that described case studies of 11 children who were characterized by their "inability to relate to themselves" and "extreme autistic aloneness" (Kanner, 1943). At the present time, autism is described as a neurodevelopmental disorder with an onset prior to the age of 3, characterized by impairments in social and communication behaviors and an unusual or restricted range of activities or interests [American Psychiatric Association (APA), 2000]. Along with pervasive developmental disorder- not otherwise specified (PDD-NOS) and Asperger's syndrome, autism is currently categorized in the DSM-IV as a pervasive developmental disorder (APA, 2000). In clinical practice the term autism spectrum disorders (ASD) has often been used to collectively refer to autism, PDD-NOS and Asperger syndrome. In fact, the DSM-V will use a new category, ASD, to include autism, Asperger's disorder, childhood disintegrative disorder and PDD-NOS. (APA, 2012). The term ASD will be used throughout this proposal.

Within the ASD category, individuals may present with great symptom profile variability (APA, 2000, 2012). For example, the communication deficits may present as a lack of spoken language in one child while another child may demonstrate intact spoken language while social-use of communication is impacted. Social deficits may present as reduced social initiations and eye contact in one affected individual while another child may initiate frequently but fail to respect social conventions (e.g., body space, asking personal questions), impacting the quality of their social overtures. In one child, unusual or restricted interests may include spinning objects repetitively, while another child may hyperfocus on historical facts to a degree that reduces the quality of social interactions and precludes their pursuit of outside interests. Thus, despite shared core deficits in communication, social interactions and unusual or repetitive interests, there is great heterogeneity in the profiles of individuals with ASD.

ASD prevalence estimates may differ according to a study's methodology, geographical region and time-frame (Fombonne, 2009). Recent prevalence estimates range between 1/150 (Fombonne, 2009) to 1/88 children [Center for Disease Control (CDC), 2012], making ASD one of the most frequently occurring childhood neurodevelopmental disorders (CDC, 2012). Studies of identical twins have shown concordance rates approaching 90 percent (Bailey, Lecauteur, Gottesman & Bolton, 1995; Folstein, 1977). Heritability, defined as the proportion of variation in diagnoses in the total population due to genetic variation, is reported as 80% (Lichtenstein, 2010). Given the heritable nature of ASD, relatives of affected individuals are more likely to present with measurable differences in traits related to ASD when compared to parents of children without ASD. This profile of milder but qualitatively similar ASD traits in family members has been described as the broader autism phenotype (BAP) (Bernier, Gerdts, Munson, Dawson & Estes, 2012; Folstein & Rutter, 1977). Thus, there is a clear familial-genetic basis for ASD.

ASD Symptoms in the First Two Years of Life

While understanding of the behavioral characteristics of ASD has increased (Chawarska et al., 2007) identifying these characteristics in the first two years of life has remained a greater challenge. Parents may report concerns as early as the first year of life (Chawarska et al., 2007; Zwaigenbaum et al., 2005). In fact, in a recent prospective longitudinal study of the offspring of 14,541 pregnant women, when compared to parents of typically developing children, parents of children who developed ASD reported developmental differences in the first year of life. Specifically, parents of infants that went on to have ASD retrpspectively reported social, communication, and fine motor skill differences in the affected child as early as 6 months of age (Bolton et al., 2012). Despite these early concerns, an actual diagnosis is rarely made prior to 2 to 3 years of age (Lord, Rutter & Couteur, 1994). Given the discrepancy between age of first parent concern and age of diagnosis, various research methodologies have emerged in an effort to better identify early signs of ASD (Osterling & Dawson, 1994; Ozonoff et al., 2011; Saint-Georges et al., 2011; Werner & Dawson, 2005).

Retrospective Home Video Studies

In the past 30 years, retrospective studies involving examination of early home videos of children who went on to develop ASD have contributed greatly to the understanding of early development in this population (Mars, Mauk & Dowrick, 1998; Osterling & Dawson, 1994; Saint-Georges et al., 2011; Werner & Dawson, 2005). Various retrospective home video analyses of 12-24 old children have shown that those who went on to develop ASD demonstrated a reduced response to their name, lower eye contact quality and quantity, less positive facial expression and reduced intersubjective behaviors (e.g., showing shared attention) compared to children who did not develop ASD (Mars et al., 1998; Osterling & Dawson, 1994; Saint-Georges et al., 2011). In addition, these studies confirmed the clinical validity of the regression phenomena (loss of skills) reported by parents of a small percentage of children who went on to develop ASD (Saint-Georges et al., 2011; Werner & Dawson, 2005).

Osterling & Dawson (1994) were the first researchers to use home videos of children's 1st birthday parties to study early ASD symptoms. They analyzed home videotapes of the 1st birthday parties of infants that went on to develop ASD as well as infants that went on to be typically developing. Infants as young as 12 months of age who were later diagnosed with ASD could be distinguished from 1-year-old typically developing infants. The frequency with which a child looked at the face of another person correctly classified 77% of children. When gaze was combined with social behaviors (e.g., showing, pointing, and orienting to name), 91% of the infants with typical development and ASD were correctly classified. In a related retrospective home video analysis study of infants ages 8-10 months, failure to respond to name was the best discriminator between infants that went on to develop ASD and typically developing infants (Werner et al., 2000). In order to differentiate early signs of ASD and early signs of general developmental delay, Osterling and colleagues (2002) analyzed home videos of 1-year-olds with ASD, 1-year-olds with delayed development and 1-year-olds with typical development. Findings indicated that failure to respond to name and reduced social orienting differentiated between ASD, typical development and general developmental delay (Osterling et al., 2002). These retrospective videotape analyses have revealed numerous social-communicative behavior differences unique to children with ASD in the first year of life. However, in order to improve early identification, efforts have continued to identify and treat these signs and symptoms proactively; that is, prior to receiving a diagnosis of ASD.

Prospective Infant Sibling Studies

Another method of identifying early signs of ASD is to study infant siblings of children with ASD (HR infants). Given the heritable nature of ASD, infant siblings of children with ASD are at higher genetic risk for developing ASD themselves. In the most recent and largest study of recurrence risks in infant siblings to date, Ozonoff and colleagues (2011) reported recurrence rates between 19 -32%. This study involved 664 infants whose development was followed from 6 months, before ASD symptoms typically appear, to 36 months of age. Findings indicated that 19 percent of younger siblings of children with ASD developed ASD, a rate significantly higher than the general population prevalence of approximately .01% (Fombonne, 2009; CDC, 2012).

Recurrence rates were higher in families with more affected siblings. If there were two children with ASD in the family, the risk of the third sibling developing ASD increased to more than 32 percent. Gender also impacted recurrence rates as male infants who had an older sibling with ASD had an almost three times greater risk of developing ASD than female infants (26 percent compared with 9 percent). The severity of the older sibling's symptoms did not affect the risk for ASD in later-born children, nor did the parents' characteristics such as age, socio-economic status or ethnicity (Ozanoff et al., 2011).

Advantages of prospective infant sibling studies. Given the increased genetic risk infant siblings face, prospective infant sibling study designs allow researchers to study the earliest emerging symptoms in a sample that is enriched for ASD. The emergence of prospective infant sibling studies has demonstrated numerous advantages in identifying earlier signs of ASD (Ozonoff et al., 2005, 2008, 2011; Yirmiya et al., 2006; Zwaigenbaum et al., 2007). First, examination of early neurodevelopmental systems can begin at younger ages than studies that rely on diagnosis. Subjects can be identified by familial risk and followed prior to symptom emergence over the course of infancy. Second, retrospective parent report methods may be prone to errors and distortions of recall, especially when parents are asked to recall behaviors from far earlier in their child's development. Similarly, retrospective videotape analyses fail to provide standardized contexts in which to observe behavior, which may impact the ability to compare videotape observations across individuals. Prospective infant studies allow elicitation of specific behaviors in standardized conditions to allow for more reliable comparability between and within individuals over longer periods of time. In addition, parents of children that have already received a diagnosis of ASD may bias their retrospective reports to include behaviors that are consistent with that diagnosis. Prospective studies allow clinicians to focus on a broader range of behaviors that may or may not currently be associated with ASD.

While prospective infant sibling studies offer promising advantages over retrospective designs, researchers must keep in mind the potential for ascertainment bias (Zwaigenbaum et al., 2007). First, parents with developmental concerns may be more likely to seek out research participation opportunities as a form of developmental monitoring. If parents are more sensitive to a specific area of development, this may bias the developmental profile distribution of participating infants (i.e., low risk infants with motor concerns are more highly represented). If high-risk parents who observe concerning behaviors in their infant may be more likely to enroll, recurrence rates in infant sibling studies may be somewhat inflated compared to recurrence rates reported in population studies. Finally, more general family characteristics such as socioeconomic status and education level may influence participation in research studies and bias outcomes.

Prospective infant studies: diagnostic outcomes. Although diagnostic stability is generally not achieved until 3 years of age, prospective infant sibling studies have identified behaviors at 12 months of age that may distinguish infants that go on to develop ASD from infants that do not develop ASD (Ozonoff et al., 2011; Zwaigenbaum et al., 2005). In a study of 12 month old genetically high-risk (HR) infants and low-risk (LR) controls, Zwaigenbaum and colleagues reported several specific behavioral markers which differentiated HR children that went on to develop ASD at 24 months from LR and control infants who went on to be typically developing. Reported differences included the following: atypicalities in eye contact, visual tracking, disengagement of visual attention, orienting to name, imitation, social smiling, reactivity, social interest and affect, sensory-oriented behaviors and language development (Zwaigenbaum et al., 2005).

In a similar high-risk infant sibling design, Ozonoff and colleagues (2011) studied atypical object exploration at 12 months as a predictor of subsequent ASD diagnosis. A sample of 35 high-risk infants and 31 low-risk infants were observed with novel play materials. Nine of the high-risk infants were subsequently diagnosed with ASD at 24 months, and were distinguished by increased frequency of spinning, rolling and rotating the objects, and unusually prolonged visual inspection of objects.

In a prospective infant sibling study of 87 HR and LR infants, Landa and Garrett-Meyer (2006) examined the relationship between the Mullen developmental scores at ages 6, 14, and 24 months and diagnostic outcome (unaffected, ASD, or language delayed). This study was unique as it included language delay as a separate outcome group. Results indicated that at 14 months of age, children who developed ASD performed significantly worse in language and motor domains when compared to the unaffected group, though non-verbal problem solving skills were comparable across groups. By 24 months of age, the ASD group performed significantly worse in all domains (language, motor and non-verbal problem solving skills) compared to children that went on to be typically developing. Compared to the language-delayed group, the ASD group demonstrated lower scores in gross motor, fine motor, and receptive language while expressive language scores were comparable between groups. Regarding developmental trajectories across timepoints, Landa and Garrett-Meyer reported that the developmental trajectory of the ASD group was slower than both the language-delayed and typical groups with a significant decrease in development between the first and second birthdays (Landa & Garrett-Meyer, 2006).

These various prospective infant sibling studies have demonstrated robust differences in the early development of children that go on to develop ASD. While developmental differences between 12-14 months have been consistently cited across the various studies, findings on younger infants have been less consistent. Differences in sensory and temperament behaviors including increased passivity and decreased positive affect have been reported as early as 6 months of age (Zwaigenbaum, 2005); however, there continues to be insufficient 6-month-old data to make conclusive statements regarding predictive behaviors at such a young age.

Prospective infant sibling studies: broader autism phenotype. Infant sibling studies have also shed light on a previously neglected population—individuals that do not develop ASD but are impacted by broader autism phenotype (BAP) features; that is, features that are milder but qualitatively similar to diagnostic features of ASD (Folstein & Rutter, 1977). Recognition of a broader autism phenotype was first reported in Folstein and Rutter's 1977 study examining 21 same-sex twin pairs (11 monozygotic and 10 dizygotic) in which at least one twin had ASD. Findings pointed to the increased concordance of Autism in monozygotic versus dizygotic twins. Moreover, they found significantly higher concordance rates of language and cognitive deficits *similar* to ASD (even if the individual did not have ASD themselves), particularly in monozygotic twin pairs (Folstein & Rutter, 1977). The existence of behavioral markers of vulnerability for ASD is now widely acknowledged (Losh et al., 2008); however, researchers are continuing efforts to identify which behavioral markers have the strongest genetic liability. Losh and colleagues (2008) compared personality, social and language profiles of parents of individuals with Down Syndrome to simplex Autism families (families with one child with ASD) and multiplex Autism families (families with more than one child with ASD). Parents of children with Down Syndrome were least likely to possess personality characteristics of aloofness, rigidity, neuroticism, anxiety, and untactful behavior; simplex parents demonstrated higher levels while multiplex families demonstrated the highest levels of these personality traits. This same linear association across groups was also found in degree of social isolation and of pragmatic language deficits (Losh et al., 2008).

Similarly, Bernier and colleagues (2012) blindly assessed the social, conversational and restricted behaviors of control, simplex and multiplex parents using the Broader Phenotype Autism Symptom Scale (BPASS; Dawson et al., 2007). The BPASS is a quantitative measure of autism-related traits in individuals with ASD and their family members. Overall, findings indicated elevated ASD symptoms in multiplex families compared to simplex, developmentally delayed and typically developing groups. However, simplex parents did not demonstrate a greater number or intensity of BAP traits compared to the general population (Bernier, Gerdts, Munson, Dawson & Estes, 2012). Thus, additional research is needed to better understand the potentially unique transmission mechanisms of ASD and/or BAP between single-incidence and multiple-incidence families.

As the understanding of the BAP profile in adults has increased, researchers have begun to investigate potential BAP profiles in infant siblings of children with ASD (Messinger, et al., 2013; Toth et al., 2007). Improving the understanding of the developmental needs of infant siblings, regardless of whether these needs are associated with an ASD diagnosis or with a broader autism phenotype, may allow families access to earlier identification and intervention. Utilizing a prospective infant sibling study design, these studies focus on the developmental processes underlying genetic vulnerability to ASD (the ‘broader autism phenotype’), by examining differences related to risk status, rather than diagnostic outcome. For example, in a prospective study of early development in young NonASD siblings of children with ASD, Toth and colleagues compared 42 non-autistic 18-27 month old siblings of children with ASD to 20 typically developing children with no family history of ASD (Toth et al., 2007). This study was unique in that it focused exclusively on infants at a high genetic risk of developing ASD but did *not* go on to develop ASD. Results indicated a range of social-communication, imitation, play and language differences between groups. Overall developmental/cognitive development (as measured by Mullen Early Learning Composite) was comparable between groups, though a higher percentage of the HR group had below average composite IQ scores as compared to the LR group. In the area of language development, the HR infant siblings demonstrated lower receptive language skills based on clinician assessment than the LR group, though there was no difference in parent-reported level of receptive language skills. While mean expressive language abilities were comparable between groups, a significantly higher number of HR infants presented with below average expressive language scores. In the area of social-communication, HR infants demonstrated reduced language comprehension and symbolic use of objects during play, and had less frequent use of words, distal gestures and responsive social smiles during social interactions when compared to LR infants. Similarly, Messinger and colleagues (2013) reported that HR-NonASD siblings demonstrated higher mean levels of ASD symptom severity and lower levels of developmental functioning compared with LR-NonASD children. Four-fifths of the HR-NonASD siblings did not differ significantly from LR controls. However, a subset of HR-Non-ASD siblings did demonstrate an early-emerging pattern of developmental differences . These results demonstrated that siblings of children with ASD may still be affected by broader autism phenotype features, even if they do not actually meet criteria for ASD themselves (Messinger, 2013; Toth et al., 2007).

While differences are present by 12 months of age, there is less known about risk group differences prior to 12 months. For example, Ibanez and colleagues (2008) examined how HR versus LR infants oriented to their mothers' faces during the active and neutral engagement phases of the 'still face' paradigm. Results indicated that while high-risk infants showed prolonged gaze away from parents' faces compared to low-risk infants, gaze towards parents' faces was of similar duration in the two groups. However, findings on eye gaze in 6-month-old HR infants have been somewhat inconsistent (Merin, Young, Ozonoff & Rogers, 2007; Young, Merin, Rogers & Ozonoff, 2008). Additional research is necessary to more clearly understand differences between risk groups and outcome groups prior to 12 months of age.

Summary of the Contributions from Various Research Methodologies

Great strides have been made in the early identification of ASD. Retrospective studies have established the presence of ASD symptoms prior to the average age of diagnosis. Given the heritable nature of ASD, prospective infant studies have allowed for a more standardized examination of very early development of infants at high genetic risk. Through the prospective study of infant siblings, unique developmental profiles have been identified both in HR infants that go on to develop ASD as well as infants that do not develop ASD, but present with BAP features. Continued exploration of the earliest developmental profiles of infant siblings of children with ASD will allow for early identification and intervention, regardless of specific diagnostic outcome.

Early Communication Development

Communication has been identified as an essential feature of both BAP and ASD (Goldberg et al., 2005; Toth et al., 2007). In order to contextualize unique aspects of communication development in these populations, an understanding of early communication development in normative and NonASD populations must be established. Communication assessment in very young children with limited verbal language has historically been a challenge as many assessments focus on expressive language inventories and syntax (Coggins, 1998). However, in the last 20 years, attention to communication modalities prior to speech development has received increased attention (Wetherby et al., 1992; 1998; 2003; 2008; Wilcox, 1993). There is now a large body of research describing the developmental progression from preintentional, to intentional presymbolic, to symbolic communication in typical and developmentally delayed populations. Presymbolic communication serves as an important indicator of future symbolic language development (Wetherby, Reichle, & Pierce, 1998; Wetherby & Prizant, 2002; Wilcox, 1993). Thus, assessment of children with limited verbal communication requires attention to children's profiles of communicative and social affective abilities, verbal and non-verbal communication. In this overview, three dimensions of early communication development will be discussed: Communication Modalities (*how* children communicate), Communication Functions/Social Communication (*why* children communicate) and Receptive Language (*what* children understand).

Communication Modalities

Preintentional behaviors. All newborns begin in the perlocutionary or "preintentional" stage of communication (Bates, 1979). In this stage, the physiological and emotional state of the child is expressed, but dependent on the interpretation of the observer (Rowland, 2004). For example, when a baby frowns, cries or gurgles, these behaviors may be reflexive, unintentional responses to an internal state such as discomfort or hunger. While intentional *communication* does not develop until later in infancy, as early as 3 months of age infants do demonstrate contingency awareness leading them to demonstrate intentional *behaviors* such as affective expressions and vocalizations to regulate interactions between infant and caregiver. In these interactions, an infant is demonstrating an emotional or physiological state, though they are not yet *directing* these acts toward a communication partner to communicate specific intentions (Stern, 1989; Tronick, 1989). For example, 3-month old infants participate in social exchanges in which the infant varies their behavior to achieve a shared emotional state with their mothers (Stern, 1989). That is, both mother and infant gauge their emotional responses by the feedback they receive from the emotional display of the other (Lavelli & Fogel, 2005; Stern 1989).

Preintentional vocalizations are another way in which infants may regulate interactions in their first few months of life (Bates, 1979; Tronick, 1989). Distress vocalizations (e.g., crying and whining) as well as non-distress vocalizations (vocalic sounds and syllabic/speech like sounds) elicit affective and behavioral responses from caregivers. In turn, an infant modifies the frequency and sophistication of their vocalizations. For example, in a longitudinal study of infant vocalizations in mother-infant dyads, Hsu and Fogel (2001) reported that infants produce more vocalic vocalizations when alone and when interacting with a non-responsive partner, whereas speech-like/syllabic vocalizations predominate when mothers are available and responsive. Moreover, the longer the mothers and their infants were reciprocally involved in the interaction, the more the infants vocalized. On the other hand, the longer the infants disengaged from the interaction, the less they produced vocalizations of either type (Hsu & Fogel, 2001).

Throughout the preintentional stage, the reciprocal responses of both infant and caregiver greatly impact the reinforcement and consequent reproduction of these early affective and vocal behaviors. A caregiver's responsiveness to and interpretation of preintentional behaviors is crucial to the infant's transition to intentional communication (Paavola, Kunnari, & Moilanen, 2005; Tamis-LeMonda, Bornstein & Baumwell, 2011; Warren &Yoder, 1998; Wetherby, Warren, Reichle, 1998).

Intentional Presymbolic Communication

Directed communication. When infants become aware of the impact of their undirected behaviors have on others, they learn to associate their behaviors with the impact on the listener and to intentionally direct their behaviors toward a communication partner (Bates, 1975; Rowland, 2004). When a child begins to *direct* their intentional behaviors, they have entered into the stage of intentional communication (Rowland, 2004). Wetherby and colleagues describe intentional, directed communication as meeting the following three criteria (1) the act is a gesture, vocalization or verbalization (2) the act is directed toward a communication partner (does not necessitate eye contact) (3) the acts serves a communication function (Wetherby, 1998). In typically developing (TD) populations, this transition typically begins by 9 months of age and is marked by the emergence of presymbolic communication methods—that is, communication signals that do not require an association between a symbol and its referent (Wetherby & Prizant, 1992). Intentional presymbolic communication begins with the emergence of directed eye gaze shifts, vocalizations and gestures (Tomasello, 1995). Initially, children rely primarily on gestures and/ or vocalizations but increasingly pair gestural and pre-linguistic vocalizations together as they move toward symbolic communication (Wetherby, 1988).

Gestures. A large body of research has described a continuum of gestures ranging from early contact gestures to later developing distal gestures. (Brady, Mclean & Johnston, 1995; Mclean, Brady & Etter, 1991; McLean, Brady & Mclean, 1996). Contact gestures refer to gestures that require contact between a child and object/caregiver, such as pushing away a toy or giving objects (Werner &Kaplan, 1963). These gestures are typically earlier developing, first emerging around 9-10 months of age. Distal gestures, which do not require contact with an object/caregiver (e.g., pointing and reaching), are typically later developing and emerge between 10-12 months of age (Wetherby, 1992) This continuum of gesture type and its implications for communication development have been explained by Werner and Kaplan’s “distancing theory”, which proposes that children generally begin with contact gestures as they are more concrete/obviously related to their referent. Children then learn to use less concrete distal gestures during their transition toward symbolic communication (Werner & Kaplan, 1963).

While the "distancing theory" has been widely cited in research, a more recent analysis by Crais and colleagues (2004) suggested several caveats due to their findings that the contact to distal gesture hierarchy varied by communication context. In a sample of 12 children, the order of gesture development appeared to be related not only to contact versus distal and gesture type, but also to the function of the gesture. Specifically, reaching toward objects and reaching to be picked up developed prior to the emergence of many contact gestures (e.g., giving). Crais and colleagues hypothesized that despite being distal gestures, reaching toward a caregiver or toy is more closely related to the actions from which they emerge (e.g., grabbing a toy or being lifted up). Thus, in reference to the distancing theory, the contextualization of these gestures may make them more "concrete" than other distal gestures (e.g., pointing) that are not as contextually bound (2004). With these caveats in mind, the contact-to-distal conceptualization can still be useful in assessing early presymbolic communication development. Use of distal gestures above and beyond use of contact gestures has been associated with more advanced communication skills such as higher frequency of communication, wider range of communication functions and greater ability to repair communication breakdowns (Mclean, Brady & Etter, 1991; Wetherby, 2004). As distal gestures may be conceptualized as a stepping-stone to symbolic communication, children who continue to rely on contact gestures in isolation may be demonstrating a disruption is early symbolic development.

Importance of presymbolic communication. Though children with developmental delays may reach communication milestones later in life, presymbolic communication skills provide the foundation for later symbolic communication in both typically developing and developmentally delayed populations (Brady, Marquis, Fleming & Mclean, 2004; Wetherby, et al., 2003; Wilcox et al., 2000). Presymbolic skills that predict later symbolic communication skill levels include complexity and frequency of vocalizations (Stoel-Gammon, 1991; 1998; Wetherby, et al., 2003), rate of intentional communication (Brady et al., 2004; Calandralla & Wilcox, 2000), presence/absence of distal gestures (Brady et al., 2004), combining gestures with vocalizations (Mundy, 1995; Wetherby et al., 1988), symbolic play skills (McCathren et al., 1998), and variety of gestures used (Brady et al., 2004; Calandralla & Wilcox, 2000). Indeed, several researchers have reported that nonverbal intentional communication rates approaching 1 per min are associated with children's transition from presymbolic to initial symbolic communication (Wetherby et al., 1989; Wetherby & Prizant, 1993; Wilcox, 1993). Moreover, presymbolic communication abilities at 12 months of age are predictive of receptive and expressive communication outcomes at 3 and 4 years of age in neurotypical, language-delayed and developmentally delayed populations (Wetherby, 2003; Mcatherine, Yoder & Warren, 1999). Children with limited presymbolic communication competency struggle to develop any forms of symbolic communication (Mcatherine, Yoder & Warren, 2000; Wilcox, 1993; Wetherby, 2003). Deficits in early communication are also highly associated with later social emotional and behavioral difficulties (Beitchman, Hood, & Inglis, 1990; Carson, Klee, Lee, Williams & Perry, 1998). Thus, rather than waiting for children to develop verbal language, assessment of presymbolic predictors is an essential part of improving early identification and intervention.

Symbol Use

Symbolic communication. Children who establish a range of presymbolic behaviors that are then reinforced by communication partners typically transition to symbolic communication around 12-13 months of age (Wetherby, 1998). Symbolic communication refers to communication signals that do require an association between a symbol (e.g., word, sign or picture) and its referent (Wetherby & Prizant, 1992). It is important to note that symbolic communication can include a range of non-verbal modalities such as sign language or picture communication systems; however, this discussion will focus on verbal symbolic communication.

First words are typically context or event-related such that they may not refer to specific objects/people but instead symbolize a highly contextualized situation (e.g., saying "uh-oh" when a block tower crashes). Over time, children increasingly develop words associated with specific objects/people that are less context-bound (Wetherby, Reichle &Pierce, 1998). Initial word acquisition is typically slow and includes "vocabulary attrition" as children will stop using an old word when a new word emerges and then reintegrate their old words with their newer vocabulary (Bloom &Lahey, 1978; Wetherby et al., 1998). By 18 months, children typically produce about 50 single words (Brown, 1973). In many, but not all children, this is followed by a "vocabulary burst" from 18-21 months (Bates, Dale &Thal, 1995; Bloom, 1993). During this "burst" many children may gain up to 3 words per week (Bloom, 1993). By 24 months of age, a typically developing child is producing frequent 2-word combinations and relying on verbal language more than gestures to communicate (Crais, 2009; Wetherby et al., 1998). When combining words, prosodic emphasis is used to indicate new ideas or words that the child cannot yet symbolically express within an utterance; infants mimic their mother's use of intonation to produce conversational utterances with intonational expression (Marwick, 1987). Throughout this process, maternal use of language modeling and responsivity play pivotal roles in a child's vocabulary acquisition (Yoder et. al, 1998).

Symbolic play. Symbolic play has received increased attention in discussion of symbolic language development, as these distinct domains appear to emerge in parallel. As a child begins to use single symbols (words) in language, they are also beginning to use single step symbolic actions in their play. As their communicative use of symbols advance, symbolic play advances in parallel (McCune,1995). Thus, it has been theorized that symbolic play and language are both reflections of an underlying capacity for symbolic representation (McCune, 1995). Symbolic play during the second year of life is predictive of later symbolic communication abilities in neurotypical and developmentally delayed populations (Lyytinene, Poikkues, Laakso, Eklund & Lyytinen, 1999; 2001). Similarly, symbolic play levels may differentiate between children who are "late bloomers" with language and those who go on to develop more significant impairments such as ASD (Wetherby & Prizant, 1992). As early assessment focuses on naturalistic contexts that typically include opportunities for play, symbolic play may be an important aspect of early communication assessment.

Summary of Communication Modalities

By their second birthday, children have established an array of presymbolic and symbolic communication modalities (Wetherby et al., 1998). Throughout a child's transition through these early stages of communication development, a bidirectional, reciprocal relationship exists between parent responsiveness and the quality of a child's communication signals (Wetherby, Warren & Reichle, 1998). Moreover, in typical and DD populations, a child's mastery of each stage of communication builds the foundation for the next stage. Thus, communication modalities extend beyond the use of words and envelop a complex range of social-cognitive and environmental factors that must be considered.

Communication Functions

In addition to developing an array of communication means, the development of communication *functions* is an equally important aspect of communication (Wetherby & Prizant, 2001). Communication functions refer to the "why" of communication: That is, the intention of the communicator and/or the effect of communication on the communication partner (Bruner, 1981; Wetherby & Prizant, 1989). Prior to the development of symbolic communication, children learn to communicate for a variety of reasons. These functions are often divided into three categories, first conceptualized by Bruner (1981): behavior regulation (acts used to regulate the behavior of another for the purposes of obtaining or restricting environmental goals), social interaction (acts used to direct the attention of another to oneself or for affiliative purposes) and joint attention (acts used to direct the attention of another for purposes of sharing the focus on an entity or event). Behavior regulation functions typically emerge first, between 7 and 10 months of age. Expressive joint attention and social interaction typically emerge after behavior regulation has emerged, between 9-15 months of age (Butterworth & Grover, 1990; Carpenter, 1983; Crais et. al, 2004). In typical development, most children use all three of these communication functions before their first words have emerged (Wetherby, 1988). Children with language delays demonstrate this same pattern, communicating a range of communication functions commensurate with language-matched controls (Leanard, Camarate, Rowan & Capman, 1982; Rom and Bliss, 1981). Thus, social uses of communication are not dependent on the emergence of verbal language.

Receptive Language

Language comprehension is often overlooked in discussions of early language development. Early receptive language development plays an important role in later receptive and expressive language abilities (Wetherby et al., 1998). According to the social-pragmatic theory of language acquisition (Carpenter & Tomasello, 2000), all language skills emerge out of a child's nonverbal understanding of the world. This non-verbal understanding develops across shared social experiences with caregivers in which infant and caregiver jointly focused on events or objects in their environment (Carpenter & Tomasello, 2000). Thus, understanding social-cognitive development provides an important foundation for early language development.

One of the most highly studied social-cognitive underpinnings of early receptive language development is joint attention (Butterworth & Jarret, 1991; Mundy et al., 1995; Tomasello, 2000). Joint attention is described as the ability to coordinate attention between people and objects for social purposes (Tomasello, 2000). The ability to *respond* to joint attention by following the gaze and/or head turn of an adult emerges around 6 months of age and refines through 18 months of age (Butterworth & Jarret, 1991). Mundy and colleagues (1995) reported that a child's ability to follow an adult's gaze or point (*respond* to a bid for joint attention) was a significant predictor of receptive language development, even when controlling for variance in initial language and cognitive abilities. Moreover, the ability to *follow*, not initiate, a gaze or point for the purposes of joint attention, was uniquely predictive of receptive language abilities (1995). Thus, the conventional understanding of receptive language as referring to comprehension of only symbolic language (e.g., words) neglects the social-cognitive underpinnings of a child's ability to comprehend and attend to non-verbal cues in their environment. Indeed, similar to expressive language development, there appears to be a continuum from presymbolic comprehension (e.g., responding to non-verbal social and environmental) to symbolic comprehension (e.g., responding to words) in receptive language development.

As a typically developing child transitions into symbolic expressive language development, the ability to respond to these non-verbal cues is less predictive of later language ability. Instead, response to *verbal* language becomes more predictive of further language development (Tomasello, 2001). Thus, learning new words is not “wedded” to specific non-verbal cues such as gaze direction, bur rather on the verbal modeling of caregivers. In neurotypical children, language comprehension precedes symbolic language expression (Huttenlocher, Janellen Solso, Robert L.,1974; Wetherby et al., 1998). Young children begin to understand words as their presymbolic communication skills develop, around 9 or 10 months of age (Bates, 1979; Fenson et al., 1994). Initially, children rely on various contextual cues to respond to verbal language (Wetherby et al., 1998). By 12 months of age, children understand familiar words in context and by 18 months children demonstrate understanding of 50 single words (Fenson, 1994). As a child decreasingly relies on environmental cues to comprehend language, there is a positive relationship between a child’s comprehension level and the amount of adult scaffolding provided (Platt & Coggins, 1990).

Receptive language during this period in which children develop symbolic language, is a significant predictor of later receptive and expressive language abilities (Watts et. al, 2006). In Bates and colleagues’ “Three strand model” of early language development, the first strand is conceptualized as the mechanism responsible for language comprehension (Bates et al., 1988). In their detailed analysis of the first strand of language development from 10 to 28 months of age, these researchers concluded that children with higher comprehension abilities early in life “have reached insight into the idea that things have names” (Bates et.al, 2008). This early symbolic association between a symbol/word and its referent receptively provides a natural bridge to symbolic expression.

Though comprehension is indeed important, direct assessment of receptive language has been criticized as unreliable in infants under 2-years of age due to difficulty differentiating lack of compliance from comprehension deficits (Coggins et al., 1998). Thus, for young children, parent report has been suggested as a more reliable measure of language comprehension (Bates, 1993). As a result, there has been an effort to create more reliable direct assessment methods of early receptive language (Coggins, 1998). Watt and colleagues reported that in assessing young children, the receptive language component of the Communication Symbolic Behavior Scales: Developmental Profile (CSBS:DP) revealed more valid and reliable results than many other direct assessment methods, with CSBS comprehension scores correlating strongly with parent reported comprehension scores on related measures (Watt et al,2006). This suggests that reliable direct assessment of early receptive language abilities may be achievable when naturalistic, parent-participatory assessment strategies (such as the CSBS:DP) are utilized.

In summary, a broad conceptualization of receptive language is necessary when assessing very young children. First, social-cognitive underpinnings of language comprehension, such as the ability to respond to joint attention bids and share focus with caregivers, must be considered. In addition, as a child begins to understand symbols and consequently move toward symbolic expression (e.g., acquisition of words), naturalistic, parent involved contexts may be especially important in the validity of receptive language assessment.

Early Communication Development in Autism Spectrum Disorders

As the understanding of early communication development in neurotypical and developmentally delayed populations has increased, researchers have discovered a unique early communication profile in children with ASD. Communication impairment is one of the key diagnostic features of ASD and is the earliest symptom reported by most parents of children with ASD (Filipek et al., 1999; Landa, 2006). Moreover, one of the strongest predictors of long-term outcomes for children with ASD is the acquisition of spoken communication (Toth et al., 2006). An understanding of the unique communication profiles of children with ASD has significant implications for early assessment and intervention. As in the previous discussion of communication development in neurotypical populations, aspects of communication development in children with ASD will be broken into three dimensions of early communication development: Communication Modalities (*how* children communicate), Communication Functions (*why* children communicate) and Receptive Language (*what* children understand).

ASD: Communication Modalities

Preintentional behaviors in ASD. Differences in communication development of children who are later diagnosed with ASD may be present as early as the first year of life (Paul, Fuerst, Ramsay, Chawarska, & Klin, 2010; Sheinkopf, Mundy, Olier, and Steffens, 2000; Trevathern & Daniel, 2005; Yirmaya, Gamleil, PIlowsky, 2006). For example, the vocalizations of infants that go on to develop ASD may be desynchronized with their caregivers when compared to children that go on to develop typically (Trevathern & Daniel, 2005; Yirmaya, Gamleil & Pilowsky, 2006). Children that go on to develop ASD are also more likely to have a history of delayed onset of babbling in infancy (Iverson & Wozniak, in press). Presymbolic vocalizations may also be unusual in ASD populations as a greater proportion of their vocalizations include atypical sounds such as squeals, growls and yells (Sheinkopf, Mundy, Olier, & Steffens, 2000). Though there is less information available about the preintentional phase of development in ASD, these findings suggest that infants that go on to develop ASD may demonstrate deficits in the preintentional communication methods that typically serve to regulate interactions between infant and caregiver.

Intentional presymbolic communication in ASD. Specific deficits in the presymbolic communication modalities of children with ASD have also been documented in numerous research studies. Children with ASD do not compensate for lack of verbal skills with gestures as might be seen in young typically developing infants who have not yet developed language or in language delayed children (Landa, 2007; Wetherby et al., 1998). Instead, their language impairment is associated with gestures that are limited in both quantity and quality (Woods & Wetherby, 2003). Children that go on to develop ASD use communicative gestures with less frequency than children that go on to demonstrate typical development (Wetherby, 1984, 1998). In addition, children with ASD tend to rely on contact gestures in a manner not seen in neurotypical or developmentally delayed populations (Shumway & Wetherby, 2009). In addition to having a general deficit in early presymbolic communication, children with ASD may also demonstrate an atypical order of development (Lord, 1995; Cassel, 2006; Woods & Wetherby, 2003). That is, individuals may continue to struggle to use more basic communicative means such as gaze shifts and pointing despite emergence of more advanced communicative behaviors such as leading and word approximations (Lord, 1995; Cassel, 2006). Wetherby and colleagues also reported that children with ASD are more likely to use gestures in isolation while children with typical development integrate gestures with vocalization (1998). In a longitudinal prospective study of infant siblings at high and low genetic risk for ASD, Estes and colleagues reported significant expressive language differences in infants that went on to develop ASD as early as 6 months of age (2012, in press). This pivotal finding at such a young age indicates significant communication differences in the earliest stages of communication development. These findings suggest that children enter the presymbolic stage of communication with deficits that may go on to impact their progression through more advanced stages of communication.

Importance of presymbolic communication. Presymbolic communication deficits have significant implications for later language development (Wetherby et al., 1998; Watt et al., 2006). Gesture use is predictive of later symbolic language in children with ASD (Stone &Yoder, 2001). Reduced gestural communication at 12 and 24 months of age distinguishes between children with ASD and Developmental Delay or Language Delay (Adren et al., 1993). Children that go on to develop ASD possess a more restricted means of communication and communicate less frequently than children with typical development (Woods & Wetherby, 2003). As the frequency and clarity of communicative signals is reduced, the reciprocal relationship between a child's communication signals and parent facilitation/responsivity is disrupted. This disruption may play a role in a child's continued communication deficits transitioning to symbolic language development.

Symbolic communication in ASD. The onset of symbolic communication is delayed in many children that go on to develop ASD (Luyster, 2009). Delay in spoken language is often the first ASD referral concern reported by parents and speech-language pathologists (Landa, 2006). Interestingly, the importance of single word vocabulary in gauging ASD symptoms reduces with age. Over time, single word vocabulary actually becomes a relative strength for most children with ASD as their scores on single word vocabulary assessments may be significantly higher than assessments that focus on more complex or pragmatic aspects of communication (Paul, 1987).

As children with ASD move beyond single word use, their language may be marked by unusual characteristics including unusually scripted or repetitive language, echolalia and pronoun reversal (APA, 2000). The majority of children with ASD go through a period of immediate and/or delayed echolalia production (Prizant, Scheuler, Wetherby & Rydell, 1997). These echolalic utterances are often used purposefully, but may lack symbolic association; rather than demonstrating a word-referent association for each unit of meaning, the child may treat the entire utterance as having a single unit of meaning (e.g., "It's time for dinner" is used to express hunger) (Woods & Wetherby, 2003). Many children with ASD who purposefully use echolalia will learn to break these utterances into smaller meaningful units and use them more flexibly as they progress in their symbolic language development (Prizant & Rydell, 1993).

Symbolic play in ASD. In children with ASD, these deficits in symbolic language are often paralleled by unique deficits in symbolic play (Landa, 2006). Children with ASD demonstrate a unique play profile as they may possess age appropriate or even advanced levels of construction play (e.g., puzzles, stacking blocks), while demonstrating deficits in functional object use and symbolic play when compared to typically developing children or children with language delays (Wetherby et al., 1998). Indeed, lack of varied, spontaneous symbolic play is one of the four possible features listed under communication impairments in the DSM-IV (APA, 2000). The inclusion of symbolic play under the communication category of impairment is illustrative of the relationship between symbolic use in play and symbol use in language. Thus, the symbolic deficit observed in ASD may extend to domains beyond symbolic language acquisition into the play behaviors.

Summary of Early Communication Modalities in ASD

Children with ASD clearly demonstrate differences in their acquisition of various communication modalities throughout the early stages of communication development. In addition, it is important to note that the *trajectory* of skills across these stages is also unique in infants and young children that go on to develop ASD (Landa & Garret-Meyer, 2006). Indeed, prospective studies of HR infant siblings have reported a progressive slowing in the rate of expressive language development from 6-24 months of age (Landa & Garrett-Mayer, 2006). Moreover, regression in communication skills in the second and third years of life has been reported in up to 20-40% of children with ASD (Lord, 2004; Ozonoff et al., 2005). This pattern of progressive slowing and regression in many children with ASD is unique to this population. Approximately 80% of children with ASD will acquire at least 5 spoken words (Lord et al., 2004). The majority of these children will continue to demonstrate significant delays in receptive and expressive language while 1/3 of children will demonstrate social-communication/pragmatic deficits without language impairment (Aleen & Rapin, 1990, 1992). As social-communication is impacted, regardless of level of expressive or receptive ability, attention to how and why children with ASD communicate is particularly relevant.

ASD: Communication Functions

Many early language assessments may focus predominantly on inventories of words and sounds (Wetherby & Prizant, 1992). However, social-communication, that is how and why a child uses their communication methods, is particularly important for children at risk for ASD (Ozonoff, Goddlin-Jones & Solomon, 2005). Deficits in social-communication may be more evident at younger ages compared to deficits in language and syntax (Zwaigenbaum, 2005). The functions of early communication demonstrated by children that go on to develop ASD appear to be unique from developmentally delayed and neurotypical populations. Children with ASD initiate all communication functions less frequently than typically development children (Landa, 2007; Wetherby, 2004). However, children with ASD demonstrate unique and more extreme deficits in social functions of communication (Mundy, 1989; Wetherby, 1986; Wetherby and Prutting, 1984; Osterling & Dawson, 1994). That is, the preponderance of their communication acts serve behavior regulation purposes such as requesting or protesting; social interaction functions are significantly reduced and Joint Attention functions are rare to absent in young children with ASD when compared to typically developing children. Indeed, reduced joint attention is considered a core deficit in autism (Landa, 2006).

ASD: Receptive language

The ability to follow the attentional focus of caregivers was previously discussed as a potentially important underpinning of receptive language development. The ability to attend to non-verbal cues to share focus with others may provide a bridge to comprehension of verbal cues. Thus, a discussion of differences in early social-cognitive skills should be included in discussions of receptive language development in ASD.

Prospective infant sibling studies have revealed that children that go on to develop ASD may have deficits in visual attention as early as 4 months of age (Bryson, 2004; Landry & Bryson, 2008). Zwaigenbaum and colleagues (2005) also reported that siblings who later develop ASD demonstrate atypical visual attention development. In a prospective longitudinal study of 65 high-risk infant siblings and 75 low-risk controls, these researchers found that children who develop ASD have significant difficulties shifting visual attention between two competing stimuli (e.g., shifting attention from a rattle being shaken on one side of their visual field when a squeaky toy is introduced on the right hand side). Interestingly, performance at 6 months did not predict diagnosis. However, a subgroup of children demonstrated a worsening (increased latency in shifting attention) from 6-12 months. This worsening was unique to infants that went on to develop ASD. In comparison, typically developing infants demonstrated consistent improvement (decreased latency) across timepoints. Thus, while findings regarding the onset in early attention difficulties are inconsistent, unique deficits in the ability to visually shift attention appear to be present within the first year of life in children that go on the develop ASD (Zwaigenbaum et al., 2005).

Early reports with small samples have also suggested that 6-month old infants who go on to develop ASD may shift their spontaneous attention mainly toward nonsocial stimuli rather than toward social stimuli when compared to neurotypical children (Maestro, et al., 2002). These differences in early attention have been discussed as a possible underlying contributor to this population's ongoing difficulties attending to non-static, novel social stimuli. Consequently, children that go on to develop ASD may not establish the ability to attend to and understand non-verbal cues in their social environment. Without understanding these cues, they may struggle to attend to and comprehend later symbolic verbal cues.

By 12 months of age, reduced receptive language abilities in children that go on to develop ASD are evident through parent report (Zwaigenbaum et al., 2005), retrospective home videotape analysis (Osterling, 2005), and standardized behavioral assessment (Zwaigenbaum et al., 2005; Estes, in preparation). In contrast to typically developing children, the relationship between response to non-verbal cues and language outcomes appears to persist even as children advance in their expressive language abilities. For example, Murray and colleagues (2008) found that the ability of 3-5 year old children with ASD to *respond* to the joint attention bids was positively correlated with receptive language scores and mean length of utterance. Interestingly, for many children that go on to develop ASD, receptive language scores may be more significantly impacted than expressive language scores (Maljaars, Noens, Scholte, 2012; Stone 1997; Toth et al., 2007; Wetherby 1998; Zwagenbaum et al.,2005). While language delayed children may have stronger receptive than expressive language, children with ASD may demonstrate a unique profile in which receptive language was more impacted in early development of children with ASD.

Summary of Early Communication Development in ASD

From differences in babble and gesture inventories to delayed onset of verbal language and social-communication deficits, children with ASD present with a unique profile of early communication behaviors. Infants and young children who present with intact expressive language scores on measures that focus on sound/word inventories and syntax, may still be at risk for ASD or BAP characteristics (e.g., language disorders or social-communication deficits), particularly if receptive language, symbolic play and social communication are atypical. Thus, when evaluating children at risk for ASD, a wide range of communication behaviors must be considered, including presymbolic communication, symbol use, social-communication, and receptive language development.

Communication Spontaneity

One aspect of early communication development that has received limited attention is communication spontaneity (CS). CS has been conceptualized as the level of environmental support required for a child to initiate a communication act (Carter, 1996). CS has been described as an important aspect of functional communication (Charlop et al., 1985; Carr & Kolingsky, 1983; Carter, 2002). For example, spontaneous communication allows individuals control over the instigation and termination of interactions rather than relying on a communication partner to determine these aspects of an interaction (Jones & Feeley, 2007; Reichle & Johnston, 1999). In addition, if spontaneity is limited, an individual's personal needs may not be met until those needs are obvious to others in their environment, resulting in reduced independence and potential frustration or discomfort (Potter & Whittaker, 2001). **In fact, promoting spontaneity of communication in children with ASD has been suggested as a priority for early intervention programs** (Woods & Wetherby, 2003).

CS can range from very low (i.e., dependent on adult cues) to very high (i.e., based on individual, internal motivation). Within the existing literature on CS, there has been extensive debate and diversity in the definition of spontaneity with two conceptualizations predominating (Carger & Hotchkins, 2002). First, the *Binary* model, in which a communication act is seen as either spontaneous or reactive, dependent on the antecedents to a communicative act (Carter & Hotchkis, 2002; Carter et al., 1996). For example, communicative acts preceded by a prompt within a maximum number of seconds (the amount of which varies by study) would be considered reactive and all other communicative acts spontaneous. In contrast, the *Continuum* model of CS has been proposed as a way to more fully address the wide range of environmental variables that influence communication (Carter, 1992, 2002; Carter & Hotchkis, 2002; Halle, 1987). The continuum conceptualization recognizes that all communication occurs in an environmental context that provides a wide range of levels and types of cues. Thus, communication spontaneity is not an "all or nothing" phenomenon; but rather communication acts have a level of spontaneity based on the obviousness and intrusiveness of the prevailing antecedents (Halle, 1987,Carter & Hotchkins, 2002). For example, a child may initiate a request for a cookie in response to the internal sensation of hunger; another child may initiate in response to the environmental cue of seeing someone else eating a cookie; whereas another child may not initiate this request until an adult asks, "Do you want a cookie?" These three children represent different levels on the CS continuum.

Current Understandings of CS

Previous research has focused on spontaneity of symbolic communication in individuals aged 3 and older (Charlhop et al., 1985; Carr & Kolingsky, 1983; Carter, 2002). For example, Charlop and colleagues (1985) studied verbal communication and reported that children with

ASD required high levels of prompting to communicate verbally. Carr and Kolingsky (1983) reported similar findings of prompt dependence for children with ASD learning sign language. Tone and Caro- Martinez (1990) and Zonolli (1997) both reported that children with ASD required adult prompts to initiate social interactions resulting in low rates of initiation. While these studies documented potential deficits in spontaneity in ASD populations, they utilized a binary conceptualization of spontaneity and focused on symbolic communication. Moreover, there were no control groups utilized to offer a normative comparison for observed CS in individuals with ASD.

More recently, several studies have begun to utilize a continuum conceptualization of communication spontaneity (Chiang, 2008, Carter, 2003). Chiang (2008) conducted a preliminary analysis of communicative spontaneity of children with ASD who had limited spoken language in their natural environment. 32 children ages 3-16 years were observed in their classroom environments. Their communication acts were coded according to the continuum model (based on level of antecedent intrusiveness). The majority of communicative acts (76.18%) were at the highest end of the continuum (least spontaneous). Less than 10 percent of the communicative acts were at the lowest end of the continuum (most spontaneous). A key finding was that the level of communicative spontaneity was higher in non-symbolic communicative forms (e.g., gestures) than symbolic forms (e.g. writing, graphic symbols).

One study by Carter (2003) studied 23 children with high support needs who used Augmentative and Alternative Communication (AAC) in a classroom setting using a continuum conceptualization of communication spontaneity. Results indicated that spontaneity was found to be highly variable, with many students lacking the spontaneity associated with functional communication. Students required higher levels of adult support to use aided AAC systems (e.g., voice output devices, picture communication systems), resulting in lower spontaneity when compared to signing or non-symbolic communication (e.g., gestures or vocalizations). In addition, communication acts for behavior regulation functions (e.g. requesting and protesting) were demonstrated more spontaneously than social communication functions (e.g. commenting).

In a related study, the same authors examined teacher responses to these same students' various communication attempts. Results indicated that the probability of communication being successful decreased with increasing spontaneity. That is, it appeared that spontaneous student requests and rejections were generally not particularly effective in obtaining appropriate delivery or removal of relevant items or activities. Conversely, more prompted communicative acts were more likely to be associated with a relevent response from the teacher (Carter, 2003).

In a more recent study, Colgan and colleagues (2006) analyzed early gesture use in 14 typically developing 9-12 month old children and 12 9-12 month old children later diagnosed with ASD. The authors retrospectively analyzed home videos of all children and coded their social interaction gestures. Their logistic regression analysis found that decreased variety in *type* of social interaction gestures (e.g., pointing, showing, waving) was significantly associated with ASD status. Neither number of total gestures nor spontaneity of gestures (child-initiated vs. prompted) was significantly associated with ASD status. However, the authors emphasized the need for additional research on the relationship between communication initiation and diagnostic outcomes given their small sample size and lack of additional studies measuring this relationship. Moreover, this study focused solely on social interaction gestures; it is unclear if these findings would hold true for all communication functions, such as requesting and protesting (Behavior Regulation) or joint attention functions in children with ASD.

Future Directions in CS Research

While existing literature has documented potential deficits in CS in various populations, there is a clear need for additional research. Previous studies have largely focused on symbolic communication in children ages 3 and up. The limited research on *presymbolic* communication has focused on social gesture use. There continues to be a need for information on very young children's presymbolic communication spontaneity across communication functions.

In addition, previous examination of gesture spontaneity relied on observation in naturalistic contexts (e.g., home videos or classroom observation). While this provides an advantageous glimpse of the child in naturalistic environments, a more standardized analysis might better control for variables such as variations in communication environment and parent responsivity, thus allowing greater comparability both within and between individuals over time.

Perhaps one of the most significant shortcomings in CS research is the lack of understanding of the nature of CS. To date, there is no normative data of CS development in typically developing populations. Without normative data, findings regarding CS in developmentally delayed or ASD populations are difficult to interpret. Before understanding CS deficits, the field must determine if CS is a developmental construct. In other words, is CS something that children master with age? Are differences in CS due to a skill deficit or simply individual differences associated with other variables such as temperament? For example, in longitudinal study of HR and LR infant siblings, Zwaigenbaum et al. (2006) reported that "marked passivity" temperament styles in 6 month olds may be associated with later ASD diagnosis. That is, at 6 months of age children that went on to develop ASD were observed to be somewhat passive, with relatively few initiations and less responsiveness to efforts to engage their attention compared to those that did not receive an ASD diagnoses. However, it is not understood how this temperament quality in infancy may impact communication development as a child transitions into acquiring presymbolic and later, symbolic communication skills. For example, do more passive children require more prompts to communicate, thus have lower CS? Normative data will allow us to put data on CS in ASD populations in context.

In addition to the lack of understanding for the nature of CS, there is a gap in the field regarding the relevance/predictive value of communication spontaneity. Small studies focusing on severely impacted individuals have suggested a link between CS, functional communication, and independence (Carter & Grunsell, 2001; Kaczmarek, L, 1990; Kaczmarek, Evans & Stever, 1995); however, there are no data showing the relationship between CS and later communication development.

Finally, there is limited understanding of the causation for possible CS deficits described in ASD. In an overview of CS and ASD, Chiang and Carter (2008) described potential explanations that have been offered in the literature including the following: (1) overly structured intervention methods potentially decreasing the spontaneity of children with ASD (2) failure to systematically instruct for spontaneity (3) inherent deficits associated with ASD (e.g., attention deficits) (4) impact of comorbid intellectual disability (5) difficulty attending to relevant multiple stimuli inherent in complex social and communication interactions.

Additional research is needed to better understand the nature, relevance, and development of communication spontaneity in typically developing children as well as children with developmental disabilities such as ASD. CS may be an aspect of the social-communication profile of children with ASD. If so, additional research will aid in the development of appropriate assessment tools and interventions.

Purpose of the Present Study

The purpose of the current study is to explore early communication development – with a focus on communication spontaneity (CS) – in infants at high and low genetic risk for developing autism spectrum disorder (ASD), and to examine whether aspects of CS uniquely contribute to ASD diagnosis and symptom severity. Working with HR infants prior to diagnosis may allow for earlier identification of ASD symptoms. Inclusion of low-risk (LR) infants (children with no older sibling with ASD) was important to obtain important data on communication development in non-clinical populations. The following research questions and corresponding hypotheses will be examined from the data collected.

Research Question #1: What is the Communication Spontaneity (CS) profile among low-risk (LR) and high-risk (HR) 12-month-old children, and among children who meet Autism Diagnostic Observation Schedule (ADOS) criteria for ASD at 24 months and those who do not (ASD and NonASD diagnostic groups)? What are the relationships between CS and other aspects of social communication development, including expressive and receptive language, and other measures of social communication at 12 and 24 months, as well as ASD diagnosis and symptom severity at 24 months?

Hypothesis: Children in ASD and HR-NonASD groups will demonstrate lower scores on measures of language and social-communication, including CS, as compared to LR-NonASD children. Children with higher CS scores will demonstrate higher language and social communication scores at 12 and 24 months of age. Higher 12- and 24-month CS will be associated with lower 24-month ASD symptom severity scores.

Research Question #2: What is the unique relationship between 12-month CS and 24-month ASD outcomes (ADOS diagnostic group and symptom severity), after controlling for language abilities? Specifically, what is the unique contribution of CS of communication acts in response to direct prompts from the communication partner (CS-SP-Direct Prompts subscore)?

Hypothesis. CS-SP-Direct Prompts will contribute significantly to ADOS ASD diagnosis and severity score, after controlling for language. Specifically, children with lower CS-SP-Direct Prompts scores will be more likely to be in the ASD group and demonstrate higher ADOS ASD symptom severity scores at 24 months.

Research Question #3: Does CS change between 12- and 24-months of age, and does CS development between 12- and 24-months differ by risk or diagnostic group?

Hypothesis*:* Children in all groups will demonstrate increases in CS between 12- and 24-months of age. There will be differences between diagnostic groups, but not risk groups, on CS: children in the ASD group will demonstrate smaller gains in CS compared to NonASD children.

Research Question #4: Are CS differences part of the broader autism phenotype (BAP)? Specifically, within the NonASD group, do HR children demonstrate lower CS than LR children? In HR-NonASD children (who are more likely to demonstrate BAP characteristics), what is the unique relationship between 12-month CS and 24-month ASD symptom severity, after controlling for language?

Hypothesis. CS will be associated with the BAP features. Specifically, within the NonASD group, HR children will demonstrate lower 12-month CS compared to LR children.

Within the HR-NonASD group, lower CS will be uniquely associated with higher ASD symptom severity at 24 months.

Chapter 3: Methods

Sample

There were 81 participants for this study. Participants were a subsample of the Infant Brain Imaging Study[1] (IBIS), a multi-site, longitudinal study of early brain development in infants at risk for ASD. The IBIS examines the brain and social-behavioral development of high and low risk children from 6 to 36 months of age. As described by Estes and colleagues (in preparation), exclusionary criteria for participation in the IBIS study include the following: (1) diagnosis or physical signs of known genetic conditions or syndromes (e.g., significant dysmorphology, asymmetry on physical exam), (2) significant medical or neurological conditions affecting growth, development or cognition (e.g., CNS infection, seizure disorder, diabetes, tuberous sclerosis, congenital heart disease) or sensory impairments such as significant vision or hearing loss, (or evidence during the course of the study), (3) children with birth weight less than 2000 gms and/or gestational age < 37 wks, history of significant perinatal adversity, exposure in-utero to neurotoxins (including alcohol, illicit drugs, selected prescription medications), or a history of maternal gestational diabetes, to reduce the possibility of including children who may have suffered significant perinatal brain injury, (4) contraindication for MRI (pacemaker, vascular stents, metallic ear tubes, other metal implants), (5) families with predominant home language other than English; (6) children who were adopted or half siblings, (7) FMR1 expansion, (8) 1st degree relative with psychosis, schizophrenia, bipolar disorder, and (9) infants who are twins.

Infants were defined as high risk (HR) in this study if they had a sibling who met ASD criteria on an autism screening measure (Social Communication Questionnaire; Rutter et al., 2003), and a semi-structured interview (Autism Diagnostic Interview, ADI-R; Lord et al., 1994) conducted by study staff, and confirmation by medical records. HR infants were included if they were 1) under age 6 months at enrollment, and 2) had an older, full sibling with a clinical diagnosis of an ASD based on medical records and criteria for ASD on the ADI-R conducted by study staff. Similarly, infants were defined as low risk (LR) if they had only typically developing older siblings who did not meet autism screening criteria (SCQ, FIGS) and were included if they 1) were under age 6 months at enrollment, 2) had an older sibling, and 3) had no 1st degree relative with history of ASD or intellectual disability (Estes et al., in preparation).

For brevity, a subsample of data from HR (*n*=59) and LR infants (*n*=42) from the University of Washington were selected for inclusion this study. Twenty of these infants were not included in the analysis sample (LR *n*=11, HR *n*=9) for a variety of reasons: eight infants (LR *n*=4, and HR *n*=4) did not complete the 24-month assessment or completed the 24 month assessment outside of the permitted age-window, one infant (LR n=1) withdrew from the study, four infants'(LR *n*=2, HR *n*=2) assessment recordings were uncodable due to audio-visual difficulties, and seven infants' data (LR n=4, HR n=3) were not collected in time to be included for analyses.Thus, the final analysis sample of infants included 50 HR and 31 LR infants.

Demographic information for the original and final analysis samples are summarized in Table 1. Fisher's Exact test was used to test differences in demographic characteristic proportions between (a) infants in the final analysis sample compared to those who were in the original sample, and (b) HR and LR infants in the final analysis sample. There were no significant differences between the final analysis sample and the original sample except that a larger proportion of minorities than non-minorities dropped out of the study, $p < .05$. Importantly, there were no significant demographic differences between HR and LR groups within the final analysis sample.

Measures

The following measures were collected over two days of testing. Each participant was individually assessed by a research clinician while seated at a table with their caregiver seated beside them. Children were allowed breaks and permitted to sit on their parents' lap as deemed necessary throughout the assessment.

Cognitive, Language, Motor and Adaptive Behavior. *The Mullen Scales of Early Learning (*MSEL*;* Mullen, 1995*)* and *Vineland Adaptive Behavior Scales: Parent Interview* (VABS; Sparrow, Balla, & Cicchetti, 1984) were administered during the child's first visit to the clinic. The *Mullen* and *Vineland* were both scored immediately following the assessment to provide diagnostic feedback to the family. The clinician was not blind to risk group status.

The MSEL is a standardized developmental assessment designed for children from birth through 68 months of age. This assessment examines five developmental domains: Gross Motor, Visual Reception (non-verbal problem solving), Fine Motor, Receptive Language, and Expressive Language. The domain data can be combined into the overall Early Learning Composite score. For this study, only the Expressive and Receptive Language scores were utilized. These are norm-referenced T-scores, which are scaled in the general population to have a M=40 and SD=10. Normative data for the Mullen are based on a sample of 1,849 children from the U.S.A. Internal- consistency reliabilities range from .75 to .83 for Mullen subtests and the reliability is .91 for the Early Learning Composite. Test-retest reliabilities range from .78 to .96, depending on the subtest. Inter-rater reliabilities range from .94 to .98 (Mullen, 1995).

The VABS is a standardized parent interview that assesses various areas of adaptive functioning including language, motor, daily-living and social domains. For this study, only the language and social domain scores were utilized. These scores are norm-referenced standard scores, which are scaled in the general population to have a *M*=100 and *SD*=15. Standardization was carried out on a 3,000-individual U.S. sample, representative of the general population by gender, race/ethnicity, community size, geographical region, and SES. The median split half reliabilities of the VABS range from .83 to .95. Reported test-retest reliabilities are in the .80s and .90s. Reported inter-rater reliabilities range from .62 to .75. (e.g., Atkinson, Bevc, Dickens, & Blackwell, 1992).

Social Communication. The *Communication Symbolic Behavior Scales: Developmental Profile* (CSBS:DP*;* Wetherby & Prizant, 1995) was administered during the family's second visit. The CSBS:DP is a standardized assessment of seven language predictors in children including emotion and eye gaze, communication, gestures, sounds, words, understanding and object use. Scores used for analyses were norm-referenced standard scores, which are scaled in the general population to have a *M*=100 and *SD*=15.

CSBS:DP administration includes two parts: Part 1 is a *Structured Play* task in which the clinician presents the child with four activities: wind-up toy, bubbles, balloon and snack. When the activity ends (i.e., wind-up toy stops, bubbles burst, balloon deflates, snack is eaten), the adult waits 7-10 seconds to see if the child will initiate a communication act. If there is no child initiation, the adult uses a structured prompting hierarchy of up to 3 direct prompts outlined in the CSBS manual (i.e., "need help?"). This process is repeated 2 times per activity, for a total of 8 prompting hierarchies. Between each activity, the child is provided a choice of toys to play with as a transition activity. Part 2 is a Free Play task in which the child is presented with 2 unstructured play tasks (books and pretend play materials). The adults engage with the child, predominantly following the child's lead. Part 1 and Part 2 are then coded from videotape. In this study, a group of four graduate research assistants blind to risk and diagnostic status were trained to be reliable on this measure, establishing 90% reliability on a series of CSBS training tapes, followed by 80% reliability between coders and the first author on 2 additional tapes. Ongoing reliability checks were performed every 3 months using independent paired ratings made from videotapes for a randomly selected group of participants (20% of total sample). Any tapes that were found to be unreliable were returned to coders who compared their codes and reached a consensus on all disagreements; consensus ratings were used for further analysis.

Standardization for the CSBS:DP was based on 300 children from 12 to 24 months of age. Most normative data to date have been gathered from a culturally diverse population in the Tallahassee, Florida region. Reported sensitivity ranges from 88.9-94.4% while specificity was reported at 88.9%. Inter-rater reliability has been reported to range from 92-97% (Wetherby & Prizant, 1995). In a more recent and larger study of 1725 the structure of the CSBS:DP was examined using confirmatory factor analyses (CFA). Results indicated that as measures of early communication skill for young infants, the CSBS-DP are valid clinical tools for measuring constructs broadly representing Social, Speech, and Symbolic communication skills (Eadie et. al, 2010).

Communication Spontaneity (CS) Coding. A new measure of communication spontaneity was developed for this dissertation, as CS may be conceptualized as an aspect of social-communication. CS is measured during the CSBS:DP , which provides a semi-structured, interactional context for initial examination of this construct. In addition, the elicitation and measurement of CS under standardized CSBS:DP administration conditions will allow for greater comparability both within and between individuals over time.

Measurement of CS in the CSBS:DP provides information on a previously neglected aspect of children’s early communication. Though the CSBS:DP provides an array of useful information on a child's directed, intentional communication—coded communication acts are given equal credit despite the level of spontaneity of each act. Thus, a child who relies on high levels of adult prompting may receive the same score as a child who requires no prompting to communicate. A coding scheme was designed to capture the level of spontaneity of each communication act coded within the CSBS:DP.

Figures 1 and 2 outline the coding scheme used during the CSBS. A continuum conceptualization of CS was utilized. The spontaneity of each communicative act was scored in terms of the highest prompt level (HPL). The HPL was the most intrusive antecedent prompt for a particular communicative act. CS scores for each communication act ranged from 0 (least spontaneous) to 6 (most spontaneous). Two CS-Total Scores and two subscores were calculated for each child as follows.

(1) ***Structured Play*** (CS-Structured Play Total): Spontaneity points from each communication act during the 8 prompting hierarchies and transition activities were summed. This total number of points was then divided by the total number of communication acts. The CS-Structured Play Total score reflects the mean level of spontaneity per communication act demonstrated across all four activities, including transition activities outside of the prompting hierarchy. To avoid confounding this measure with communication frequency, zero scores were not included in the analyses. All children in the sample demonstrated communication acts during the CSBS, thus the exclusion of zero scores did not exclude any children from the analysis.

To examine the unique contributions of CS in response to direct prompts from a communication partner during the prompting hierarchy (CS-SP-Direct Prompts) and CS in response to environmental cues outside of the prompting hierarchy (CS-SP-Environmental) the CS-Structured Play Total score was divided into two subscores:

a. *CS-SP-Direct Prompts*: This subscore focuses on a child's response to direct prompts from a communication partner during the standardized prompting hierarchy. A mean level of spontaneity was calculated by summing the spontaneity points from each communication act during all 8 prompting hierarchies during structured play and dividing by the total number of communication acts.

b. *CS-SP-Environmental*: This subscore includes only communication acts during transition activities in which communication acts were not preceded by a direct prompt from the communication partner, but may have been in response to other environmental cues (e.g., object cues, internal cues). One point was assigned for each communication act that occurred outside of the prompting hierarchy (acts not preceded by a direct prompt from a communication partner).

(2) ***Free Play*** (CS-FP Total score): The mean level of spontaneity during free play was created by summing the spontaneity points from each communication act coded during the free play portion of the CSBS and dividing by the total number of communication acts. Again, to avoid confounding the CS with communication frequency, zero scores were not included in the analyses.

Communication Spontaneity Coding Reliability. Four graduate research assistants were trained to code the CSBS and CS. After achieving reliability on CSBS;DP coding (see prior measure description), CS training was conducted by the first author. After achieving initial CS coding reliability agreement of 80% with the author on the Wetherby training tapes that had been used in previous CSBS:DP training, the raters then began independently coding additional tapes of children until 80% reliability on 2 consecutive tapes was established between coders and the first author. Ongoing reliability checks were performed every 3 months using independent paired ratings made from videotapes for a randomly selected group of participants (20% of total sample). Any tapes that were found to be unreliable were returned to coders who compared their codes and reached a consensus on all disagreements; consensus ratings were used for further analysis.

ASD Diagnosis and ASD Symptom Severity. The *Autism Diagnostic Observation Schedule)* (ADOS) *(Lord et al., 2000)* was administered at 24 months. The ADOS is designed to elicit behaviors consistent with the symptoms of ASD provided in the DSM-IV (APA, 2000). It was developed to diagnose ASD across a wide range of chronological and mental ages and normed on individuals ranging from 15 months through 40 years of age. An algorithm with extensive validation reliably distinguishes children with ASD from typical and developmentally disabled NonASD controls (Lord et al., 2000). Items are scored from 0 (not abnormal) to 2 or 3 (most abnormal), and a diagnosis of autism or ASD is established if the sum of algorithm items is higher than the established cut-off values. Cutoff scores yield one of three classifications: *Autism, Autism Spectrum,* and *Non-spectrum*. Though there are distinct cutoff values for Autism and Autism Spectrum, due to a small sample size, children in both groups were collapsed as one ASD group. In this paper, the "ASD group" will refer to all children that met the ADOS cutoff score for Autism or Autism Spectrum and the NonASD group will refer to all children whose ADOS scores fell in the "non-spectrum" range. It is important to note that meeting the ADOS cutoff score does not guarantee that the child met clinical diagnostic criteria for ASD. In addition, ADOS ASD severity scores (a continuous metric) were employed. As with ADOS cutoff scores, it is important to note that elevated ADOS severity scores at 24 months do not necessarily guarantee that a child received a clinical diagnosis of ASD. Table 2 provides the definitions of each risk and diagnostic group utilized in this study.

Statistical Analysis Approach

All analyses were conducted using *SPSS 16.0*. Based on the study design, the assumption of independence is tenable as infants were recruited from one geographic area at one site, and there were no instances of siblings from the same family in the sample. Descriptive statistics were calculated for each measure, by risk and diagnostic group, and by age of assessment. Bivariate correlations were also calculated to examine direct relationships among the variables of interest and to ensure no multicollinearity issues in subsequent multiple regression analyses. Analyses of variance (ANOVA) as well as multiple linear and logistic regressions were used to test the research questions. All predictors were standardized (z-scores) for regression analyses for ease of interpretation. Finally, although 81 children were used in final sample analyses, there was some variability among children regarding which specific measures were completed at each time point, thus sample sizes vary slightly for analyses with different measures (and are noted as such in the results). In sum, missing data for predictor variables was <5%, and <5% of item-level data on the CS measure was missing due to audio-visual difficulties for coding videotapes.

Chapter 4: Results

Research Question #1: What is the development of Communication Spontaneity (CS) among low-risk (LR) and high-risk (HR) 12-month-old children, and among children who meet ADOS criteria for ASD at 24 months and those who do not (ASD and NonASD diagnostic groups)? What are the relationships between CS and other aspects of social communication development, including expressive and receptive language, and other measures of social communication at 12 and 24 months, as well as ASD diagnosis and symptom severity at 24 months?

Descriptive Statistics. To date, there is limited information on Communication Spontaneity (CS) in clinical or non-clinical populations. Moreover, this is the first study to utilize the specific CSBS: CS coding scheme developed by the author. Additional information is needed regarding CS in children with ASD and in HR-NonASD children who may demonstrate broader autism phenotype features. Most importantly, information on CS in children who do *not* demonstrate ASD symptoms and are not at heightened genetic risk for BAP features (LR-NonASD group) will provide an approximation of "typical" CS development. Thus, descriptive statistics were computed for all measures across all risk and diagnostic groups at 12- and 24-months of age (see Table 3). Recall that the CS-Structured Play Total score includes two subtypes: (1) communication acts that were preceded by a social prompt within the direct prompting hierarchy (CS-SP-Direct Prompts) and (2) communication acts not preceded by a social prompt/outside of the direct prompting hierarchy (CS-SP-Environmental Prompts).

Differences between Groups. A series of 2 x 2 analyses of variance were conducted on each measure at each time point to determine whether there were (a) significant differences between risk groups (HR vs. LR) or diagnostic groups (ASD vs. NonASD), and (b) whether there were any interactions between risk and diagnostic group.

At 12 months of age, there were two measures in which there were significant differences between risk groups: LR scored higher than HR on Mullen visual reception and Vineland receptive language (*F*-test *p*-values < .05). There was one significant difference between ASD and NonASD groups, with NonASD scoring higher than ASD children on CS-SP-Direct Prompts, *F*-test *p*-value < .05 (see Table 3 for means and main effects' effect sizes). There were no significant interactions among risk and diagnostic groups (all *p*s > .05).

In contrast, at 24 months, there were differences between risk groups on both the Mullen visual reception and receptive language (but not Vineland receptive language), as well as nearly all of the CS outcomes: CS-Structured Play Total, CS-SP-Direct Prompts, and CS-SP-Environmental (*F*-test *p*-values < .05), with the LR group demonstrating higher scores, indicating higher CS, than the HR group. Further, diagnostic groups were differentiated by CSBS Symbolic Play, CS-Structured Play Total, CS-SP-Direct Prompts, CS-Free Play Total, and ASD symptom severity, with the ASD group demonstrating higher scores, indicating higher CS, than the NonASD group. There were no diagnostic group differences in CS-SP-Environmental (*F*-test *p*-values < .05).

There were significant interactions between risk and diagnostic group on CS-Structured Play Total, CS-SP-Direct Prompts, and CS-Free Play Total. To understand the nature of the interactions, subgroup means for these measures are plotted in Figures 3-5, which show that, in the NonASD group, there was little if any difference in CS between risk groups. In contrast, in the ASD group, there were risk group differences with genetically high-risk children demonstrating higher CS than ASD children from the genetically LR group.

Relationships between CS and Existing Developmental Measures. Bivariate correlations are provided for the entire sample in Table 4 (with risk group and diagnostic group dummy coded to show the differences between groups on the measured variables). Groups were then broken out by LR-NonASD children in the lower diagonal and ASD children (upper diagonal) in Table 5 to show the relationships among all variables and CS for LR-NonASD children to compare with relationships for ASD children.

As seen in Table 4, risk group was negatively associated with the following: 12 month Vineland receptive language, 24 month Vineland receptive and expressive language, 24 month CSBS symbolic composite, and 24 month non-verbal problem solving (Mullen-Visual Reception). Diagnostic group was negatively associated with the following: 12 month CS-Structured Play Total, 12 month CS-SP-Direct Prompts, 24 month Mullen receptive language, 24 month CSBS symbolic, and 24 month ASD symptoms severity scores.

As can be seen in Table 5, across both groups (LR-NonASD and ASD), CS was positively associated with language and social-communication measures, but not with non-verbal problem solving (Mullen-Visual Reception). There were also distinct patterns of relationships between CS and other developmental measures. For LR-NonASD children , 12-month CS Structured Play Total and its two subscores (CS-SP-Direct Prompts and CS-SP-Environmental) were associated with numerous measures of expressive and receptive language at 12 and 24 months of age, though CS-SP-Environmental prompts was no longer associated with these measures by 24 months. In contrast, 12-month CS Free Play was not associated with any other measures at 12 or 24 months. At 24 months, CS Structured Play Total and CS-SP-Direct Prompts were associated with concurrent social communication scores; 24 month CS-

Environmental subscores and CS Free play were not associated with any measures. Finally, none of the CS scores at 12 or 24 months was significantly related to ASD severity scores in the LR-NonASD subgroup.

For ASD children, on the other hand, CS was related to fewer language and social communication outcomes. There was a positive relationship between 12-month CS Free Play and concurrent CSBS Speech and Vineland Social Communication measures, and there was a positive relationship between 12-month CS-SP-Environmental subscores and 24-month Vineland Social. Further, CS-SP-Environmental was negatively associated with 24-month ASD symptom severity. Finally, at 24 months, CS Structured Play Total and CS-SP-Environmental were both positively associated with 24-month Mullen receptive language.

Research Question #2: What is the unique relationship between 12-month CS and 24-month ASD outcomes (ADOS diagnostic group and symptom severity), after controlling for language abilities? Specifically, what is the unique contribution of CS of communication acts in response to direct prompts from the communication partner (CS-SP-Direct Prompts subscore)?

The previous results from analyses in Research Question 1 indicated that CS-SP-Direct Prompts has a significant *direct* relationship with diagnostic group (i.e., whether a child met the ADOS cutoff score for ASD at 24 months), as evidenced by both the significant main effect and significant correlation between the two variables in Table 4. Two sets of sequential regressions were conducted to investigate the *unique* contribution of CS-SP-Direct Prompts in predicting 24-month ASD diagnosis and severity, above and beyond language abilities. Logistic regression was used to test this contribution to ADOS diagnostic group, and linear regression was used to test this contribution to ADOS ASD symptom severity scores. Results for these analyses are displayed in Tables 6 and 7, respectively. In the first block of each model, two Mullen language measures were entered; in the second block, CS-SP-Direct Prompt subscores were entered. In both regression results, neither Mullen receptive nor expressive language uniquely predicted 24-month diagnostic group or symptom severity. However, adding CS-Direct Prompts to the model significantly improved the prediction of both outcomes. As shown in Table 6, CS-SP-Direct prompts accounted for a unique 8% of the approximate variance in ASD diagnosis (and the coefficient shows that, for every standard deviation increase in CS-SP-Direct Prompts, there is a predicted decrease of 0.59 logits in ASD diagnosis). Similarly in Table 7, CS-SP-Direct prompts accounted for a unique 9% of the variance in symptom severity, with an estimated mean decrease of 0.58 points in severity for every standard deviation increase in CS-SP-Direct Prompts.

Research Question #3: Does CS change in the time between 12- and 24-months of age, and does CS development between 12- and 24-months differ by risk or diagnostic group?

A series of 2 x 2 analyses of variance were again conducted on CS measures, but this time for gains between 12 and 24 months, to determine whether there were (a) significant gains in CS between 12 and 24 months (i.e., test of the intercept against a null of zero in the model), (b) significant differences between risk groups (HR vs. LR) or diagnostic groups (ASD vs. NonASD) on gains, and (c) whether there were any interactions between risk and diagnostic group on gains. Tests of the intercepts indicated significant gains from 12 to 24 months for all CS Structured Play measures (Total and its subscores, CS-SP-Direct Prompts and CS-SP-Environmental, F-test p-values $< .05$), but not for CS Free Play ($p > .05$). There was no main effect of risk group or diagnostic group on any gains, suggesting that *children developed CS at the same rates between 12 and 24 months, irrespective of group* (even if groups started out differently at 12 months). Finally, there was no interaction between diagnostic and risk groups on any measure, indicating that, despite having distinct levels of CS as 12 months, growth from 12 to 24 months were parallel among groups.

Research Question #4: Are CS differences part of the broader autism phenotype (BAP)? Specifically, within the NonASD group, do HR children demonstrate lower CS than LR children? In HR-NonASD children (who are more likely to demonstrate BAP features), what is the unique relationship between 12-month CS and 24-month ASD symptom severity, after controlling for language?

In order to evaluate whether CS is associated with broader autism phenotype (i.e., milder, but qualitatively similar, features associated with ASD), only NonASD subjects were included for these analyses. First, the difference between risk groups on each CS measure was compared. Within the NonASD group, there were no significant differences between low-risk (LR) and high-risk (HR) children on any CS scores at 12 months of age (F-test p-values $> .05$; see Table 3 for means); however, by 24 months, the LR group demonstrated significantly higher CS-SP-Direct Prompts compared to the HR group, (F-test p-values $< .05$; see Table 3 for means). (There were no other significant risk group differences at 24 months.)

To further investigate this research question, a sequential multiple linear regression using the subsample of only the *high-risk*, NonASD children was conducted to test the unique contribution of CS-SP-Direct Prompts on ASD symptom severity scores, after controlling for language scores. Results (see Table 8) indicated that CS-SP-Direct Prompts accounted for 14% additional variance in severity scores beyond language scores, and that CS-SP-Direct Prompts had a significant unique relationship with 24-month ASD symptom severity. In other words, high-risk, NonASD children with higher 12-month CS-SP-Direct Prompts demonstrate lower symptom severity at 24 months (i.e., for every standard deviation increase in CS-SP-Direct Prompts, symptom severity lowers by 0.34 points).

Chapter 5: Discussion

The main objective of this study was to prospectively examine communication spontaneity in infant siblings of children with ASD (high-risk infants) and infants with no known genetic risk for ASD (low-risk infants). This discussion section begins with a summary of the findings from the previous chapter and their implications for the current body of literature. Next, limitations are discussed including threats to internal and external validity and statistical and measurement issues. The chapter ends with a discussion of future directions for research and practice.

Describing Communication Spontaneity

Though Communication Spontaneity (CS) has been discussed in the literature, this is the first prospective study to provide a structured measurement of CS in low-risk (LR) and high-risk (HR) groups. Consequently, descriptive information of CS across groups is a unique contribution of the study (Table 3).

Information on CS in children who do *not* demonstrate ASD and are not at heightened risk of demonstrating BAP features (LR-NonASD children) provided an approximation of "typical" CS development, which allows context in which to interpret CS data for ASD and BAP groups. Results indicated that these children became more spontaneous with age, suggesting that CS is a developmental construct. In addition, in this group, CS was positively associated with numerous existing measures of language and social communication; this was particularly true for CS in Structured contexts, in which children's communication occurred *in response to a communication partner,* as opposed to Free Play contexts, in which communication occurred on the child's own agenda. Additionally, CS was correlated with various aspects of social and communication development, but not with nonverbal problem solving, suggesting that CS may indeed be best conceptualized as a social-communication construct as opposed to an indication of nonverbal cognitive ability.

As in the LR-NonASD group, children in the ASD group demonstrated CS growth between 12 and 24 months of age, though they started out with lower CS at 12 months compared to the NonASD group. In fact, at 12 months of age, CS-Direct Prompts was the only CS, social-communication or language measure to distinguish between in the ASD and NonASD groups; this suggests that a child's CS in response to direct prompts from communication partner may be more relevant than their response to environmental cues (CS-Environmental) or their level of spontaneity when communicating on their own agenda (CS-Free Play). CS in the ASD group also demonstrated a distinct pattern of relationships with other language and social-communication measures, further supporting a unique CS profile in children with ASD. Finally, as in the LR-NonASD group, CS was not associated with non-verbal problem solving abilities, further supporting CS as a social-communication construct.

Significant interactions between risk and diagnostic groups also suggested that there may be a distinct CS profile in LR children who go on to develop ASD. This group demonstrated the lowest CS scores of all risk and diagnostic groups, even in the Free Play condition in which HR-ASD children did not demonstrate impaired CS (Figures 3-5).

CS and ASD symptoms

Results indicated that how children communicated in the Structured Play context was more relevant to social-communication abilities and ASD symptoms than communication in the Free Play context. More specifically, there was a direct relationship between how a child responded to direct prompts and their ASD diagnosis and symptom severity at 12 months. Thus, additional analyses were conducted to better understand he *unique* contributions of communication acts that occurred in response to direct prompts from a communication partner (CS-Direct Prompts) by entering CS-Direct Prompts and language scores separately into regression models. Results indicated that, above and beyond language scores, CS was *uniquely* and significantly related to both diagnostic group and ADOS severity scores. Specifically, children with lower 12 month CS-Direct Prompts subscores were more likely to meet ADOS criteria for ASD at 24 months of age. Similarly, 12-month old children with lower communication spontaneity had higher levels of 24-month ASD symptom severity. Thus, CS may be capturing an important aspect of social communication deficits in ASD that are not captured by other language and social communication assessments.

Social prompt responsiveness and the social salience framework.

Throughout this study, the CS-Direct Prompts subscore repeatedly emerged as an important aspect of CS. This suggests that children with ASD symptoms may more readily attend and respond to non-social cues (e.g., internal motivation, object cues), than social cues (e.g., verbal or gestural cues from a communication partner). If differences in CS lie more specifically in how a child responds to social cues (e.g., direct communication prompts from another person) these findings may offer support for the "social salience" framework of ASD. Numerous recent studies have described ASD as a failure to attend preferentially to social stimuli with intact attention to non-social stimuli (Dawson et al., 1998; Nair 2010; Chawarska 2012 a and b; Mcleary 2009; Hutman, Chea, Gillespie-Lynch, & Sigman, 2012). Chawarska (2012a) used eye-tracking tasks to explore whether 6-month-old infants later diagnosed with ASD exhibit atypical spontaneous social monitoring of visual scenes compared to NonASD infant siblings. Results indicated that prodromal symptoms of ASD at 6 months include a diminished ability to attend spontaneously to people and their activities. Impaired attention to social stimuli may be particularly salient when objects related to circumscribed interests are present (Nair, 2010).

Chwarska and colleagues also investigated which factors may be responsible for social attention differences by manipulating the presence of salient social (child-directed speech (CDS) and eye contact (EC)) and nonsocial (object) cues. The mere *presence of a person* within the visual field does not appear to disturb the general attention in toddlers with autism. Neither did the *presence of toys and objects*. It was only when child-directed speech and eye contact were introduced that differences between autism and control groups became pronounced. Thus, children with ASD may not present with a generalized social attention deficit or preference for objects. Rather, deficits may lie specifically in *attention to social bids for interaction* (Chwarska, 2010 b). Results from the present study offer support to these findings indicating that children may be a specific deficit in responding to social cues within interactions, including communication prompting.

Viewing CS within the social salience framework may help to explain why previous studies utilizing a binary conceptualization found no relationship between ASD and CS (Colgan, 2006). If categorized as either “prompted” or “unprompted,” differences in the *level* of prompting required are not captured. Children with various levels of ASD symptom severity appear to demonstrate comparable levels of unprompted, highly spontaneous communication. Differences lie in their responsiveness to communication prompts. In summary, with the social salience framework in mind, it is possible that differences in CS, specifically in the way that children respond to communication cues, may be tapping into underlying social attention differences in ASD. These early impairments in social attention may lead to an imbalance between social and non-social inputs, depriving the child of the social learning experiences necessary for adequate social-communication and social-cognitive development.

Reconceptualizing CS in ASD populations. If the most relevant aspect of CS lies within the CS-SP Direct Prompts subscore, this suggests that the current conceptualization of CS may envelop distinct constructs. Existing conceptualizations of CS focus on the level salience of the antecedent evoking a response, regardless of the social nature of the antecedent (Halle, 1987; Carter and Hotchkiss, 2002). However, in the ASD population, it may be the *social* nature rather than overall salience that is relevant. Thus, in light of this study's results, previous discussions of potential differences in communication spontaneity may be better conceptualized as differences in Social Prompt Responsiveness.

CS and the broader autism phenotype

The final research question in this study examined CS in unaffected HR siblings (HR-NonASD) to assess if differences may be identified in infant siblings who do *not* develop ASD, but may present with broader autism phenotype (BAP) features; that is, milder, but qualitatively similar features associated with ASD (Ozonoff et al., 2005, 2008; Toth, Dawson, Meltzoff, Greenson, Fein, 2007; Yirmiya et al., 2006; Zwaigenbaum et al., 2007). Results from this study indicated that Non-ASD children demonstrated similar CS at 12 months of age, regardless of risk group. However, within the HR group, CS-Direct Prompts uniquely accounted for a significant amount of variance in 24 month ASD symptom severity. Thus, in children that are at greater genetic risk for ASD and BAP, a higher level of CS-Direct Prompts, or "Social Prompt Responsiveness" was associated with *lower* levels of ASD symptoms at 24 months. At 24 months of age, differences in CS-Direct Prompts distinguished risk groups, with HR-ASD demonstrating lower Social Prompt Responsiveness.

Overall, as in the ASD groups, CS-Direct Prompts appears to be an important aspect of CS when assessing children at high genetic risk for ASD, though differences in NonASD children may not become clear until 24 months of age. Thus, further study is needed to determine if CS may be part of the BAP profile.

Limitations

There are a number of limitations to the current study. As with many prospective infant siblings studies, one primary limitation is small sample size. Generally, infant siblings of children with ASD are difficult to recruit, especially within one geographic location. Despite this difficulty, the study was able to recruit and retain 50 high-risk infants and 31 LR infants. The disproportionate number of LR and HR infants may have been due to the inherent disadvantage of prospective studies in that parents with developmental concerns about their infant (i.e., HR infants) may be more likely to seek research participation fro the purpose of developmental monitoring. Non-random, convenience sampling limited the power and external validity of the study. In addition, given this small sample size, analyses did not control for minority status despite a significantly higher number of minorities than non-minorities dropping out of the study. Thus, future research may further examine wither minority status plays a role in CS development.

A second limitation was the criteria utilized to define diagnostic groups. ASD rates in the sample were higher than other prospective studies (Ozonoff et al., 2011) with 16 infants (13 HR and 3 LR) meeting ADOS cutoffs for ASD. This higher rate of ASD may have been due to the use of isolated ADOS cutoff scores, rather than ADOS scores combined with a clinical diagnosis by a clinician. With this more liberal diagnostic criteria, it is possible that children that met

ADOS cutoff scores, but not full ASD diagnostic criteria were included in the ASD group, which may have reduced differentiation between groups in statistical analyses.

The age at which diagnostic category was assigned was an additional limitation of this study. Given that not all of the infants have yet reached their 36-month-old time point, an age at which diagnosis may be more stable, it is unknown whether these infants will consistently meet criteria for ASD or whether their symptoms at 24 months were associated with transient delays or developmental differences that may resolve over time. Longitudinal research will help close this gap.

Another limitation is in the continuum conceptualization of CS utilized in this study. Existing continuum models of CS include specific subtypes of antecedents/prompts that were not included in this study's CS coding. Instead, existing models were adapted to fit the range of cues present during standardized CSBS administration. For example, physical prompts would be considered a highly intrusive antecedent, but are not part of the prompting hierarchy in the CSBS. Despite this limitation, a range of antecedents that ranged in overall salience and in social salience were included in the CS coding and this range was sufficient in detecting group differences, change over time and relationships to other variables.

A final limitation of this study is the presence of multiple comparisons without adjustment for Type I error. This particular study had a limited sample size, and CS was only used to model ASD-related symptomology, thus distinct "families" of comparisons were not identified. However, if future studies used CS to predict additional outcomes such as social scores, cognitive scores, or other diagnostic categories, appropriate corrections should be applied.

Summary and Contributions

In summary, the present study offered several contributions to the current understanding of CS in young children. First, the present study demonstrated that CS can be measured in a standardized way utilizing a continuum conceptualization during existing assessment formats such as CSBS. Utilizing a continuum conceptualization, the study contributed normative information on CS development and illustrated that children communicate more spontaneously at older ages (24 versus 12 months). Moreover, the importance of utilizing a continuum rather than binary conceptualization was demonstrated by the importance of differences in levels of prompting required as opposed to the presence/absence of prompts.

This information provides important theoretical considerations suggesting that in the ASD population, Social Prompt Responsiveness may be the most relevant aspect of CS. Differences in children's Social Prompt Responsiveness were related to social-communication abilities, ASD diagnostic group, and ASD symptom severity. At 12 months of age, children's social prompt responsiveness differentiated ASD from NonASD children and uniquely predicted both diagnostic group and ASD symptom severity. Social Responsiveness may also be associated with the broader autism phenotype, though differences may not become clear until 24 months of age in HR, NonASD siblings. These findings provided support for the social salience framework of ASD and its application to early communication development. Social Prompt Responsiveness is not currently measured in existing early social-communication assessments such as the CSBS.

These findings also have important clinical implications. Results from the present study suggest that structured measurement of Social Prompt Responsiveness within existing tools is possible and may contribute important information regarding a child's social-communication development, particularly in monitoring infants at high genetic risk for ASD. Psychologists in clinical and school settings play an important role in monitoring early risk factors and ensuring that children are referred to appropriate interventions as early as possible. Psychologists must recognize the importance of communication *in social contexts*, rather than the mere presence/absence of concrete language constructs (e.g., vocabulary, syntax) in order to accurately How a child initates communication and how a child responds to communicaiton cues from others.

Directions of Future Research

A few immediate next steps for the current project include longitudinal follow-up at 36 months to examine stability of ASD diagnosis. Given the power limitation, it may be fruitful to combine samples with other prospective infant sibling research groups to examine social prompt responsiveness in children that did and did not go on to develop ASD. In this larger sample, diagnostic groups should be defined by meeting ADOS cutoff scores and receiving a clinical diagnosis to improve differentiation between diagnostic outcome groups.

In addition, though the present study suggested a relationship between ASD symptoms and Social Prompt Responsiveness, other variables such as temperament were coded but not analyzed and could impact Social Prompt Responsiveness. Similarly, future analyses would include qualitative responses to prompts which were coded but not analyzed in the present study. For example, under the social salience framework, it could be hypothesized that a lack of attention to or awareness of the presence of social prompts may underlie a child's lack of response. Children with ASD have also been reported to demonstrate higher levels of behavioral dysregulation (Dumas, Wolf, Fisman & Culligan, 1991), which may reduce a child's attention to prompts. Similarly, a lack of interest in the presented object or activity may underlie differences in prompt responsiveness. Inclusion of these qualitative response variables may elucidate why certain children are more or less responsive to social prompts. Finally, previous research has suggested that social attention differences may be detected by 6 months of age in children with ASD (Chawarska 2012 a and b; Nair, 2010). Future research could include 6-month social attention variables to examine if early general social attention deficits are related to differences in Social Prompt Responsiveness scores at 12 months of age.

Ultimately, the prospective study of Social Prompt Responsiveness may be useful in the early identification of ASD and/or BAP symptoms. Social Prompt Responsiveness can be readily measured in early stages of communication development within existing developmental assessments. Including Social Prompt Responsiveness in language and communication assessments, particularly in high-risk infants, may alert parents, clinicians, and researchers to early differences that may deprive children of the social learning experiences necessary for adequate social-communication and social-cognitive development.

Table 1

Demographic Variables of Original and Final Samples

Characteristic	Original Sample				Final Sample			
	HR n = 59		LR n = 42		HR n = 50		LR n = 31	
	N	%	*N*	%	*N*	%	*N*	%
Male	38	64%	20	48%	31	62%	14	45%
Female	21	36%	22	52%	19	38%	17	55%
Maternal Education								
No college	7	12%	1	2%	5	10%	1	3%
College Degree	52	88%	41	98%	45	90%	30	97%
Ethnicity								
Non-Minority	40	68%	32	76%	39	78%	27	87%
Minority	19	32%	10	24%	11	22%	4	13%
Hispanic	6	10%	6	14%	4	8%	3	10%
Asian	2	3%	1	2%	1	2%	1	3%
Black	1	2%	0	0%	0	0%	0	0%
Mixed/Other	10	17%	3	7%	6	12%	0	0%

Table 2

Diagnostic and Risk Group Definitions

	Risk Groups
High Risk (HR)	Children at high gentic risk for ASD due to having an older sibling with ASD
Low Risk (LR)	Children at low genetic risk for ASD
	24 month ADOS Diagnostic Groups
ASD	Children from both risk groups that meet the ADOS diagnostic group cutoff score for the Autism or Autism Spectrum at 24 months
NonASD	Children from both risk groups that do not meet the ADOS diagnostic group cutoff score for the Autism or Autism Spectrum at 24 months
	Subgroups: Risk x Diagnostic Group
LR- NonASD	Children at low genetic risk for ASD who do not meet ADOS cutoff score for Autism or Autism Spectrum at 24 months of age
LR-ASD	Children at low genetic risk for ASD who meet ADOS cutoff score for Autism or Autism Spectrum at 24 months of age
HR- NonASD	Children at high genetic risk for ASD who do not meet ADOS cutoff score for Autism or Autism Spectrum at 24 months of age (**a small group of these infants may demonstrate BAP characteristics)
HR- ASD	Children at high genetic risk for ASD who meet ADOS cutoff score for Autism or Autism Spectrum at 24 months of age

Table 3

Sample Descriptive Statistics

	Low Risk N=31						*High Risk N=50*						LR vs. HR	Non-ASD vs. ASD
	Non-ASD			ASD			Non-ASD			ASD				
Measure	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*Cohen's d*	*Cohen's d*
12 Months														
Mullen-Visual Reception	28	55.75	7.14	3	61.00	4.58	37	52.97	8.36	13	52.23	8.12	.44	.04
Mullen-Receptive Language	28	44.75	8.16	3	46.33	3.21	37	43.41	8.80	13	39.08	8.87	.31	.42
Mullen-Expressive Language	28	48.00	12.17	3	51.00	0.00	37	47.78	10.07	13	40.46	9.80	.23	.51
Vineland-Expressive Language	27	15.37	2.59	3	12.67	1.15	37	14.35	4.16	13	14.00	4.73	.22	.27
Vineland-Receptive Language	27	15.41	1.82	3	16.00	1.00	37	13.59	3.70	13	13.00	4.86	.60	.24
Vineland-Social	27	95.70	7.36	3	90.00	4.00	37	87.35	22.47	13	85.85	26.50	.43	.22
CSBS-Social	28	9.11	2.70	3	8.00	2.00	36	8.33	2.34	13	7.31	1.80	.39	.51
CSBS-Speech	28	9.36	2.38	3	9.00	1.00	36	9.25	2.57	13	8.69	2.10	.09	.23
CSBS-Symbolic	28	8.29	3.38	3	7.33	2.52	36	8.03	2.47	13	7.69	2.43	.09	.18
Comm Spont (CS) Structured Play (SP) Total	27	3.56	0.54	3	2.83	0.83	35	3.29	0.77	13	3.02	0.77	.39	.60
CS-SP-Direct Prompts	27	2.99	0.81	3	2.16	0.92	35	2.71	0.85	12	2.25	0.88	.37	.71
CS-SP-Environmental Prompts	28	2.11	1.37	3	3.39	0.58	37	2.05	1.49	13	1.77	1.24	.18	.00
CS-Free Play Total	27	3.43	0.52	3	3.39	0.74	34	3.46	0.48	12	3.51	0.41	-.10	-.08
24 Months														
Mullen-Visual Reception	21	56.24	10.64	3	62.67	15.82	35	52.89	8.74	9	48.44	6.60	.54	.23
Mullen-Receptive Language	21	57.43	7.91	3	54.33	14.57	35	50.46	9.44	9	38.33	17.53	.86	1.02
Mullen-Expressive Language	21	51.19	10.94	3	44.00	6.93	35	44.09	7.98	9	40.89	7.67	.77	.57
Vineland-Expressive Language	11	16.00	1.34	2	15.00	1.41	26	14.54	3.55	8	15.13	1.89	.40	-.04
Vineland-Receptive Language	11	15.91	1.22	2	14.50	0.71	26	15.00	3.66	8	13.75	2.66	.32	.45
Vineland-Social	11	98.09	3.78	2	91.00	5.66	26	94.77	20.39	8	93.63	8.14	.16	.17
CSBS-Social	21	8.29	2.51	2	9.50	0.71	32	8.94	2.45	9	7.56	2.60	-.10	.31
CSBS-Speech	21	10.62	2.50	2	9.50	0.71	32	10.78	2.09	9	9.78	1.30	-.02	.46
CSBS-Symbolic	21	10.05	2.80	2	7.00	5.66	32	8.16	2.29	9	6.33	2.69	.78	.94
Comm Spont (CS) Structured Play (SP) Total	20	3.96	0.23	2	3.05	0.07	32	3.83	0.33	9	3.98	0.42	.05	.22
CS-SP-Direct Prompts	20	3.59	0.34	2	2.54	0.24	32	3.38	0.36	9	3.48	0.38	.26	.43
CS-SP-Environmental Prompts	20	2.80	1.01	2	1.50	0.71	32	3.00	1.16	9	3.44	2.13	-.32	-.13
CS-Free Play Total	20	3.69	0.34	2	3.00	0.00	32	3.56	0.39	9	3.61	0.32	.16	.31
ADOS Symptom Severity	28	1.58	0.74	3	5.00	1.00	37	1.48	0.77	13	1.51	5.54	.18	-.28

Note. Cohen's *d* is the difference between groups divided by the pooled standard deviation (Cohen, 1988).

Table 4

Bivariate Correlations among all Measured Variables for Entire Sample

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.
1. Risk Group	1.00																												
2. Diagnostic Group	0.20	1.00																											
12 Month Measures																													
3. Mullen-Visual Reception	-0.21	-0.02	1.00																										
4. Mullen-Receptive Language	-0.15	-0.17	**0.33**	1.00																									
5. Mullen-Expressive Language	-0.11	-0.20	**0.34**	**0.34**	1.00																								
6. Vineland-Expressive Language	-0.11	-0.11	0.15	0.13	**0.29**	1.00																							
7. Vineland-Receptive Language	**-0.29**	-0.09	**0.24**	**0.23**	0.13	**0.82**	1.00																						
8. Vineland-Social	-0.21	-0.09	0.14	0.06	0.00	**0.81**	**0.84**	1.00																					
9. CSBS-Social	-0.19	-0.21	**0.28**	**0.25**	**0.42**	**0.29**	**0.25**	0.09	1.00																				
10. CSBS-Speech	-0.05	-0.09	0.15	0.09	**0.49**	0.22	0.08	-0.05	**0.52**	1.00																			
11. CSBS-Symbolic	-0.05	-0.08	**0.36**	**0.28**	**0.38**	**0.23**	0.10	0.00	**0.52**	**0.40**	1.00																		
12. CS-Structured Play Total Score	-0.18	**-0.23**	-0.09	0.21	**0.26**	**0.26**	0.15	0.07	**0.45**	**0.24**	**0.34**	1.00																	
13. CS-Direct Prompts Subscore	-0.18	**-0.28**	0.10	**0.29**	**0.31**	0.20	0.10	0.03	**0.40**	0.20	**0.48**	**0.83**	1.00																
14. CS-Environmental Prompts Subscore	-0.02	-0.11	0.11	0.14	**0.25**	**0.37**	**0.27**	0.13	**0.65**	**0.48**	**0.27**	**0.58**	**0.31**	1.00															
15. CS-Free Play Total Score	0.05	0.03	-0.16	-0.07	0.05	0.21	0.05	0.06	0.03	0.14	0.11	0.19	0.06	**0.32**	1.00														
24 Month Measures																													
16. Mullen-Visual Reception	**-0.25**	-0.08	**0.38**	0.12	**0.38**	0.02	0.15	0.04	**0.32**	0.21	**0.37**	0.15	**0.25**	0.12	-0.15	1.00													
17. Mullen-Receptive Language	**-0.37**	**-0.35**	**0.35**	**0.32**	**0.31**	0.02	0.17	-0.02	**0.37**	0.14	**0.30**	0.16	0.21	0.10	0.02	**0.56**	1.00												
18. Mullen-Expressive Language	**-0.35**	-0.21	0.19	**0.25**	**0.43**	0.14	0.14	0.03	**0.25**	**0.42**	**0.38**	**0.28**	**0.25**	0.14	-0.01	**0.45**	**0.55**	1.00											
19. Vineland-Expressive Language	-0.19	0.02	-0.07	0.15	**0.30**	0.06	0.04	-0.17	0.26	**0.33**	**0.34**	0.16	0.11	0.24	0.15	0.14	0.18	**0.54**	1.00										
20. Vineland-Receptive Language	-0.15	-0.19	0.07	0.23	**0.34**	0.10	0.13	-0.04	**0.33**	0.27	0.28	0.12	0.10	0.25	0.11	0.14	0.23	0.29	**0.78**	1.00									
21. Vineland-Social	-0.07	-0.07	-0.10	0.03	0.21	0.16	0.11	-0.03	0.25	0.22	0.12	0.11	-0.02	0.27	0.22	0.00	0.05	0.23	**0.84**	**0.81**	1.00								
22. CSBS-Social	0.05	-0.12	-0.09	0.05	-0.08	0.23	0.19	0.09	0.01	-0.05	0.15	0.03	0.07	0.07	0.14	-0.10	-0.09	-0.18	-0.05	0.06	-0.04	1.00							
23. CSBS-Speech	0.01	-0.18	0.18	**0.28**	**0.40**	**0.42**	**0.27**	0.16	**0.25**	**0.39**	**0.35**	**0.38**	**0.28**	**0.33**	0.14	0.12	0.12	**0.61**	**0.37**	0.20	0.27	0.14	1.00						
24. CSBS-Symbolic	**-0.34**	**-0.33**	**0.27**	0.22	0.19	0.22	0.20	0.12	**0.26**	0.07	**0.29**	0.24	**0.42**	0.04	-0.02	0.15	**0.43**	0.15	0.11	0.30	0.16	0.07	0.09	1.00					
25. CS-Structured Play Total Score	-0.03	-0.07	-0.22	0.14	-0.13	0.11	-0.09	0.08	0.05	-0.17	-0.11	**0.30**	0.25	0.14	-0.03	-0.17	-0.19	0.01	0.01	-0.06	0.02	0.01	0.20	0.10	1.00				
26. CS-Direct Prompts Subscore	-0.12	-0.14	-0.16	0.14	-0.10	0.06	-0.12	0.00	0.02	**-0.28**	-0.16	0.23	0.16	0.06	-0.10	-0.09	-0.02	0.06	-0.04	-0.07	-0.02	-0.05	0.03	0.15	**0.88**	1.00			
257. CS-Environmental Prompts Subscore	0.15	0.05	-0.19	0.09	-0.14	0.16	0.06	0.14	0.09	0.06	0.03	**0.28**	**0.26**	**0.28**	0.11	-0.24	**-0.33**	-0.12	0.12	0.03	0.13	0.22	**0.34**	-0.01	**0.61**	0.20	1.00		
28. CS-Free Play Total Score	-0.07	-0.12	-0.09	0.14	0.11	**0.33**	0.15	**0.25**	0.18	0.06	0.13	0.14	0.11	**0.28**	0.16	0.00	0.16	0.21	0.27	0.25	0.26	-0.03	**0.25**	**0.30**	**0.39**	**0.37**	0.24	1.00	
29. ADOS Symptom Severity	0.17	**0.87**	-0.02	-0.13	-0.21	-0.15	-0.11	-0.10	**-0.24**	-0.10	-0.11	**-0.34**	**-0.34**	-0.22	-0.07	-0.14	**-0.35**	**-0.27**	0.11	-0.10	-0.05	-0.14	-0.20	**-0.27**	-0.09	-0.19	0.08	-0.11	1.00

Note. **Boldface**= $p<.05$

Table 5

Bivariate Correlations among all Measured Variables by Diagnostic Group (ASD and LR-Non-ASD)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.
12 Month Measures																											
1. Mullen-Visual Reception		**0.59**	**0.63**	0.24	0.32	0.07	0.43	0.02	**0.52**	-0.38	0.08	0.03	0.02	0.55	0.47	0.08	0.09	0.62	0.09	0.41	-0.54	0.29	**-0.67**	-0.44	-0.55	-0.42	0.01
2. Mullen-Receptive Language	0.32		**0.66**	0.45	**0.69**	0.40	0.24	0.16	-0.09	-0.22	0.06	0.28	0.11	0.12	0.35	-0.04	0.14	**0.70**	0.28	0.52	0.08	-0.01	-0.26	-0.26	0.03	-0.04	0.03
3. Mullen-Expressive Language	**0.38**	0.30		0.27	0.43	0.25	0.07	-0.07	-0.10	-0.25	0.04	-0.12	-0.17	0.28	0.17	-0.16	-0.15	0.40	0.02	0.37	-0.21	-0.08	-0.51	-0.53	-0.19	**-0.61**	0.17
4. Vineland-Expressive Language	**0.48**	0.38	**0.67**		**0.84**	**0.87**	0.29	-0.05	-0.07	0.14	0.21	0.35	-0.01	-0.21	0.06	0.07	0.31	0.57	0.46	0.39	0.05	0.20	0.06	0.27	-0.07	0.20	0.20
5. Vineland-Receptive Language	**0.58**	0.33	0.10	**0.45**		**0.83**	0.28	0.09	-0.21	0.00	0.09	0.20	-0.10	0.41	**0.64**	0.30	0.50	**0.84**	0.39	0.48	0.18	0.02	-0.42	-0.39	-0.17	-0.11	0.21
6. Vineland-Social	**0.47**	0.09	0.15	**0.47**	**0.47**		0.20	-0.06	-0.30	0.11	0.16	0.17	-0.14	-0.34	-0.31	-0.53	-0.14	-0.01	-0.02	-0.27	-0.10	-0.32	0.16	0.00	0.27	-0.15	0.27
7. CSBS-Social	0.33	**0.41**	**0.40**	**0.47**	**0.51**	0.35		0.42	0.42	0.09	0.27	0.43	0.27	0.34	**0.58**	0.57	0.53	**0.84**	**0.68**	0.17	-0.51	**0.67**	-0.47	-0.37	-0.28	-0.04	0.00
8. CSBS-Speech	0.32	0.30	**0.68**	**0.55**	0.21	0.34	**0.54**		0.04	-0.12	-0.31	0.27	**0.53**	0.14	0.53	0.52	0.30	0.54	**0.65**	-0.07	-0.04	0.27	-0.40	-0.45	-0.26	0.05	-0.06
9. CSBS-Symbolic	**0.45**	**0.48**	**0.53**	**0.56**	0.36	0.25	**0.63**	**0.70**		0.03	0.40	-0.05	0.14	0.46	0.53	0.34	0.28	0.43	0.03	0.05	**-0.67**	**0.63**	-0.49	-0.24	**-0.64**	-0.28	-0.01
10. CS-Structured Play Total Score	0.03	0.27	**0.47**	**0.62**	0.31	0.25	**0.60**	**0.46**	**0.38**		**0.83**	0.48	0.10	-0.19	0.00	0.42	0.04	-0.35	0.14	-0.25	0.34	-0.05	0.54	0.56	0.25	0.07	-0.47
11. CS-Direct Prompts Subscore	0.02	0.09	**0.46**	**0.47**	0.05	0.07	**0.44**	**0.47**	**0.41**	**0.79**		0.31	-0.02	0.03	0.03	0.10	0.10	-0.15	-0.02	-0.27	-0.09	0.04	0.19	0.17	0.07	-0.29	-0.16
12. CS-Environmental Prompts Subscore	0.37	0.13	0.18	**0.45**	**0.54**	**0.61**	**0.68**	**0.40**	0.33	**0.48**	0.17		**0.56**	-0.24	0.01	0.24	0.21	0.47	**0.68**	0.23	0.27	0.05	0.42	0.51	0.35	0.48	**-0.53**
13. CS-Free Play Total Score	-0.18	-0.16	0.06	0.10	-0.17	0.13	-0.25	0.08	0.06	-0.04	-0.04	0.06		-0.46	0.06	0.07	0.52	0.62	**0.85**	-0.08	0.01	0.56	-0.01	0.03	-0.15	0.33	-0.36
24 Month Measures																											
14. Mullen-Visual Reception	**0.43**	0.02	**0.44**	0.16	0.12	0.26	0.35	0.14	0.32	0.04	0.18	0.16	-0.21		**0.63**	0.40	-0.04	0.12	-0.27	-0.01	**-0.81**	-0.06	**-0.85**	**-0.71**	**-0.72**	**-0.69**	-0.03
15. Mullen-Receptive Language	**0.45**	0.27	0.38	0.27	0.25	0.41	0.35	-0.01	0.23	0.10	0.02	0.22	0.00	**0.53**		**0.82**	0.54	0.61	0.39	0.03	-0.52	0.51	**-0.80**	-0.50	**-0.83**	-0.16	-0.02
16. Mullen-Expressive Language	**0.50**	**0.45**	**0.70**	0.23	0.16	0.22	0.27	0.38	**0.43**	0.24	0.16	0.09	0.02	0.40	**0.58**		0.50	0.39	0.54	-0.01	-0.07	0.44	-0.41	-0.12	-0.57	0.03	-0.30
17. Vineland-Expressive Language	0.06	**0.67**	0.28	0.00	0.41	0.29	0.33	0.56	0.53	0.32	0.27	0.29	0.10	0.04	0.06	**0.74**		**0.68**	**0.74**	-0.08	0.00	**0.72**	-0.32	-0.10	-0.43	0.40	0.28
18. Vineland-Receptive Language	0.17	0.29	0.02	-0.51	0.40	0.08	0.25	0.09	0.09	0.06	-0.09	-0.15	-0.57	0.32	0.35	**0.67**	0.37		**0.78**	0.39	-0.20	0.64	-0.49	-0.29	-0.40	0.22	0.08
19. Vineland-Social	0.14	-0.38	-0.31	-0.08	0.35	0.42	-0.35	0.06	-0.41	0.05	-0.17	0.12	0.27	**-0.78**	-0.41	-0.11	-0.08	0.18		0.05	0.21	0.58	-0.13	0.02	-0.19	0.44	-0.16
20. CSBS-Social	-0.11	0.03	-0.19	-0.06	0.00	-0.11	-0.19	0.15	0.05	-0.07	0.15	-0.15	-0.05	-0.09	-0.36	-0.18	0.42	0.05	-0.17		0.37	0.18	-0.05	-0.03	0.20	0.13	-0.15
21. CSBS-Speech	**0.51**	**0.50**	**0.60**	**0.61**	0.40	0.36	0.27	**0.50**	**0.52**	0.44	0.29	0.22	-0.14	0.03	0.15	**0.73**	0.58	0.05	0.35	0.27		-0.27	0.54	0.37	0.58	0.40	-0.25
22. CSBS-Symbolic	0.30	0.07	0.34	**0.45**	0.08	0.07	0.18	0.13	0.29	**0.52**	**0.74**	0.09	-0.04	0.07	0.04	0.04	-0.29	-0.57	0.11	-0.25	0.14		-0.34	-0.21	-0.36	0.24	0.40
23. CS-Structured Play Total	-0.16	0.05	0.05	0.21	-0.03	-0.17	0.17	-0.27	-0.18	0.24	0.33	-0.06	-0.36	0.05	-0.05	-0.22	-0.30	-0.66	**-0.79**	0.13	0.18	0.26		**0.87**	**0.82**	0.58	-0.24
24. CS-SP; Direct Prompts	-0.19	0.08	0.00	0.05	-0.18	-0.26	0.02	-0.40	-0.39	0.05	0.09	-0.19	-0.37	0.04	0.01	-0.07	-0.36	-0.50	**-0.86**	-0.04	0.03	0.11	**0.92**		0.49	**0.65**	-0.40
25. CS-SP- Environmental Prompts	0.13	-0.12	0.06	0.35	0.39	0.26	0.31	0.33	**0.52**	**0.46**	**0.60**	0.36	0.12	0.00	-0.14	-0.35	0.23	-0.64	0.19	0.33	0.26	0.38	0.03	-0.36		0.43	-0.02
26. CS-Free Play Total	-0.01	0.10	0.18	0.16	-0.16	0.13	0.22	0.11	0.22	0.28	0.44	0.07	0.16	0.13	0.44	0.09	-0.06	**-0.84**	-0.39	-0.19	0.08	**0.46**	0.20	0.08	0.29		0.18
27. ADOS Symptom Severity	-0.15	0.08	**-0.55**	-0.22	0.23	-0.33	-0.18	-0.34	-0.13	-0.08	-0.19	-0.13	-0.09	-0.39	-0.42	**-0.45**	0.14	-0.17	0.23	0.18	-0.03	0.00	0.12	-0.03	0.41	-0.07	

Note. **Boldface**= $p<.05$
Note. Lower Left=LR-NonASD, Upper Right=ASD

Table 6

Unique Relationship between 12-month CS-SP-Direct Prompts and 24-month ADOS Diagnostic Group for Entire Sample

	χ^2	*Pseudo* R^2	*b*	*(SE)*	*Wald(1)*		*exp(b)*
Block 1	*2.51(2)*	*0.05*					
Intercept			-1.47	(0.30)	23.73	***	0.23
12m Mullen Expressive Language			-0.40	(0.32)	1.60		0.67
12m Mullen Receptive Language			-0.17	(0.32)	0.28		0.84
Block 2	*3.85 (1)**	*0.13*					
Intercept			-1.56	(0.32)	23.41	***	0.21
12m Mullen Expressive Language			-0.29	(0.34)	0.70		0.75
12m Mullen Receptive Language			-0.03	(0.34)	0.01		0.98
12m CS-SP-Direct Prompts			-0.59	(0.30)	3.75	*	0.56

Note. N =77 for analysis.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 7

Unique Relationship between 12-month CS-SP-Direct Prompts and 24-month ADOS Symptom Severity for Entire Sample

	- R^2_{change}	- F_{change}	- R^2_{total}	R^2_{Adj}	F_{total}	*b*	*(SE)*	*t*		beta
ADOS Severity Score										
Block 1	*.04*	*1.56(2, 74)*	*.04*	*.02*	*1.56(2, 74)*					
Intercept						2.33	(0.21)	11.21	***	
12m Mullen Expressive Language						-0.34	(0.22)	-1.54		-0.19
12m Mullen Receptive Language						-0.10	(0.03)	-0.41		0.05
Block 2	*.09*	*7.12(1,73)***	*.13*	*.09*	*3.50(3,73)**					
Intercept						2.32	(0.20)	11.62	***	
12m Mullen Expressive Language						-0.19	(0.22)	-0.88		-0.10
12m Mullen Receptive Language						0.04	(0.22)	0.19		0.02
12m CS-SP-Direct Prompts						-0.58	(0.22)	-2.67	**	-0.32

Note. N=77 for analysis.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 8

Unique Relationship between 12-month CS-SP-Direct Prompts and 24-month ADOS Symptom Severity for HR, Non-ASD Children

	- R^2_{change}	- F_{change}	- R^2_{total}	R^2_{Adj}	F_{total}	*b*	*(SE)*	*t*	b
ADOS Severity Score									
Block 1	*.03*	*0.44(2, 32)*	*.03*	*.00*	*0.44(2, 32)*				
Intercept						1.47	(0.14)	10.82 ***	
12m Mullen Expressive Language						0.14	(0.15)	0.93	0.17
12m Mullen Receptive Language						-0.04	(0.13)	-0.28	-0.05
Block 2	*.14*	*4.99(1,31)**	*.16*	*.08*	*1.99(3,31)*				
Intercept						1.45	(0.13)	11.35 ***	
12m Mullen Expressive Language						0.19	(0.13)	1.35	0.23
12m Mullen Receptive Language						0.10	(0.14)	0.72	0.14
12m CS-Direct Prompts						-0.34	(0.15)	-2.23 *	-0.42

Note. N= 35 for analysis.

* $p < .05$, ** $p < .01$, *** $p < .001$.

CS Points	***Antecedent of Child's Communication Act***
6	Environmental Prompt: Child initiates communication about an object or event NOT presented by an adult (highest level of spontaneity)
5	Environmental Prompt: Child initiates communication act about the presented activity outside of the prompting hierarchies
4	1st Direct Prompt in Prompting Hierarchy: stimulus highlighting (adult draws attention to object)
3	2nd Direct Prompt in Prompting Hierarchy: verbal "need help" prompt
2	3rd Direct Prompt in Prompting Hierarchy: verbal "need help" plus distal gesture prompt
1	Final Direct Prompt in Prompting Hierarchy verbal "need help" plus proximal gesture prompt
0	Child never initiates communication

Figure 1. CS Coding for Structured Play Measure

Spont. Points	Antecedent of Child's Communication Act
6	Child initiates communication about an object or event NOT presented by an adult (bringing in a new topic outside of available materials)
5	Child initiates communication act about an object or activity NOT highlighted by the adult (adult not drawing attention to object/event)
4	Child initiates communication about presented object/activity without preceding verbal or gestural prompts by an adult
3	Child initiates after 1 adult verbal or gestural prompt
2	Child initiates after 2 adult verbal or gestural prompts
1	Child initiates after 3 adult verbal or gestural prompts
0	Child does not communicate in response to any level of prompting

Figure 2. CS Coding for Free Play Measure

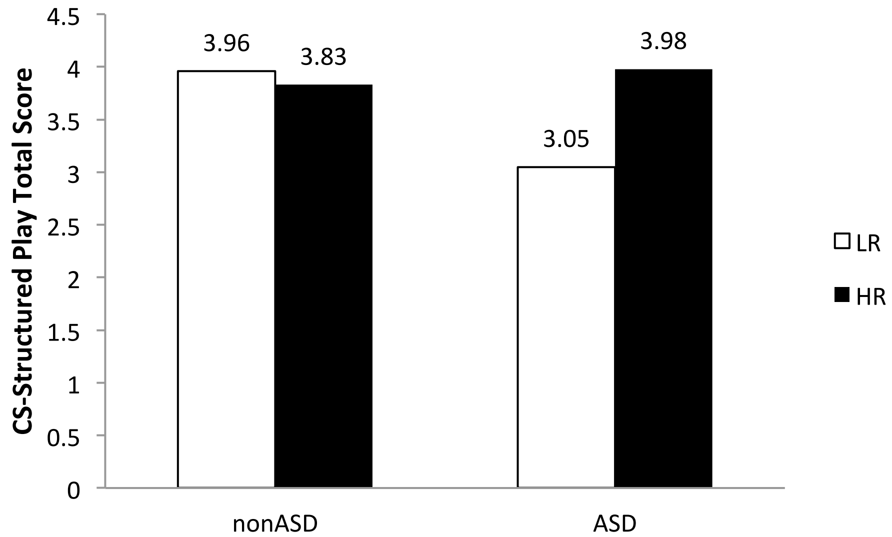

Figure 3. Mean 24-month CS Structured PlayTotal by Risk and Diagnostic Group

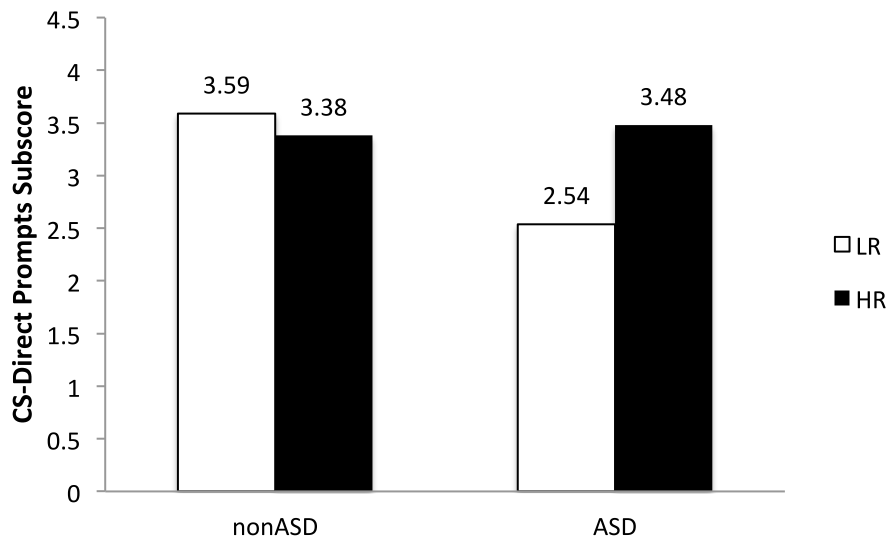

Figure 4. Mean 24-month CS-SP-Direct Prompts by Risk and Diagnostic Group

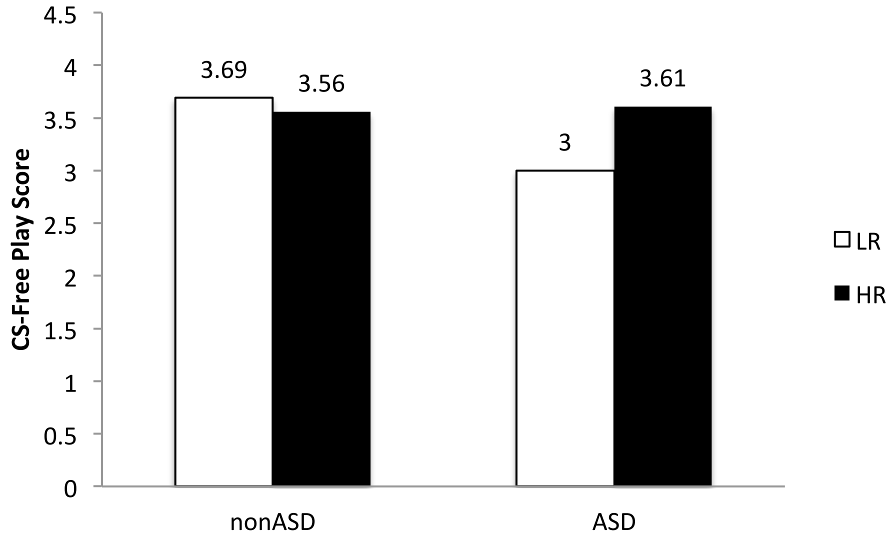

Figure 5. Mean 24-month CS Free Play by Risk and Diagnostic Group

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Footnotes

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