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Pathways between Infant Nonverbal Referential Communication and the Quality of Later Parent-Child Interaction in the Context of Autism Risk

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PATHWAYS BETWEEN INFANT NONVERBAL REFERENTIAL COMMUNICATION AND THE QUALITY OF LATER PARENT-CHILD INTERACTION IN THE CONTEXT OF AUTISM RISK

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The parent-child relationship is a central forum for the development of social and communication competencies within the first two years of life, with both parents and infants contributing to the development of these abilities. Early infant nonverbal referential communication abilities have been posited to be key infant contributions to parent-child interactions. Nonverbal referential communication is frequently, but not always, associated with social competence in typically developing children, and is consistently related to social abilities in children with autism spectrum disorders (ASD). Nonverbal referential communication difficulties are characteristic in children with ASD, and the younger siblings of children with ASD (High-Risk infants) have demonstrated such impairments by two years of age. The current study examined the impact of early nonverbal referential communication on the quality of toddler interactive behavior during play with their parent in the second year of life. Early nonverbal referential communication was also examined as a predictor of parent behavior quality during play, as it has been suggested that early behavioral differences in children at risk for an ASD may alter their social environment due to impaired interaction abilities. Early nonverbal referential communication did not predict toddler or parent behavior quality during play. Nonverbal referential communication may be associated with specific, not overall quality

of, social interactive behaviors in toddlers and parents. The parents of High- and Low-Risk infants did not differ in mean level of behavior quality during play, and toddlers did not differ by risk status in mean level of behavior quality. Parent and toddler behavior quality were strongly correlated. The association between toddler and parent behavior quality was moderated by risk status, such that parent and toddler behavior quality was strongly positively associated for Low-Risk infants. For High-Risk infants, parent behavior quality was not impacted by toddler behavior quality. While the current study does not support the direct effect of infant nonverbal referential communication on the overall quality of toddler and parent behavior during play, it adds to our understanding of the potential effects of having a High-Risk infant on parent behavior.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF APPENDICES

Page

CHAPTER 1: INTRODUCTION

Nonverbal referential communication

Nonverbal referential communication refers to a set of interrelated abilities that emerge within the first year of life (e.g., Bakeman & Adamson, 1984; Mundy et al., 2007) and create a shared context for social and communicative learning opportunities within adult-infant interactions (Hobson, Patrick, Crandell, Garcia Perez, & Lee, 2004; Mundy, Kasari, & Sigman, 1992; Striano, Chen, Cleveland, & Bradshaw, 2006). Nonverbal referential communication can be categorized into three classes of behaviors: initiating joint attention, responding to joint attention, and initiating behavioral requests. Infant-initiated joint attention (IJA; Seibert, Hogan, & Mundy, 1982; Mundy et al., 2007) is the ability to direct the attentional focus of a social partner to a shared referent. Responding to joint attention (RJA; Seibert, Hogan, & Mundy, 1982; Mundy et al., 2007) is the ability to use the nonverbal and verbal cues of a social partner to attend to the partner's object of focus. Infant-initiated behavioral requesting (IBR; Seibert, Hogan, & Mundy, 1982; Mundy et al., 2007) is the ability to request objects or events from a social partner. All three aspects of nonverbal referential communication create learning opportunities for infants through socially interactive experiences such as participation in turn-taking games and shared attention to objects as they are labeled.

Children with autism spectrum disorders (ASD) demonstrate deficits in nonverbal referential communication, which are part of the core social and communication impairments characteristic of ASD (e.g., APA, 2000; Dawson et al., 2004; Mundy, 1995; Mundy, Sigman, Ungerer, & Sherman, 1986). Early nonverbal referential communication and later language abilities tend to be associated in both children with ASD and typically

developing children (e.g., Carpenter, Nagell, & Tomasello, 1998; Laakso, Poikkeus, Katajamaki, & Lyytinen, 1999; Mundy & Kasari, 1995; Siller & Sigman, 2008), demonstrating the importance of these early infant abilities in both typical and atypical language development.

Nonverbal referential communication and social development

While the importance of early nonverbal referential communication is well-documented with regard to the development of language, less is known about the role of these early behaviors in the development of social competence. Current evidence suggests inconsistent support for the association of these early infant abilities with later social competence in typically developing children. Vaughan Van Hecke and colleagues (2007) found that infant nonverbal referential communication predicted parent-reported social abilities at 30 months in typically-developing toddlers. Nonverbal referential communication has also predicted teacher-reported social competence in preschoolers prenatally exposed to cocaine (Sheinkopf, Mundy, Claussen, & Willoughby, 2004). However, Parlade and colleagues (2009) did not find infant nonverbal referential communication to predict parent-reported social competence at 30 months in typically-developing toddlers. They did, however, find that nonverbal referential communication combined with positive affect predicted 30 month parent-reported social competence, suggesting that infant nonverbal referential communication may play an important role in the development of social competence in typically developing children.

Among children with ASD, nonverbal referential communication is consistently associated with social abilities, including concurrent observed social competence, including social orienting, in three-to-four year olds with ASD (Dawson et al., 2004), as

well as concurrent levels of observed peer engagement in older children with ASD (Travis, Sigman, & Ruskin, 2001). Infant nonverbal referential communication also predicts prosocial responding to an examiner's distress, another aspect of social competence, in preschoolers with ASD (Clifford & Dissanayake, 2009). Importantly, these findings include children preschool-age and above. The consistency of these associations in children with ASD suggests that nonverbal referential communication may be an essential early developmental ability within the context of atypical development, such that variation in these early infant abilities uniquely impacts the development of later child competencies in High-Risk children.

But how does nonverbal referential communication lead to social competence? In both typical and atypical development, infants with well-developed nonverbal referential communication are likely to learn more from interactions with their parents due to their ability to attend to others' foci and draw others' attention to their interests, thus developing social abilities within such interactions. Infants with poorly-developed nonverbal referential communication are likely to learn less from interactions with their parents because they do not attend or respond as frequently to their parent's bids for attention, and capture their parents' attention less frequently. The current study examined the impact of infant nonverbal referential communication on the quality of toddler social interactive behavior during play with the parent.

Nonverbal referential communication and parent-child interaction

In addition to examining whether early infant behaviors influence later toddler developmental abilities, it is also important to understand the effect of infants on their caregivers. Within the first two years of life, parent-child interactions are the most

significant arena for the development of social engagement abilities (Bell, 1979; Belsky, 1990; Vaughan et al., 2003). Both infants and parents contribute to dyadic social interactions, and the contributions of each partner are essential for the development of infant social abilities (e.g., Sameroff, 2010).

Parents' contributions to parent-child interactions, including responding sensitively to their infant's abilities and interests and scaffolding play materials, are well-documented. Parental sensitivity is often conceptualized as encompassing a warm, positive, socially engaging interaction style that scaffolds children's development through sensitive teaching and modeling (e.g., NICHD ECCRN, 1997; 1999). These contributions have been shown to positively impact infant well-being and development. For example, maternal sensitivity is not only related to the development of secure attachments in infants (Bowlby, 1969; NICHD ECCRN, 1997; Schore, 2001; Shaver & Brennan, 1992), it is also associated with observed child positive engagement from 15 to 36 months in typically developing children (NICHD ECCRN, 1999), and has predicted teacher-reported social competence through sixth grade (Belsky et al., 2007).

Infant influences on parent behavior during interactions are often examined in terms of the effect of infant temperament on parenting behaviors. Different temperament categories (e.g., difficult versus easy) have been found to evoke different responses from parents (e.g., more versus less directive interaction style), thus changing the social environment of the infant (e.g., Bell & Chapman, 1986; Lagace-Seguin & d'Entremont, 2006; Mills-Koonce et al., 2007). In the current study, infant nonverbal referential communication was expected to play a similar role during parent-child interactions, such that interaction with infants demonstrating differing nonverbal referential communication

abilities may impact the quality of social interactive behaviors demonstrated by parents. This study examined the association of infant nonverbal referential communication with the quality of parent behavior during parent-toddler interaction, in order to understand whether variability in nonverbal referential communication was associated with later parenting behavior quality.

The importance of nonverbal referential communication in the development of social competence within typical and atypical development is supported by the limited research in this area. However, there is little research examining these associations early in development, and no studies examining these factors in relation to parent-child interaction. It is important to have a better understanding of these relations within the first two years of life in order to understand the typical development of social abilities and aid in the identification of atypical social development. As ASD is not typically diagnosed prior to three years of age (Mandell, Novak, & Zubritsky, 2005), a prospective understanding of the impact of early development of nonverbal referential communication on parent and toddler behaviors during play within the context of ASD risk is provided through observing the younger siblings of children with ASD (High-Risk infants).

High-Risk infants are at heightened risk for developing an ASD (Ozonoff et al., 2011), and demonstrate nonverbal referential communication deficits similar to those of children with ASD (Cassel et al., 2007; Goldberg et al., 2005; Presmanes, Walden, Stone, & Yoder, 2007; Rozga et al., 2010; Yirmiya et al., 2006). The current study examined nonverbal referential communication and behavior quality during parent-child interaction in High-Risk infants as well as the infant siblings of children without ASD (Low-Risk

infants), in order to understand the developmental relations of these early competencies across developmental groups. This will enhance our ability to identify the early emergence of different developmental associations in High-Risk toddlers that may signal differing developmental trajectories with regard to social abilities.

The Current Study

The current study examined the relationships between infant nonverbal referential communication at 8 and 10 months and the quality of toddler and parent behavior during free play at 12, 15, and 18 months in order to understand whether early infant behaviors impact later parent-toddler interaction quality during play. In addition, ASD risk group was examined as a moderator of these associations, in order to examine the possibility that High-Risk and Low-Risk infants exhibit different developmental relations between nonverbal referential communication and later toddler and parent behavior quality. Specifically, the following three aims were examined.

Aims

Aim 1: Examine the relation between infant nonverbal referential communication and the quality of toddler behavior. Infant nonverbal referential communication at 8 and 10 months was examined as a predictor of toddler behavior quality during free play with the parent at 12, 15, and 18 months.

Hypothesis 1: More frequent infant nonverbal referential communication will predict higher quality toddler behavior at 12 to 18 months.

Aim 2: Examine the relation between infant nonverbal referential communication and the quality of parent behavior. Infant nonverbal referential

communication at 8 and 10 months was examined as a predictor of the quality of parent behavior during free play at 12, 15, and 18 months.

Hypothesis 2: More frequent infant nonverbal referential communication will predict higher quality parent behavior from 12 to 18 months.

Aim 3: Examine whether ASD risk status moderates the relation between infant nonverbal referential communication and the quality of parent and toddler behavior. ASD risk status was examined as a moderator of the associations between infant nonverbal referential communication and the quality of parent and toddler behavior during play.

Hypothesis 3: Three Potential Pathways to Moderation.

High-Risk infants will exhibit stronger associations between nonverbal referential communication and quality of behavior during parent-child interactions. High-Risk infants may demonstrate increased variability in nonverbal referential communication in comparison to Low-Risk infants, and this variability may contribute to stronger relations between infant nonverbal referential communication and toddler and parent behavior quality during parent-child interaction with High-Risk infants. Should this be the case, nonverbal referential communication might be considered a "prerequisite" infant ability in High-Risk infants for the development of high quality behavior during play with a caregiver. By contrast, the variability in nonverbal referential communication in Low-Risk infants, because it is occurring within the context of overall typical development, may not impact parent-child interaction quality.

High-Risk infants will exhibit weaker associations between nonverbal referential communication and quality of behavior during parent-child interactions. Alternatively,

High-Risk infants may be developing in an atypical fashion such that early abilities do not build to later competencies as expected in typical development, which would be demonstrated by weaker associations between infant nonverbal referential communication and behavior quality during parent-child interaction for High-Risk infants.

High-Risk infants will exhibit associations between nonverbal referential communication and toddler, but not parent, behavior. Finally, it is possible that, in High-Risk infants, infant nonverbal referential communication has strong associations with the quality of *toddler*, but not *parent*, behavior during play. This might be the case because parents of children with an ASD are motivated to engage with their younger children in specific ways, regardless of their toddlers' weaknesses, or strengths, in nonverbal referential communication. There is some evidence for the parents of children with ASD "compartmentalizing" different aspects of their daily functioning (Ekas & Whitman, 2011), and this same phenomenon may be occurring during play with their younger child. The current study examined the above possibilities in order to better understand the early developmental associations between infant nonverbal referential communication and behavior quality during play in High- and Low-Risk infants and their parents.

CHAPTER 2: METHOD

Participants

Participating infants were drawn from a longitudinal study of early development, the Sibling Studies Measuring Infant Learning and Emotion (Sib SMILE) Project, at the University of Miami. High-Risk infants (n = 51, 33 male) had at least one older sibling with a community diagnosis of an autism spectrum disorder (ASD). Older siblings' ASD diagnoses were confirmed upon study enrollment by the administration of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and clinical diagnosis by a licensed clinical psychologist using the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; APA, 2000). Low-Risk infants (n = 34, 14 male) were the infant siblings of children with no community ASD diagnosis and no elevations (i.e., did not exceed conservative cut-off score of nine) on the Social Communication Questionnaire (SCQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999), an ASD symptomatology screener. Inclusionary criteria for both groups included attendance for at least one of the 8 or 10 month visits and at least one of the 12, 15, or 18 month visits.

One Low-Risk infant was born prior to 37 weeks gestation and no High-Risk infants were born prior to 37 weeks; this was not a significant difference between groups, $X^2(1, n=86)=1.62$, $p=.20$. Gender differed based on risk group, $X^2(1, n=86)=4.57$, $p<.05$. There was no difference between High-Risk, $M=20.61$, $SD=16.04$, and Low-Risk, $M=16.88$, $SD=14.74$, infants with regard to parent level of overall distress, $t(55)=-.91$, $p=.37$, measured as Global Severity Total Score on the Brief Symptom Inventory (Derogatis, 1993) completed by parents at the 15 month visit.

There was no difference between the current sample and participants from the larger longitudinal study who were not included in the current sample (due to missing all relevant visits) with regard to child ethnicity, $X^2(4, n=167)=6.55$, $p=.16$, gender, $X^2(1, n=167)=1.33$, $p=.25$, gestational age, $X^2(1, n=129)=.09$, $p=.77$, pregnancy or birth complications, $X^2(1, n=125)=2.86$, $p=.24$, or ASD risk status, $X^2(1, n=160)=1.24$, $p=.27$. Maternal education level was higher in the current sample than in those participants omitted from the current sample due to missing data, $X^2(4, n=156)=9.67$, $p=.05$.

Measures and Procedures

Early Social Communication Scales (ESCS). The Early Social-Communication Scales (ESCS; Mundy et al., 2003), a semi-structured child-examiner assessment of nonverbal communication lasting approximately 15 - 20 minutes, were administered to study participants at 8 and 10 month visits. The assessment began with an adult examiner and the infant facing one another at a small table, with the infant seated on a caregiver's lap. The examiner systematically presented the infant with an array of novel toys (five active wind-up toys and three hand-activated toys). In each presentation, the examiner activated the toy on the table in front of, but out of reach of, the child. After the toy ceased moving, the examiner allowed the infant to play with the toy briefly. This was the context in which Initiating Joint Attention (IJA) and Initiating Behavioral Requesting (IBR) were typically coded. In addition, twice during the ESCS the examiner systematically called the infant's name and pointed to four items of interest (i.e. posters) on the walls to both sides and behind the infant. It was in this context that Response to Joint Attention (RJA) was coded.

Parent-Child Free Play. At 12, 15, and 18 month visits, mothers were asked to play with their toddlers as they would at home. A variety of age appropriate toys were arranged on a mat, and the mother and toddler were given five minutes to play.

Coding and Rating

Early Social Communication Scales (ESCS). IJA, RJA, and IBR were coded during the ESCS by research assistants and expert raters trained to reliability and blind to subject status. The ESCS defines IJA as eye contact to the examiner while holding or watching a toy, pointing to an object of interest with or without eye contact, and showing a toy to the examiner by holding it up toward the examiner's face with eye contact. RJA is defined as the infant orienting toward the attentional focus of the examiner by turning their head in the direction of the examiner's point. IBR includes reaching toward a toy with or without eye contact to the examiner, eye contact to the examiner regarding an out-of-reach inactive toy, pointing to a desired object with or without eye contact, and giving a toy to the examiner with or without eye contact. Twenty percent of ESCSs were coded for reliability, which was acceptable for all variables of interest: (8 months n = 14: IJA *Absolute Single Measure ICC* = .96; RJA *Absolute Single Measure ICC* = .85; IBR *Absolute Single Measure ICC* = .75; 10 months n = 14: IJA *Absolute Single Measure ICC* = .91; RJA *Absolute Single Measure ICC* = .86; IBR *Absolute Single Measure ICC* = .86).

Parent-Child Free Play. The quality of toddler behavior during free play was rated by research assistants trained to reliability and blind to subject status in 71 percent (n = 143) of free plays. Adaptations of the National Institute for Child Health and Human

Development Early Child Care Research Network (NICHD ECCRN) scales (1997; 1999; Fenning, Baker, Baker, & Crnic, 2007) were utilized.

The NICHD ECCRN (1999) scales were adapted for the University of Miami Sib SMILE Study for use with 15 to 30 month old children potentially demonstrating ASD symptomatology by including two scales capturing the toddler's social interest and competence in interactions with the parent (Baker, Messinger, Lyons, & Grantz, 2010). The six constructs of interest were child enthusiasm, persistence, affection toward parent, social interest, social competence, and negativity toward parent (see Appendix 1 for the complete coding system).

The NICHD ECCRN (Cox & Crnic, 2003; NICHD ECCRN; 1997) scales intended for use with 3 to 12 month old infants were adapted for the University of Miami Sib SMILE Study for use with 12 month old infants at risk for an ASD by including one scale capturing infant's social interest in interactions with the parent (see Appendix 2 for the complete coding system). Social competence was not included at 12 months because it was deemed less developmentally relevant than social interest at this age.

The quality of parent behavior during free play was rated by research assistants and expert raters trained to reliability and blind to subject status in 71 percent (n = 143) of free plays. The NICHD ECCRN (1999) scales (Baker, Messinger, Lyons, & Grantz, 2010; Fenning, Baker, Baker, & Crnic, 2007) were used to rate the quality of parent behavior at 15 and 18 months (see Appendix 1 for the complete coding system). The NICHD ECCRN (Cox & Crnic, 2003; NICHD ECCRN, 1997) scales were used to rate the quality of parent behavior with their 12-month-olds (see Appendix 2 for the complete coding system). Both systems capture the same constructs of parental sensitivity and

responsivity, stimulation of the child's cognitive development, detachment, positive and negative regard toward the child, and hostility toward the child.

In addition to rating the quality of each social partner's behavior individually, each parent-child dyad was also rated using one global code capturing the dyad's overall interaction quality throughout the 5-minute free play. This was treated as a supplemental outcome.

Twelve-month free plays were rated independently by two expert raters blind to subject status in 53 percent (*n*=23) of cases. In an additional 41 percent (*n*=22) of cases, one rater was blind and the other was non-blind. In the final six percent (*n*=3) of cases, both raters were not blind to subject status. Repeated Measures ANOVAs indicated there were no differences in ratings between the blind and non-blind rater for Parent, *F*=.86, *p*=.37, or Toddler, *F*=.92, *p*=.35, Mean composites, nor was there a difference between the blind and non-blind rater for Dyadic Mutuality, *F*=-.00, *p*=1.00, and thus the mean of both raters was used in all analyses. Reliability was acceptable for the constructs of interest: Parent Behavior *Mean Average Raters Absolute ICC* = .79, Toddler Behavior *Mean Average Raters Absolute ICC* = .85, and Dyadic Mutuality *Average Raters Absolute ICC* = .77.

At 15 months, 65 free plays were rated in teams of two raters trained to reliability and blind to subject status in 73 percent (*n*=47) of cases. Fifteen of these free plays were included in the sample used by Baker and colleagues (2010). An additional 20 free plays were rated independently by expert raters, including six coded by one expert rater, of which 85 percent (*n*=17) were coded blind to subject status. Reliability was acceptable for the constructs of interest: original sample (*n*=65): Parent Behavior *Mean Single*

Measures Absolute ICC = .83, Toddler Behavior *Mean Single Measures Absolute ICC* = .91, and Dyadic Mutuality *Single Measures Absolute ICC* = .81; coded for this project (*n*=20): Parent Behavior *Mean Average Absolute ICC* = .81, Toddler Behavior *Mean Average Absolute ICC* = .85, and Dyadic Mutuality *Average Absolute ICC* = .79.

At 18 months, 46 free plays were rated in teams of two raters trained to reliability and blind to subject status in 74 percent (*n*=34) of cases. An additional 22 free plays were rated independently by expert raters, including 10 coded by one expert rater. All expert raters were blind to subject status at 18 months. Reliability was acceptable for the constructs of interest: original sample (*n*=46): Parent Behavior *Mean Single Measures Absolute ICC M* = .86, Toddler Behavior *Mean Single Measures Absolute ICC M* = .81, Dyadic Mutuality *Single Measures Absolute ICC M* = .79; coded for this project (*n* = 22): Parent Behavior *Mean Average Absolute ICC* = .90, Toddler Behavior *Mean Average Absolute ICC* = .93, Dyadic Mutuality *Average Absolute ICC* = .80.

CHAPTER 3: RESULTS

Infant-initiated joint attention (IJA) and behavioral requesting (IBR) were separately summed and divided by the total duration of the Early Social Communication Scales (ESCS) to create rate-per-minute (RPM) frequencies. The number of responses to joint attention (RJA) were summed to a total score (range = 0 to 8).

Due to non-normal distributions (defined as skew > |.8| or kurtosis > |3|) IJA and IBR at 8 and 10 months were transformed with square root transformations (sqrt(X+1)). 8 and 10 month transformed IJA and IBR were then converted to *z*-scores to account for change in frequency of these behaviors over time (see Tables 2, 3). As IJA and IBR were strongly associated between 8 and 10 months, means of IJA and IBR were created and used as the final variables in analyses.

RJA was zero inflated at 8 and 10 months, with less than 50 percent of infants demonstrating RJA during the ESCS at 8 or 10 months. Accordingly, RJA across 8 and 10 months was dichotomized, such that 0 indicated no correct responses to RJA trials at 8 or 10 months, and 1 indicated at least one correct response to an RJA trial during the ESCS at 8 and/or 10 months. This dichotomized RJA variable was used as the final variable in analyses.

High-Risk infants (8 months: M= 1.04, SD=.35; 10 months: M= 1.15, SD=.37) demonstrated less IJA during the ESCS at 8 and 10 months than Low-Risk infants (8 months: M= 1.23, SD=.33; 10 months: M= 1.38, SD=.32), 8 months, $t(61)=2.09$, $p<.05$; 10 months, $t(77)=2.77$, $p<.02$. At 10 months, High-Risk infants were less likely to demonstrate RJA (35%) during the ESCS than Low-Risk infants (59%), $X^2(1,$

N=80)=4.57, $p<.05$. High- and Low-Risk infants did not differ in the frequency of IBR during the ESCS at 8, $t(61)=1.47$, $p=.15$, or 10 months, $t(77)=1.51$, $p=.14$.

The quality of toddler and parent behavior during play was rated on a Likert scale for the entire five minute free play (see Appendices 1 and 2 for full rating sheets). Free play constructs at 15 and 18 months were rated on 1-to-7 Likert scales, and 12 month free play constructs were rated on 1-to-5 Likert scales. Toddler Behavior scales (*Average Consistency ICC* = .86-.94) and Parent Behavior scales (*Average Consistency ICC* = .79-.93) exhibited high internal consistency, and thus the means of Toddler and Parent Behaviors were calculated. Parent Behavior mean composite, Toddler Behavior mean composite, and Dyadic Mutuality were normally distributed at 12, 15, and 18 months. Prior to analyses, 12, 15, and 18 month free play variables were transformed to *z* scores at each age to allow use of free play at all ages. *Z*-scored mean Toddler Behavior, mean Parent Behavior, and Dyadic Mutuality at 12, 15, and 18 months were the final variables used in analyses. Parent and toddler behavior quality were associated at each age, *r*s(54-83)=.41-.43, *p*s<.01.There were no differences between High- and Low-Risk infants in toddler or parent behavior quality during play at any age, *p*s>.50.

Aims

Examination of the stability and predictors of parent and child behavior quality and dyadic mutuality was done using Hierarchical Linear Modeling, with Full Maximum Likelihood used in the estimation of parameters.

Aim 1: Examine the relation between infant nonverbal referential communication and the quality of toddler behavior during play.

Preliminary analysis: Consistency of toddler behavior quality. Toddler behavior quality was examined using an unconditional hierarchical linear model in order to assess variance within- and between-subjects. Significant variability in the quality of toddler free play behavior was demonstrated, with 20 percent of variability within toddler behavior quality explained by between-subject variability.

Next, Age (age_{ti}) was added to the model at the level of individual observations in order to examine within-subject change in toddler behavior quality from 12 to 18 months. Age was transformed such that Age=0, 3, 6, corresponded to ages 12, 15, and 18 months, respectively, and a 3-unit increase in age_{ti} corresponded to a 3-month increase in toddler age. Age effects were not significantly different from zero, β=-.00, SE=.03, p=1.00, indicating that toddler behavior quality did not change systematically over time from 12 to 18 months. In addition, the model including Age did not significantly improve model fit from the unconditional model, $X^2(3, I=85)=.89$, $p>.50$.

The lack of a significant age effect was expected, as the NICHD rating scales used to rate toddler behavior quality were designed to be developmentally appropriate, thus reducing the likelihood of finding age effects. In addition, toddler behavior quality was converted to *z*-scores at each age in order to allow all ages of free play to be used in analyses simultaneously, which removed the possibility of finding an age effect. As Age was neither significant nor a primary focus of the study, Age was not retained in further modeling.

Predicting toddler behavior quality with nonverbal referential communication. Mean parent behavior quality at each age (Parent Behavior) was added to the model as a time-varying covariate to control for the association between parent behavior quality and toddler behavior quality at each age. Parent Behavior was significantly positively associated with toddler behavior quality, β=.41, *SE*=.06, $t(84)=6.36$, $p<.01$ (see Table 5, Graph 1). The inclusion of Parent Behavior significantly improved model fit, from the unconditional model, $X^2(3, I=85)=44.34$, $p<.01$. Parent Behavior was retained as a time-varying covariate in the following models examining the effect of infant nonverbal referential communication on toddler behavior quality. Each nonverbal referential communication behavior was examined separately.

Infant-initiated joint attention. See Table 4 for final model. Infant-initiated joint attention between 8 and 10 months (IJA) was added to the model as a Level 2 predictor of toddler behavior quality. IJA did not predict toddler behavior quality, and the inclusion of IJA did not improve model fit above and beyond the model including Parent Behavior, $X^2(1, I=85)=.32$, $p>.50$. Next, IJA was included at Level 2 for Parent Behavior, to examine whether IJA moderated the relation between Parent Behavior and toddler behavior quality. IJA did not moderate the relation between Parent Behavior and toddler behavior quality, and the inclusion of this interaction did not improve model fit from the model with Parent Behavior only, $X^2(2, I=85)=.74$, $p>.50$. This model was run removing Parent Behavior in order to explore the relation of IJA to toddler behavior quality while retaining the shared variance between toddler play behavior and Parent Behavior. IJA remained non-significant in predicting toddler behavior quality.

Infant-initiated behavioral requesting. See Table 4 for final model. Infant-initiated behavior requesting between 8 and 10 months (IBR) was examined as a Level 2 predictor of toddler behavior quality. IBR did not predict toddler behavior quality, and did not moderate the relation between Parent Behavior and toddler behavior quality. The inclusion of IBR did not improve model fit from the model with Parent Behavior only, $X^2(2, I=85)=1.27, p>.90$. With Parent Behavior removed, IBR remained non-significant in predicting toddler behavior quality.

Infant response to joint attention. See Table 4 for final model. Infant response to joint attention at 8 and 10 months (RJA; 0=no RJA during ESCS at 8 or 10 months, 1=at least one RJA demonstrated during ESCS at 8 and/or 10 months) was examined as a Level 2 predictor of toddler behavior quality. RJA did not predict toddler behavior quality, and did not moderate the relation between Parent Behavior and toddler behavior quality. The inclusions of RJA did not improve model fit from the model with Parent Behavior only, $X^2(2, I=85)=1.85, p>.90$. With Parent Behavior removed, RJA remained non-significant in predicting toddler behavior quality.

In sum, Aim 1 was not supported: infant nonverbal referential communication did not predict the quality of toddler behavior during play.

Aim 3a: Assess whether ASD risk status moderates the relation between infant nonverbal referential communication and the quality of toddler behavior during play.

Gender and risk status were first included in the unconditional model to understand their impact on toddler behavior quality. Gender was coded such that 0=male, 1=female. Risk status was coded such that 0=Low-Risk infant, 1=High-Risk infant.

Gender and risk status did not predict toddler behavior quality, and the inclusion of risk status and gender did not improve model fit from the unconditional model, $X^2(2, I=85)=.11, p>.50$.

Gender and risk status were then included in the model with Parent Behavior. Gender and risk status did not moderate the relationship between Parent Behavior and the quality of toddler behavior, nor did the inclusion of these variables improve model fit from the model with Parent Behavior only, $X^2(4, I=85)=1.60, p>.50$. Despite the lack of gender and risk status main effects and interaction effects with the covariate, these variables were retained in further models in order to examine the possibility of interactions between risk status, gender, and nonverbal referential communication in the prediction of toddler behavior quality.

Infant-initiated joint attention. See Table 4 for final model. IJA was entered into the model with Parent Behavior, risk status, and gender, along with the following interaction variables: risk status by IJA, gender by IJA. These variables were entered at Level 2 for the intercept, and did not significantly predict toddler behavior quality. IJA, risk status, gender, risk status by IJA, and gender by IJA were then included at Level 2 for the Parent Behavior control variable. These variables did not predict toddler behavior quality, and were not significant moderators of the relation between Parent Behavior and toddler behavior quality. This model did not significantly improve model fit from the model with Parent Behavior only, $X^2(10, I=85)=5.46, p>.50$. With Parent Behavior removed from the model, IJA, risk status, gender, and the interaction of these variables were not significant predictors of toddler behavior quality.

Infant-initiated behavioral requests. See Table 4 for final model. IBR was entered into the model with Parent Behavior, risk status, and gender, along with the following interaction variables: risk status by IBR, gender by IBR. These variables were entered at Level 2 for the intercept, and did not significantly predict toddler behavior quality during play. IBR, risk status, gender, risk status by IBR, and gender by IBR were then included for the Parent Behavior control variable. These variables did not predict toddler behavior quality, and were not significant moderators of the relation between Parent Behavior and the quality of toddler behavior. This model did not significantly improve model fit from the model with Parent Behavior only, $X^2(10, I=85)=6.64, p>.50$. With Parent Behavior removed from the model, IBR, risk status, gender, and the interaction of these variables were not significant predictors of toddler behavior quality.

Infant response to joint attention. See Table 4 for final model. RJA was entered into the model with Parent Behavior, risk status, and gender, along with the following interaction variables: risk status by RJA, gender by RJA. RJA, risk status, risk status by RJA, and gender did not significantly predict toddler behavior quality. These variables were then included at Level 2 for the intercept and for the Parent Behavior control variable. Risk status by RJA did not significantly predict toddler behavior quality, nor did this variable moderate the relation between Parent Behavior and toddler behavior quality. This model did not significantly improve model fit from the model with Parent Behavior only, $X^2(10, I=85)=15.06, p=.13$. With Parent Behavior removed from the model, RJA, risk status, gender, and the interaction of these variables were not significant predictors of toddler behavior quality.

Additional findings. When examining RJA as a predictor of toddler behavior quality, the interaction of gender and RJA emerged as a significant predictor of toddler behavior quality, β=.72, *SE*=.29, $t(79)$=2.45, $p<.05$. The presence of RJA in girls was associated with higher quality play behavior, while the opposite association was observed for boys. This interaction effect was significant both including and excluding Parent Behavior as a covariate.

In sum, Aim 3a was not supported: ASD risk status did not moderate the relations between infant nonverbal referential communication and toddler behavior quality during play. Gender emerged as a moderator of the effect of RJA on toddler behavior quality.

Aim 2: Examine the relation between infant nonverbal referential communication and the quality of parent behavior during play.

Preliminary analysis: Consistency of parent behavior quality. Parent behavior quality was examined using an unconditional hierarchical linear model in order to assess variance within- and between-subjects. Significant variability in the quality of parent behavior was demonstrated, with 38 percent of variability within parent behavior quality explained by between-subject variability.

Next, Age (age_{ti}) was added to the model at the level of individual observations in order to examine within-subject change in parent behavior quality from 12 to 18 months. Age was transformed such that Age=0, 3, 6, corresponded to toddler ages 12, 15, and 18 months, respectively, and a 3-unit increase in age_{ti} corresponded to a 3-month increase in toddler age. Age effects were not significantly different from zero, β=.00, *SE*=.02, *p*=.91, indicating that parent behavior quality did not change systematically over time from 12 to

18 months. In addition, the model including Age did not significantly improve model fit from the unconditional model, $X^2(3, I=85)=1.60, p>.50$.

The lack of a significant age effect was expected, as the NICHD rating scales used to rate parent behavior quality were designed to be developmentally appropriate, thus reducing the likelihood of finding age effects. In addition, parent behavior quality ratings were converted to *z*-scores at each age in order to allow all ages of free play to be used in analyses simultaneously, which removed the possibility of finding an overall age effect. As Age was neither significant nor a primary focus of the study, Age was not retained in further modeling.

Predicting parent behavior quality with nonverbal referential communication. Mean toddler behavior quality at each age (Toddler Behavior) was added to the model to control for the effect of toddler behavior quality on the quality of parent behavior. Toddler Behavior was significantly associated with parent behavior quality, $\beta=.46$, $SE=.07$, $t(84)=6.99$, $p<.01$ (see Table 5, Graph 1). The model with Toddler Behavior included significantly improved model fit from the unconditional model, $X^2(3, I=85)=56.63$, $p<.01$. Toddler Behavior was retained as a time-varying covariate in models examining the effect of infant nonverbal referential communication on parent behavior quality.

Infant-initiated joint attention. See Table 5 for final model. Infant-initiated joint attention between 8 and 10 months (IJA) was added to the model as a Level 2 predictor of parent behavior quality. IJA did not predict parent behavior quality, and the inclusion of IJA did not significantly improve model fit from the model including Toddler Behavior only, $X^2(1, I=85)=.52$, $p>.50$. Next, IJA was included at Level 2 for Toddler

Behavior, in order to examine whether IJA moderated the relation between Toddler Behavior and parent behavior quality. IJA did not moderate the relation between Toddler Behavior and parent behavior quality and the inclusion of this interaction did not improve model fit from the model with Toddler Behavior only, $X^2(2, I=85)=.68, p>.50$. This model was run removing Toddler Behavior in order to explore the relation of IJA to parent behavior quality while retaining the shared variance between parent play behavior and Toddler Behavior. IJA remained non-significant in predicting parent behavior quality.

Infant-initiated behavioral requesting. See Table 5 for final model. Infant-initiated behavior requesting between 8 and 10 months (IBR) was examined as a Level 2 predictor of parent behavior quality. IBR did not predict parent behavior quality, and did not moderate the relation between Toddler Behavior and parent behavior quality. The inclusion of IBR did not improve model fit from the model including Toddler Behavior only, $X^2(1, I=85)=.20, p>.50$. With Toddler Behavior removed, IBR remained non-significant in predicting parent behavior quality.

Infant response to joint attention. See Table 5 for final model. Infant response to joint attention at 8 and 10 months was examined as a Level 2 predictor of parent behavior quality. RJA did not predict parent behavior quality, and did not moderate the relation between Toddler Behavior and parent behavior quality. The inclusion of RJA did not improve model fit from the model with Toddler Behavior alone, $X^2(1, I=85)=.73, p>.50$. With Toddler Behavior removed, RJA remained non-significant in predicting parent behavior quality.

In sum, Aim 2 was not supported: infant nonverbal referential communication did not predict parent behavior quality during free play.

Aim 3b: Assess whether ASD risk status moderates the relation between infant nonverbal referential communication and the quality of parent behavior during play.

Gender and risk status were first included in the unconditional model to understand their impact on parent behavior quality. Gender was coded such that 0=male, 1=female. Risk status was coded such that 0=Low-Risk infant, 1=High-Risk infant. Gender and risk status did not predict parent behavior quality. The inclusion of risk status and gender did not improve model fit from the empty model, $X^2(2, I=85)=.58$, $p>.50$.

Next, gender and status were included the model with Toddler Behavior. Gender did not moderate the relationship between Toddler Behavior and parent behavior quality. Risk status, $\beta=-.28$, $SE=.13$, $t(82)=-2.10$, $p<.05$, moderated the relation between Toddler Behavior and parent behavior quality (see Graph 5). Toddler Behavior was significantly positively associated with parent behavior quality for Low-Risk infants, $r(34)=.52$, $p<.01$. This association was not significant for High-Risk infants, $r(51)=.20$, $p=.15$. The model including gender and risk status with Toddler Behavior did not significantly improve model fit over the model including Toddler Behavior only, $X^2(4, I=85)=5.89$, $p=.21$. A model including risk status (omitting gender) was compared to a model including risk status with Toddler Behavior, in order to understand whether the inclusion of risk status improved model fit above Toddler Behavior, excluding gender from the model. The inclusion of risk status did not improve model fit above that of Toddler Behavior, $X^2(2,$

I=85)=4.09, *p*=.13. Thus, results for the following models including risk status must be interpreted as preliminary.

Infant-initiated joint attention. See Table 5 for final model. IJA was entered into the model with Toddler Behavior, gender, and risk status, as well as the following interaction variables: risk status by IJA, gender by IJA. These variables were entered at Level 2 for the intercept, and did not significantly predict parent behavior quality. IJA, risk status, gender, risk status by IJA, and gender by IJA were then included at Level 2 for Toddler Behavior. IJA, gender, risk status by IJA, and gender by IJA did not predict parent behavior quality, and were not significant moderators of the relation between Toddler Behavior and parent behavior quality. Risk status, β=-.29, *SE*=.14, $p<.05$, was a significant moderator of the relation between Toddler Behavior and parent behavior quality, indicating that risk status persisted in moderating the relation between Toddler Behavior and parent behavior quality with the inclusion of IJA (see Graph 5). This model did not significantly improve model fit from the model with Toddler Behavior only, $X^2(10, I=85)=7.23$, $p>.50$. With Toddler Behavior removed, IJA, risk status, gender, risk status by IJA, and gender by IJA did not predict parent behavior quality.

Infant-initiated behavioral requests. See Table 5 for final model. IBR was entered into the model with Toddler Behavior, risk status, and gender, along with the following interaction variables: risk status by IBR, gender by IBR. These variables were entered at Level 2 for the intercept, and did not predict parent behavior quality. IBR, risk status, gender, risk status by IBR, and gender by IBR were then included for the Toddler Behavior control variable. IBR, gender, risk status by IBR, and risk status by gender were not significant predictors of parent behavior quality, and did not moderate the relation

between Toddler Behavior and parent behavior quality. Risk status remained a significant moderator of the relation between Toddler Behavior and the quality of parent behavior, β=-.29, *SE*=.13, $p<.05$ (Graph 5). This model did not significantly improve model fit from the model with Toddler Behavior only, $X^2(10, I=85)=9.24$, $p>.50$. With Toddler Behavior removed from the model, IBR, risk status, gender, IBR by risk status, and IBR by gender did not predict parent behavior quality.

Infant response to joint attention. See Table 5 for final model. RJA was entered into the model with Toddler Behavior, risk status, and gender, along with the following interaction variables: risk status by RJA, gender by RJA. These variables were entered at Level 2 for the intercept, and did not predict parent behavior quality. RJA, risk status, gender, risk status by RJA, and gender by RJA were then included at Level 2 for the Toddler Behavior covariate. These variables were not significant predictors of parent behavior quality, nor did they moderate the relation between Toddler Behavior and parent behavior quality. This model did not significantly improve model fit from the model with Toddler Behavior only, $X^2(10, I=85)=11.80$, $p=.30$. With Toddler Behavior removed from the model, RJA, risk status, gender, risk status by RJA, and gender by RJA were not significant predictors of parent behavior quality.

Additional findings. When examining RJA as a predictor, gender by RJA was a significant moderator of the relation between Toddler Behavior and the quality of parent behavior. Behavior quality in parents of boys who did not demonstrate RJA, $r(24)=.57$, $p<.01$, was more strongly associated with their toddlers' behavior quality than parents of boys who demonstrated RJA, $r(23)=-.17$, $p=.43$. The parents of girls did not show this differential association based upon presence of absence of RJA in their girls as infants

(RJA: $r(22)=.44$, $p<.05$; no RJA: $r(16)=.49$, $p=.06$). In addition, gender approached significance as a moderator of the relation between Toddler Behavior and parent behavior quality, $\beta=-.35$, $SE=.18$, $t(79)=-1.98$, $p=.05$.

In sum, Aim 3b was not supported: ASD risk group did not moderate the relations between infant nonverbal referential communication and parent behavior quality during free play. However, ASD risk did moderate the relation between toddler and parent behavior quality, such that quality of parents' interactions with their High-Risk infants was not impacted by their infants' behavior, whereas the quality of behavior in parents of Low-Risk infants was highly correlated with the quality of their infants' behavior. Additionally, the effect of RJA on gender moderated the effect of Toddler Behavior on parent behavior quality during play.

Supplementary Analyses: Dyadic Mutuality

Consistency of Dyadic Mutuality during Play. Dyadic Mutuality, an overall summary score of interaction quality between toddler and parent, was examined using an unconditional hierarchical linear model in order to assess variance within- and between-subjects. Significant variability in dyadic mutuality was demonstrated, with 25 percent of variability within dyadic mutuality explained by between-subject variability.

Next, Age (age_{ti}) was added to the model at the level of individual observations in order to examine within-subject change in dyadic mutuality from 12 to 18 months. Age was transformed such that Age=0, 3, 6, corresponded to ages 12, 15, and 18 months, respectively, and a 3-unit increase in age_{ti} corresponded to a 3-month increase in age. Age effects were not significantly different from zero, $\beta=-.00$, $SE=.03$, $p=.92$, indicating that dyadic mutuality ratings did not change systematically over time from 12 to 18

months. In addition, the inclusion of Age in the model did not improve model fit beyond the unconditional model, $X^2(3, I=85)=.88, p>.50$.

Again, the lack of a significant age effect was expected, as the NICHD rating scales used to rate dyadic mutuality during play were designed to be developmentally appropriate, thus reducing the likelihood of finding age effects. In addition, dyadic mutuality ratings were converted to *z*-scores prior to analysis in order to allow all ages of free play to be used in analyses simultaneously, which removed the possibility of finding an overall age effect. As Age was neither significant nor a primary focus of the study, Age was not retained in further modeling.

The relation between infant nonverbal referential communication and the quality of dyadic mutuality. Infant-initiated joint attention (IJA) did not predict dyadic mutuality, nor did the inclusion of IJA improve model fit from the empty model, $X^2(2, I=85)=.74, p>.50$. Infant-initiated behavioral requesting (IBR) did not predict dyadic mutuality, and did not improve model fit from the empty model, $X^2(4, I=85)=2.50, p>.50$. Infant response to joint attention (RJA) did not predict dyadic mutuality, and did not improve model fit from the empty model, $X^2(4, I=85)=1.23, p>.50$.

The relation between infant nonverbal referential communication and dyadic mutuality: Exploring ASD moderation. Gender and risk status were included in the unconditional model to understand their impact on dyadic mutuality. Gender and risk status did not predict dyadic mutuality. However, the inclusion of risk status and gender improved model fit from the empty model, $X^2(1, I=85)=8.19, p<.05$. Next, gender, risk status, and interaction variables between risk status, gender, and each nonverbal referential communication variable were entered into each nonverbal referential

communication model in order to examine whether gender or risk status moderated the relationship between nonverbal referential communication and dyadic mutuality.

Gender and risk status did not moderate the relation between IJA and dyadic mutuality, and the inclusion of these variables did not improve model fit from the model with risk status and gender only, $X^2(0, I=85)=2.01$, $p>.50$. Gender and risk status also did not moderate the relation between IBR and dyadic mutuality, and the inclusion of these variables did not improve model fit from the model with risk status and gender only, $X^2(0, I=85)=2.00$, $p>.50$. Gender and risk status did not moderate the relation between RJA and dyadic mutuality, and the inclusion of these variables did not improve model fit from the model with risk status and gender only, $X^2(0, I=85)=2.42$, $p>.50$.

In sum, toddler behavior quality was strongly associated with concurrent parent behavior quality. Parent behavior quality was strongly associated with concurrent toddler behavior quality, but this effect was moderated by risk status, such that higher quality toddler behavior predicted higher quality parent behavior only for Low-Risk infants. For High-Risk infants, parent behavior quality was not related to toddler behavior quality, suggesting that parents are behaving in specific ways with their High-Risk infants, regardless of the strengths or weaknesses demonstrated by their infant. Dyadic mutuality was not predicted by infant nonverbal referential communication behavior, nor was it impacted by risk status or gender.

CHAPTER 4: DISCUSSION

Nonverbal referential communication is an important early precursor to later social and language competencies, presumably through the learning opportunities afforded by shared attention to objects and events. The current study examined the impact of these early behaviors on interaction quality during parent-toddler free play in infants at risk for an autism spectrum disorder (ASD; High-Risk infants) and comparison infants with older siblings without an ASD (Low-Risk infants). Parent and toddler behavior quality were strongly associated from 12 to 18 months in both groups. Nonverbal referential communication did not predict the quality of parent or toddler behavior during play from 12 to 18 months for High- or Low-Risk infants. The current null findings suggest that infant nonverbal referential communication may be important for the development of *specific* communication and social abilities. The global measure of child and parent interaction quality used in this study may not have been sensitive to the impact of early nonverbal referential communication.

ASD risk status did not moderate associations between nonverbal referential communication and toddler or parent behavior quality. However, ASD risk status moderated the effect of toddler behavior quality on parent behavior quality. Low-Risk toddlers' and their parents' behavior quality were strongly positively associated. High-Risk toddlers' behavior quality was not associated with their parents' behavior quality. While the study's main hypotheses were not supported, findings support a theory of compartmentalization in parents of children with and at risk for an ASD: an adaptive buffering of parenting skills in the face of developmental atypicalities.

Aim 1: Examine the relation between infant nonverbal referential communication and the quality of toddler behavior during play.

In the current study, it was hypothesized that early infant nonverbal referential communication would predict toddler behavior quality during play. Nonverbal referential communication involves the use of eye contact and gestures to communicate interest to and request items and objects from a social partner. Two fundamental components of nonverbal referential communication (joint attention and behavioral requesting), were the foci of the current study. These abilities are posited to be precursors to integrated verbal social communication, whereby children not only use verbal language to communicate, but draw their communicative partner into a social exchange through the use of eye contact and nonverbal communication (e.g., gestures, facial expressions) in combination with language.

In children without ASD, nonverbal referential communication has been associated with social abilities, including theory of mind (Charman et al., 2000), frequency of parent-child joint engagement episodes (Markus, Mundy, Morales, Delgado, & Yale, 2000), and parent- and teacher-rated social competence (Sheinkopf, Mundy, Claussen, & Willoughby, 2004; Vaughan Van Hecke et al., 2007). These associations have also been found in children with ASD (e.g., Clifford & Dissanayake, 2009; Travis, Sigman, & Ruskin, 2001), and in their younger siblings (High-Risk infants; Sullivan et al., 2007; Yoder, Stone, Walden, & Malesa, 2009). Of note, all studies utilized specific aspects of social abilities such as prosocial helping or frequency of peer social engagement.

The current study was constructed to examine the development of social abilities within the first two years of life in High-Risk infants, with the hypothesis that infant nonverbal referential communication would impact overall toddler interaction quality at these early ages. A global measure of toddler interactive behavior quality was the outcome measure of social ability, and measures of infant-initiated and response to joint attention and infant-initiated behavioral requests during the ESCS were utilized to capture infant nonverbal communication abilities. Nonverbal referential communication did not predict toddler interactive behavior quality alone or in association with ASD risk status in the current study.

One possible explanation for this lack of association is that infant nonverbal referential communication may not predict *overall* child interactive behavior quality, but may instead predict more specific aspects of toddler behavior. The NICHD Early Child Care Research Network (ECCRN) rating systems adapted for this study were developed to look at parent and child overall interaction quality, and thus do not include measures of specific behaviors or frequency of behaviors. In the literature on the association between nonverbal referential communication and social abilities, specific aspects of social competence were examined, suggesting that nonverbal referential communication abilities are more robust predictors of specific social abilities than broader interaction quality.

Aim 2: Examine the relation between infant nonverbal referential communication and the quality of parent behavior during play.

It was hypothesized that parent behavior quality would be impacted by infant nonverbal referential communication. This was consonant with the neurodevelopmental

model of ASD (Mundy & Burnette, 2005; Dawson, 2008), whereby differences in infants' early nonverbal social communication abilities would change their social environment. The current study hypothesized that this change would occur via frequency of infant nonverbal referential communication predicting quality of parent interactive behavior during play. This hypothesis was not supported: infant nonverbal referential communication did not predict parent behavior quality during play.

As in Aim 1, the NICHD rating scales were designed to measure global aspects of individuals' interaction styles (Appendix 1, 2). The global nature of these rating scales allows them to be adapted for use with dyads with a range of functioning (e.g., Fenning & Baker, 2012; NICHD ECCRN, 2002; Quittner et al., 2010), providing rich information regarding the interaction of parents and children across a range of physical and developmental abilities. However, in order to support use across ability levels, the scales, by nature, are not tied to the occurrence or frequency of specific behaviors. They instead encompass more global domains (e.g., parental sensitivity) which can include a range of behaviors depending upon the needs of the child. It may be that nonverbal referential communication is associated not with overall parent behavior quality, but with specific parenting behaviors, for example parent-initiated joint attention or frequency and type of parent vocalizations.

Aim 3: Examine whether ASD risk status moderates the relation between infant nonverbal referential communication and the quality of parent and toddler behavior during play.

Finally, the current study hypothesized that ASD risk status would moderate the relations between infant nonverbal referential communication and the quality of parent

and toddler behavior during play. This was not the case. This lack of moderation indicates that the lack of association between infant nonverbal referential communication and parent and toddler behavior quality does not distinguish High- from Low-Risk toddler-parent dyads.

While Aim 3 was not supported, ASD risk status was found to moderate the relation between quality of parent and toddler behavior. Low-Risk parents' interactive behavior quality was impacted by their toddler's interactive behavior quality, such that higher quality toddler behavior was associated with higher quality parent behavior. However, this association was not found for High-Risk parents: the quality of their interactive behavior did not change in relation to their toddler's behavior quality.

The current study found no difference in the interactive behavior quality of parents of High- and Low-Risk toddlers. However, there was a difference in the way parenting was impacted by child behavior. While stress in parents of children with ASD has been emphasized (e.g., Schieve, Blumberg, Rice, Visser, & Boyle, 2007; Singer, 2006; Tomanik, Harris, & Hawkins, 2004), less attention has been given to how stress might impact parenting. Emerging research on stress in parents of children with ASD suggests that parents are often able to maintain effective parenting strategies despite high levels of stress (e.g., Osborne & Reed, 2010). The current study supports the concept of "compartmentalization" in parents of children with an ASD: equivalent parenting in parents of High- and Low-Risk infants provides evidence of buffering of parenting behaviors from potentially atypical child behavior quality.

Gender had an unexpected role as a moderator of toddler behavior quality. While there were no gender effects on RJA, toddler gender interacted with RJA to predict

toddler behavior quality. Boys who did not demonstrate RJA had higher behavior quality than boys who did; by contrast, girls who demonstrated RJA had higher behavior quality than girls who did not. This is the first time this finding has been reported. It may be that parents are generally less concerned about the development of girls (e.g., Leiter & Reiker, 2012), so that differences in RJA do not signal developmental concerns in parents of girls. Conversely, parent concern over the lack of RJA in boys may lead them to interact in more purposeful ways with their boys to facilitate the development of communication skills and to obtain the boys' attention. It is possible that this purposeful interaction style would facilitate higher-quality interactive behavior among boys. This would explain the finding that boys who did not demonstrate RJA had higher quality behavior during play, while the expected positive association of RJA and behavior quality was found for girls.

In sum, the most significant predictor of toddler and parent behavior quality during play was their partner's behavior quality. This is consistent with the literature on the impact of each partner on the other during dyadic interactions (e.g., Bell, 1979; Chow, Haltigan, & Messinger, 2010; Hinde & Stevenson-Hinde, 1987; Sameroff, 2010): social partners influence each others' behavior. Early infant nonverbal referential communication did not predict toddler or parent behavior quality, and ASD risk status did not moderate the effect of infant nonverbal referential communication on toddler or parent behavior quality. ASD risk status did moderate the effect of toddler behavior quality on parent behavior quality, providing additional support for the idea of parental compartmentalization in parents of children with and at risk for an ASD. Further research is needed to better understand the developmental domains impacted by infant nonverbal

referential communication and the ways in which parents can be supported in providing high quality interactions with their children despite the challenges faced by parenting children with and at risk for an ASD.

The current study had several limitations that suggest caution in the interpretation of findings. First, not all children attended each study visit. This was managed through the use of full maximum likelihood (FIML) in multilevel models. Second, the finding that ASD risk status moderated the association between parent and toddler behavior quality must be considered preliminary. While ASD risk status was a significant moderator of this association, the overall model including ASD risk status did not fit the data significantly better than the model without ASD risk status. Finally, while the current sample did not differ from the larger longitudinal sample on a variety of demographic variables, parents in the current sample were more highly educated than parents in the full sample, making these results particularly salient to families with higher education levels.

Despite these limitations, the current study contributes to a better understanding of early development and parenting within the context of ASD risk. Infant nonverbal referential communication did not predict parent or toddler behavior quality during play, perhaps because these early infant abilities relate to specific social abilities, not overall behavior quality. Toddlers and their parents were influenced by each other during play, leading to a dynamic interaction that was more than the sum of either part. The behavior quality of High-Risk toddlers' parents did not differ from that of Low-Risk toddlers' parents. However, ASD risk status moderated the relation between parent and toddler behavior quality during play. Parents of High-Risk toddlers' were not impacted by their

toddler's interactive competency, which suggests "compartmentalizing" of parenting behaviors.

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Table 1.

Sample demographics by ASD risk group

Demographic variable	Total n (%)	Low-Risk n (%)	High-Risk n (%)
ASD risk	86	34 (40%)	52 (60%)
Gender			
Male	47 (55%)	14 (30%)	33 (70%)
Female	39 (45%)	20 (51%)	19 (49%)
Ethnicity			
White/Caucasian	31 (36%)	13 (38%)	18 (35%)
African-American	2 (2%)	1 (3%)	1 (2%)
Hispanic/Latino	41 (48%)	15 (44%)	26 (50%)
Asian/Asian-American	3 (3%)	2 (6%)	1 (2%)
Mixed Ethnicity/Other	9 (10%)	3 (9%)	6 (12%)
Maternal Education			
High school	3 (3%)	1 (3%)	2 (4%)
Some college	6 (7%)	2 (6%)	4 (8%)
2-year college	13 (15%)	3 (9%)	10 (19%)
4-year college	19 (22%)	9 (27%)	10 (19%)
Advanced/Professional degree	44 (51%)	19 (56%)	25 (48%)
Pregnancy			
Full-Term	85 (99%)	26 (77%)	43 (100%)
Premature	1 (1%)	1 (3%)	0 (0%)
Brief Symptom Inventory			
Global Severity Total Score	*M*(SD) 18.91(15.44)	*M*(SD) 16.88(14.74)	*M*(SD) 20.61(16.04)

Table 2.

Means (SDs) of and Correlations within Early Social Communication Scales (ESCS) by Age

Measure	Age (y)									
	8 months(63)					10 months(79)				
Infant-Initiated Joint Attention	1.36 (.84)					1.70 (.96)				
Infant-Initiated Behavioral Requesting	.44 (.40)					.61 (.52)				
Infant Response to Joint Attention	.67 (1.11)					1.04 (1.57)				
	1	2	3†	4	5	6†				
8 months										
1. IJA	-	-.08	.08	.60**	.29*	.07				
2. IBR		-	.31*	-.07	.33*	.51**				
3. RJA			-	.02	.16	.35**				
10 months				-	.07	-.09				
4. IJA					-	.28*				
5. IBR						-				
6. RJA										

* Significant correlation at .05 level; ** Significant correlation at .01 level; Spearman's ρ

Table 3.

Means (SDs) of and Correlations within Parent-Child Interaction Ratings by Age

Measure	Age (n)								
	12 months(54)			15 months(83)			18 months(78)		
Child Mean	3.44 (.49)			4.61 (.69)			4.75 (.74)		
Parent Mean	3.60 (.49)			5.41 (.72)			5.50 (.82)		
Dyadic Mutuality Mean	2.67 (.75)			4.36 (.90)			4.51 (1.03)		
12 months	1	2	3	4	5	6	7	8	9
1. Child Mean	-	.41**	.71**	.29*	.02	.08	.09	-.16	-.01
2. Parent Mean		-	.75**	.17	.36**	.23	.04	.23	.21
3. Dyadic Mutuality Mean			-	.31*	.30*	.32*	.23	.13	.21
15 months				-	.43**	.75**	.27*	.17	.25*
4. Child Mean					-	.71**	.07	.41**	.24**
5. Parent Mean						-	.26*	.24*	.24*
6. Dyadic Mutuality Mean							-	.41**	.73**
18 months								-	.77**
7. Child Mean									-
8. Parent Mean									
9. Dyadic Mutuality Mean									

* Significant correlation at .05 level; ** Significant correlation at .01 level

Table 4.

Final Models Predicting Toddler Behavior Quality during Play

Predictor	Final Model
Infant-Initiated Joint Attention (IJA)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IJA}) + r_1$
Infant-Initiated Behavioral Requesting (IBR)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IBR}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IBR}) + r_1$
Infant Response to Joint Attention (RJA)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{RJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{RJA}) + r_1$
IJA, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IJA}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{IJA}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{IJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IJA}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{IJA}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{IJA}) + r_1$

IBR, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IBR}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{IBR}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{IBR}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IBR}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{IBR}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{IBR}) + r_1$
RJA, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{RJA}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{RJA}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{RJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{RJA}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{RJA}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{RJA}) + r_1$

Table 5.

Final Models Predicting Parent Behavior Quality during Play

Predictor	Final Model
Infant-Initiated Joint Attention (IJA)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ToddlerBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IJA}) + r_1$
Infant-Initiated Behavioral Requesting (IBR)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ToddlerBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IBR}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IBR}) + r_1$
Infant Response to Joint Attention (RJA)	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ToddlerBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{RJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{RJA}) + r_1$
IJA, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ParentBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IJA}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{IJA}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{IJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IJA}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{IJA}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{IJA}) + r_1$

IBR, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ToddlerBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{IBR}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{IBR}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{IBR}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{IBR}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{IBR}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{IBR}) + r_1$
RJA, Risk Status, Gender	Level-1 Model: $Y = \pi_0 + \pi_1*(\text{ToddlerBehavior}) + \varepsilon$ Level-2 Model: $\pi_0 = \beta_{00} + \beta_{01}*(\text{RJA}) + \beta_{04}*(\text{RiskStatus}) + \beta_{05}*(\text{RiskStatus} * \text{RJA}) + \beta_{08}*(\text{Gender}) + \beta_{09}*(\text{Gender} * \text{RJA}) + r_0$ $\pi_1 = \beta_{10} + \beta_{11}*(\text{RJA}) + \beta_{14}*(\text{RiskStatus}) + \beta_{15}*(\text{RiskStatus} * \text{RJA}) + \beta_{18}*(\text{Gender}) + \beta_{19}*(\text{Gender} * \text{RJA}) + r_1$

Figure 1.

Toddler and Parent Behavior Quality are Associated at 12, 15, and 18 Months

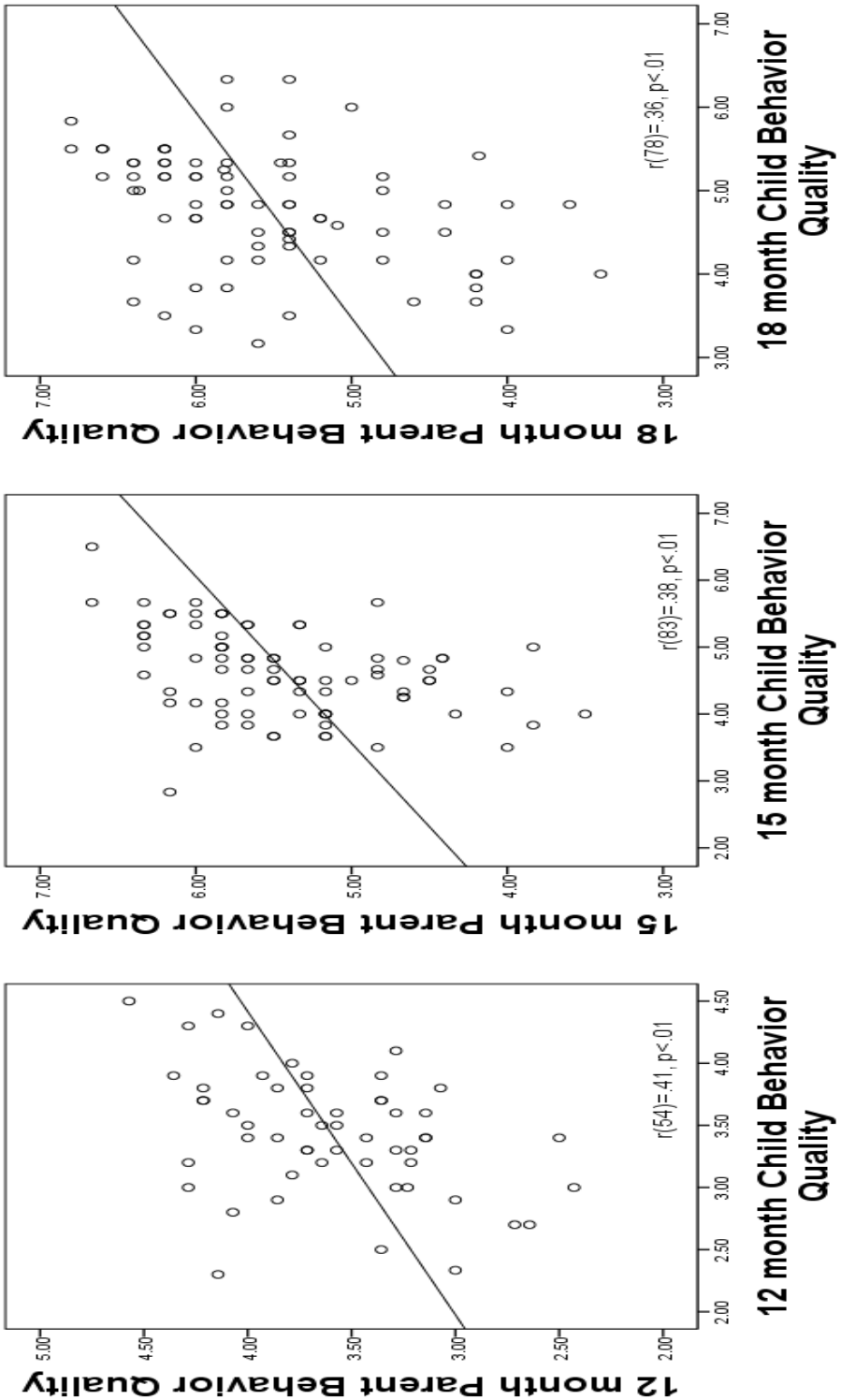


Figure 2.

Gender Moderates the Relation between RJA and Toddler Behavior Quality during Play

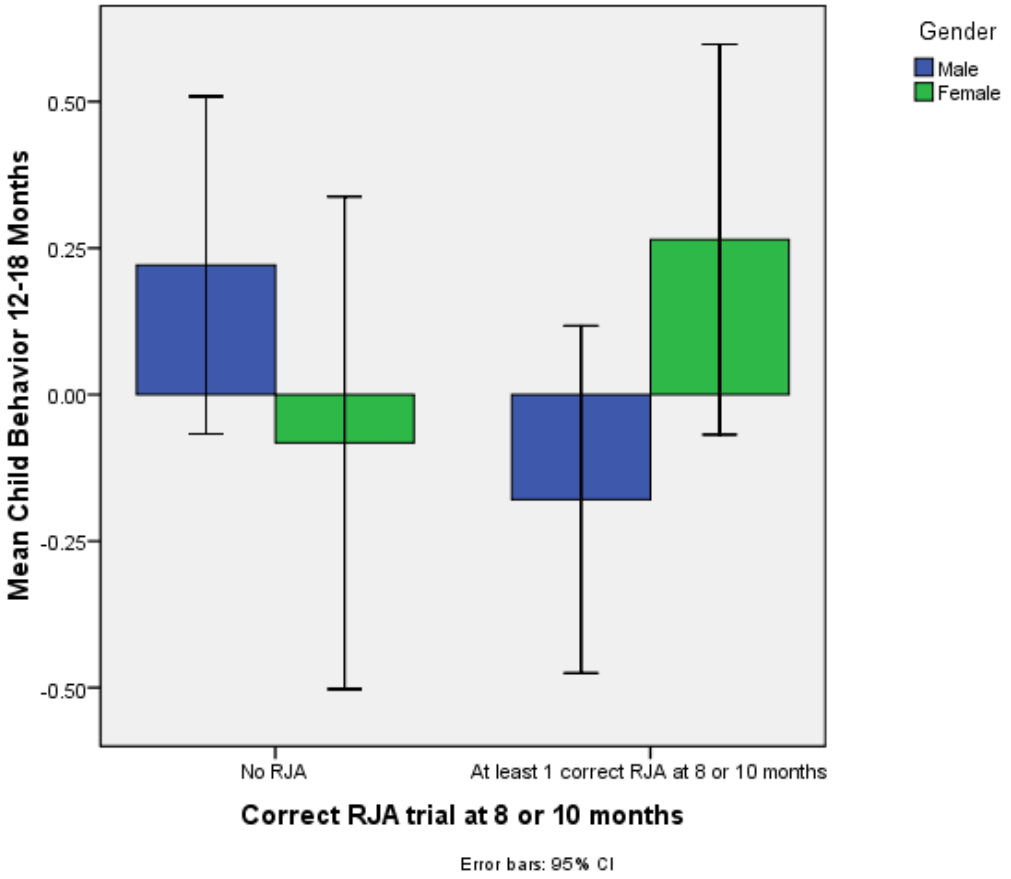


Figure 3.

Risk Status Moderates the Relation between Toddler and Parent Behavior Quality during Play

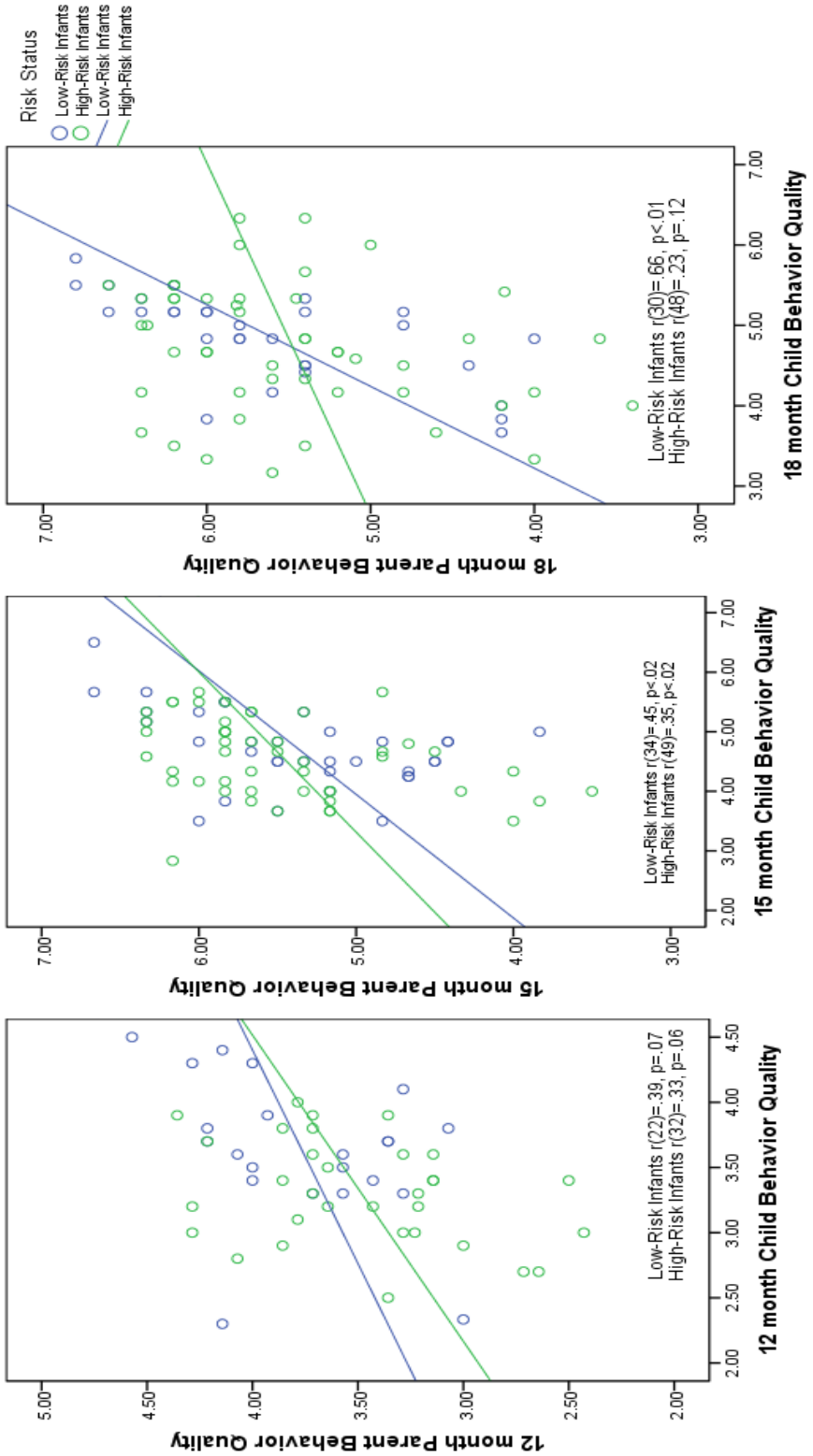
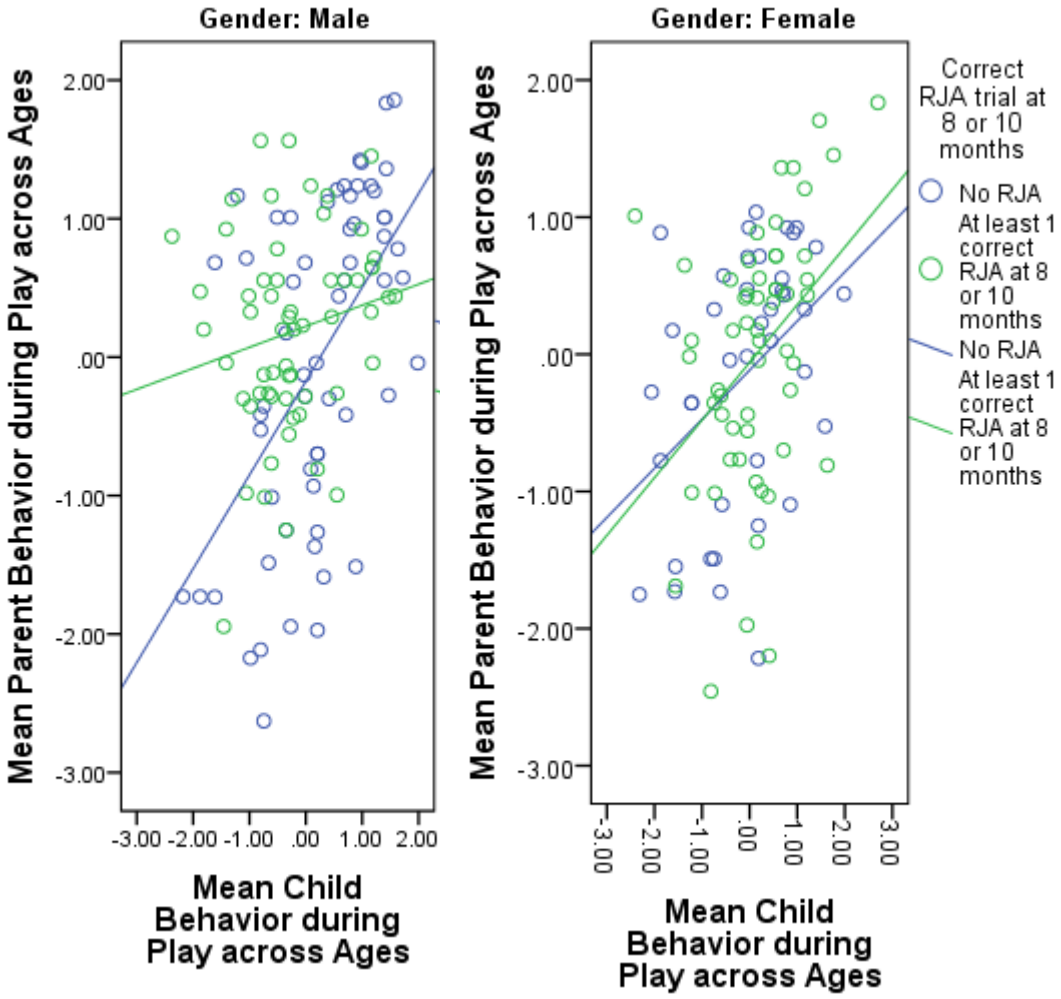


Figure 4.

Gender Moderates the Effect of RJA on the Relation between Parent and Toddler Behavior Quality during Play



APPENDIX 1: FREE PLAY RATING SHEET 12 MONTHS
Ratings of Parent-Child Interaction

12 Months (Cox/Crnic System with Baker/Grantz modifications)

PARENT CODES

Sensitivity/Responsiveness	1	2	3	4	5
Intrusiveness	1	2	3	4	5
Detachment/Disengagement	1	2	3	4	5
Positive Regard for Child/Positive Affect	1	2	3	4	5
Negative Regard for Child/Negative Affect	1	2	3	4	5
Animation	1	2	3	4	5
Stimulation of Development	1	2	3	4	5

CHILD CODES

Positive Mood	1	2	3	4	5
Negative Mood	1	2	3	4	5
Activity	1	2	3	4	5
Sustained Attention	1	2	3	4	5
Social Interest	1	2	3	4	5

DYADIC CODES

Dyadic Mutuality	1	2	3	4	5

APPENDIX 2: FREE PLAY RATING SHEET 15 AND 18 MONTHS

Parent-Child Interaction Coding for Sib Study

Rating Sheet (NICHD ECCRN system adapted by Quittner with Baker modifications)

PARENT CODES

Sensitivity/Responsivity:	1	2	3	4	5	6	7
Respect for Child Autonomy:	1	2	3	4	5	6	7
Stimulation of Cognition:	1	2	3	4	5	6	7
Detachment:	1	2	3	4	5	6	7
Positive Regard:	1	2	3	4	5	6	7
Hostility:	1	2	3	4	5	6	7

CHILD CODES

Enthusiasm:	1	2	3	4	5	6	7
Negativity towards Mother:	1	2	3	4	5	6	7
Persistence:	1	2	3	4	5	6	7
Affection towards Mother:	1	2	3	4	5	6	7
Social Interest	1	2	3	4	5	6	7
Social Competence	1	2	3	4	5	6	7

DYADIC CODES

Affective Mutuality/Felt Security:	1	2	3	4	5	6	7