

The Relation between Maternal Behavior and Social Smiling in Infants at High Risk for  
Autism Spectrum Disorder

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A thesis  
submitted in partial fulfillment of the  
requirements for the degree of

Master of Science

University of Washington

2014

Committee:

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Program Authorized to Offer Degree:

Psychology

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**Abstract**

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Psychology

Infant siblings of children diagnosed with autism spectrum disorder (ASD; High-Risk, HR-infants) are at an increased risk of developing ASD compared to infant siblings of typically developing children (Low-Risk, LR-infants; Messinger et al., 2013; Ozonoff et al., 2011). Limited social smiling has been identified as an early behavioral risk marker of ASD (e.g. Ozonoff et al., 2010). Recent theories propose that maternal behaviors that promote engagement and reciprocity during parent-child interactions may attenuate ASD symptom development over time for infants at high risk for developing ASD (Dawson, 2008). This study examined maternal and infant behaviors in HR- and LR-infants during free play sessions. Maternal responsiveness and directiveness at 9 months were examined as predictors of growth in infant social smiling between 9 and 18 months. Both maternal responsiveness and directiveness predicted growth in infant social smiling. Higher levels of responsiveness were associated with increased growth in social smiling for HR- and LR-infants. Conversely, higher levels of maternal directiveness were associated with slower growth in infant social smiling for both groups. Mothers of HR-infants displayed higher levels of maternal directiveness, but not responsiveness, relative to mothers of LR-infants. No group differences were found for trajectory of growth in infant social smiling. These findings provide further evidence that early maternal behaviors may play an important role in the social development of infants at high and low risk for ASD.

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by impairments in communication and social functioning and the presence of restricted and repetitive behaviors (American Psychiatric Association [APA], 2013). According to the Centers for Disease Control and Prevention (CDC) the current prevalence rate of ASD is 1 in 68 children, and 1 in 42 boys (CDC, 2014). This rate represents a ten-fold increase in prevalence within the past 40 years, signifying a growing public health crisis, and driving research efforts to identify risk factors and early diagnostic indicators of ASD.

Genetic and family studies support a strong genetic basis for ASD (Hallmayer et al., 2011; Szatmari, Jones, Zwaigenbaum, & MacLean, 1998). Infants with an older sibling with ASD (High-Risk, HR-infants) are at an elevated risk of displaying ASD symptoms relative to infants with an older sibling with typical development (Low-Risk, LR-infants). The recurrence risk for the presence of ASD in HR-infants is estimated to be as high as 20% (Ozonoff et al., 2011). Additionally, approximately 20% of HR-infants are estimated to present sub-clinical impairments in social and communicative functioning (Georgiades et al., 2012; Messinger et al., 2013), which are indicative of a 'broader autism phenotype' (Constantino et al., 2006; Dawson et al., 2002; Landa & Garrett-Mayer, 2006; Losh, Sullivan, Trembath, & Piven, 2008; Zwaigenbaum et al., 2005). Due to the great variability in their developmental outcomes, infant siblings of children with ASD provide valuable information about the early etiology and trajectory of ASD symptoms.

In the past, research studies investigating early signs of ASD were conducted retrospectively, relying on parent report or the analysis of early home videotapes. Retrospective studies that used parent report involved asking parents of children with ASD to recall their child's early development, in an effort to identify behaviors associated with a future diagnosis of

ASD. Results from these studies indicated that from an early age, children with ASD exhibited less social orienting, imitation, joint attention, and affect sharing as compared to delayed and typically developing peers (e.g. Dahlgren & Gillberg, 1989; Stone & Lemanek, 1990; Vostanis et al., 1998; Watson et al., 2007). Moreover, evidence from home videotape studies indicated that children who were later diagnosed with ASD displayed less orienting to name, attending to others, and joint attention than typically developing children and children with developmental delays (e.g. Baranek, 1999; Osterling & Dawson, 1994; Osterling, Dawson, & Munson, 2002; Werner, Dawson, Osterling, & Dinno, 2000).

Despite the important knowledge gained from these studies, there are limitations inherent to retrospective research designs. Criticisms of studies that rely on parent report are that parents may inaccurately recall past events or that their recollections of their child's early behavior may be unduly influenced by their current awareness of their child's ASD diagnosis. With regard to home videotapes, there may be a selectivity bias in that parents typically choose to film positive interactions and special events; furthermore, the settings of the events captured are not standardized across children (Palomo, Belinchón, & Ozonoff, 2006). Consequently, retrospective designs make it difficult to interpret and generalize research findings; thus, there has been a movement in the field of ASD research toward the use of prospective research designs.

In ASD research, prospective designs involve stratifying infants based on risk group status and monitoring their development longitudinally, to examine the relationship between risk group, infant behavior, and later diagnostic outcome. Prospective studies of HR-infants offer researchers the unique opportunity to learn about the earliest signs of ASD as they manifest. Findings from these prospective studies indicate that on average, children who later receive a diagnosis of ASD display typical social development during the first 6 to 9 months of life, but

that substantial behavioral differences are often evident by 2 years of age (Ozonoff et al., 2010). Through these prospective studies, researchers have begun to identify a number of early social-communicative symptoms (e.g., limited eye gaze, delayed language development, lack of shared/joint attention) indicative of an increased risk for a later ASD diagnosis (Cassel et al., 2007; Goldberg et al., 2005; Ozonoff et al., 2010; Presmanes, Walden, Stone, & Yoder, 2007; Zwaigenbaum et al., 2005). Moreover, these social-communicative impairments are particularly salient as they are often among the first symptoms observed by parents and professionals (Zwaigenbaum et al., 2009). Researchers have suggested that limited social smiling may be one early behavioral risk marker for ASD (Nichols, Ibañez, Foss-Feig, & Stone, 2013; Ozonoff et al., 2010).

### *Social smiling*

Social smiling, a motoric expression of a positive affective state, is an early form of social communication that emerges in infancy between 1 and 2 months of age (Anisfeld, 1982). Indicative of infant social engagement, socially-directed positive affect such as social smiling can be interpreted as an important form of social sharing that influence the quality of an infant's social interactions (Kasari, Sigman, Mundy, & Yirmiya, 1990) and plays a role in initiating and maintaining early parent-child interactions (Messinger & Fogel, 2007). In typically developing infants, social smiling frequency increases between 2 and 6 months of age, as it becomes a progressively more complex and intentional form of infant social communication (Malatesta, Culver, Tesman, & Shepard, 1989; Maltesta, Grigoryev, Lamb, Albin, & Culver 1986). Between 6 and 9 months of age, infants both respond to and initiate social smiles with their mothers, suggesting that they are becoming increasingly participatory in social interactions (Cohn & Tronick, 1987).

Empirical evidence from longitudinal studies of HR-infants suggests that HR-infants who later receive a diagnosis of ASD exhibit less frequent social smiling than both LR-infants (Landa, Holman, & Garrett-Mayer, 2007; Ozonoff et al., 2010) and HR-infants who do not receive a diagnosis of ASD (Zwaigenbaum et al., 2005). These findings lend support to the hypothesis that limited social smiling may be an early behavioral indicator of ASD. There is also research evidence that suggests that as a group, HR-infants display less frequent social smiling than LR-infants (Cassel et al., 2007; Nichols et al., 2013). Cassel et al. (2007) found that HR-infants exhibited less social smiling than LR-infants at 6 months. As this study did not examine diagnostic outcomes, definitive conclusions about overarching risk-group differences could not be made. However, Nichols et al. (2013) examined social smiling in HR- and LR-infants during administration of an interactive ASD screening tool, and found that HR-infants displayed less social smiling than LR-infants at 15 months, regardless of later diagnostic outcome. This finding suggests that early impairments in social engagement may not be limited to HR-infants who are later diagnosed with ASD and may reflect a more global characteristic of genetic vulnerability inherent to the high-risk group.

Studies investigating social smiling in HR-infants typically examine the frequency of social smiles that occur during standardized assessments with an examiner (Landa et al., 2007; Nichols et al., 2013; Ozonoff et al., 2010; Zwaigenbaum et al., 2005) or during the Face-to-Face Still-Face (FFSF) paradigm, an experimental task in which mothers are instructed to interact with their child, then withdraw for a short period of time, and then resume the interaction (Cassel et al., 2007; Tronick, Als, Adamson, Wise, & Brazelton, 1978). These studies provide valuable information about the frequency of social smiling in HR-infants during standardized procedures

in a controlled laboratory setting; however, there is a lack of research evidence about social smiling in HR-infants in the context of more naturalistic parent-child interactions.

Rozga and colleagues (2011) attempted to address this gap in the research by examining infant social smiling during a parent-child free play interaction. Findings from this study indicated that HR-infants who received an ASD diagnosis could not be distinguished from HR-infants who were not diagnosed with ASD or a low-risk control group on frequency of social smiling at 6 months (Rozga, et al., 2011). A limitation of this study was that the free play interaction was only 1-minute in duration, which may not be a sufficient amount of time to capture infant behavior. Furthermore, mothers were instructed to interact with their child without using touch or toys. Though this design allows for procedural standardization, it is a less ecologically valid representation of typical parent-child interactions, perpetuating a need for a study examining social smiling during a more naturalistic parent-child free play setting. Therefore the proposed study will examine rate per minute of infant social smiling during a 5-minute laboratory-based parent-child free play interaction in which mothers were instructed to play with their child as they normally would at home, in an effort to measure its occurrence in a more naturalistic situation.

#### *Parent-child interactions*

Empirical findings from neurobiological research indicate that early childhood environments play an influential role in infant brain development (Cicchetti & Curtis, 2006). Furthermore, it has been suggested that the early environment (e.g., parenting style) may be even *more* influential for infants at risk for developmental challenges than for low-risk infants (Landry, Smith, & Swank, 2006). The *differential susceptibility model* encapsulates this risk-sensitivity hypothesis, and proposes that at-risk children are particularly sensitive to both positive *and*

negative early environments (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). This dual model of risk suggests that, compared to low-risk peers, children at risk for developmental challenges may benefit even more strongly from positive rearing environments and, similarly, may be more vulnerable to the effects of negative rearing environments.

The differential-susceptibility model is encouraging as it suggests that child outcome is not pre-determined and that parents may act as effective agents of change for their children. There is a growing body of research that supports the application of this model to children with ASD and their parents. Baker and colleagues (2010) examined maternal behavior in a sample of HR- and LR-infants and found that maternal sensitive responding was associated with increased expressive language growth in HR-infants with emergent ASD, but not in LR-infants or HR-infants who did not receive an ASD diagnosis. These results support the differential susceptibility model and suggest that with regard to language development, children who exhibited early symptoms of ASD benefitted more from maternal responsive behaviors than did children with typical development.

With regard to early rearing environment, the differential susceptibility model of ASD highlights the potential importance of parent mediated interventions for children with ASD. Indeed, research indicates that parents of children with ASD can be taught strategies that are associated with improved child communication, social-emotional, and behavioral outcomes (e.g. Ingersoll & Gergans, 2007; Koegel & Schreibman, 1996; Mahoney & Perales, 2003; Minjarez, Williams, Mercier, & Hardan, 2011; Moes & Frea, 2002). However, there remains a need for research to identify parenting behaviors that specifically stimulate and maintain social engagement in HR-infants. It has been theorized that early impairments associated with ASD

(e.g., limited social smiling) may affect the quality of parent-child interactions, which over time may lead to an increasingly atypical social developmental trajectory (Dawson, 2008).

Research involving typically developing children suggests that there are specific parenting qualities and behaviors that characterize the parent-child interactions that lead to optimal developmental outcomes (Landry, Smith, & Swank, 2003). The most important aspect of parent behavior that has been identified repeatedly in the literature as having positive effects on child development is maternal responsiveness (Mahoney & Nam, 2011). Maternal responsiveness is defined as interactive behaviors that are sensitive, contingent, immediate, appropriate, and support a child's social, emotional, communicative, and play behaviors (Bornstein, Tamis-LeMonda, Hahn, & Haynes, 2008; Mahoney, 2008; Mahoney & Nahm, 2011). Maternal responsiveness is characterized by behaviors that promote parent-child reciprocity, maintain the child's interests, and facilitate high levels of parent involvement in parent-child interactions (Mahoney & Nam, 2011).

Maternal responsiveness is associated with positive cognitive, language, social, and emotional outcomes for both typically developing children (Bornstein & Tamis-LeMonda, 1989; Tamis-LeMonda, Bornstein, Baumwell, 2001; Tomasello & Farrar, 1986; Weizman & Snow, 2001) and children at high risk for developmental challenges, including ASD (Landry et al., 2006; Siller & Sigman, 2002; Yoder & Warren, 1998, 2004). Moreover, research indicates that a responsive parenting style may play an even *more* significant role in the development of high-risk children than it does for typically developing children, as they may be particularly susceptible to their social environment (Landry et al., 2006).

There are divergent findings with regard to research investigating maternal responsiveness in mothers of children with ASD. Findings from some early research studies

indicate that mothers of children with disabilities including ASD display less responsive behaviors than mothers of typically developing children (e.g., Kim & Mahoney, 2004). However, a majority of research studies investigating maternal behavior have found no group differences in maternal responsive behaviors between mothers of children with ASD and typically developing children (Baker, Messinger, Lyons, & Grantz, 2010; Van Ijzendoorn et al., 2007). There is limited research with regard to maternal behaviors and infants at high risk for ASD. Emerging evidence indicates that mothers of HR-infants may display less responsive behaviors when interacting with their children than mothers of LR-infants (Wan et al., 2012). Wan and colleagues (2012) examined maternal responsive behavior during a free play interaction in a sample of HR ( $n = 45$ ) and LR-infants ( $n = 47$ ) between 6 to 10 months of age, and found a trend for lower sensitive responding in mothers of HR-infants as compared to mothers of LR-infants. Given the established influence of early rearing environments on child outcomes, the authors suggest that these findings may have important implications for preventative interventions for emergent ASD.

Another influential domain of parenting behavior is maternal directiveness, defined as parenting behaviors that direct a child's immediate attention or behavior, e.g., physically prompting, instructing, or requesting (Mahoney, 2008). Empirical evidence indicates that mothers of children with ASD demonstrate more directive behaviors as compared to mothers of typically developing children and children with other developmental delays (Kasari, Sigman, Mundy, & Yirmiya, 1988; Lemanek, Stone, Fishel, 1993; Saint-Georges, et al., 2011). Findings are mixed regarding the effects of maternal directiveness on child behavior for typically developing children and children at high risk for developmental challenges. It has been hypothesized that maternal directiveness may have changing influence throughout development

(Landry, Smith, Swank, & Miller-Loncar, 2000); when children are very young, it may be adaptive in teaching new skills, but as children mature and develop competence in some developmental domains, it may be less adaptive (Landry, Smith, Swank, Assel, & Vellet, 2001). McCathren, Yoder, and Warren (1995) suggested that for children with developmental delays, directive behaviors that are used to maintain a child's engagement, introduce a new focus to an unengaged child, or teach a new skill may enhance language development, whereas behaviors that redirect an engaged child's attention may be detrimental to language learning.

There is limited research with regard to maternal directiveness and infants at high risk for ASD. It is reasonable to hypothesize that mothers of HR-infants may be more directive than mothers of LR-infants as a means of eliciting responses from their child or scaffolding functional play behaviors. Indeed, emerging research indicates that parents of HR-infants display more directive behaviors than parents of LR-infants (Wan et al., 2012); however, it remains unclear whether maternal directiveness has a beneficial or adverse impact on the social engagement of HR-infants, whose social initiations may be limited.

The present study aims to explore the extent to which maternal responsiveness and directiveness during free play interactions are associated with growth in infant social smiling for infants at high and low risk for ASD. Risk-group status (HR-infants vs. LR-infants) will be examined as a moderator of the association between maternal behavior and infant social smiling growth. As previous literature has identified a positive correlation between maternal responsiveness and infant positive affect (e.g., Lowe et al., 2012; Wan et al., 2012) it is hypothesized that higher levels of maternal responsiveness at 9 months will be associated with increased growth in infant social smiling between 9 and 18 months for both groups. Furthermore, the differential susceptibility hypothesis suggests that the association between maternal

responsiveness and growth in infant social smiling will be stronger for HR-infants. Due to the limited research surrounding maternal directiveness and infant social engagement, no a priori hypothesis was made regarding the association between maternal directiveness and growth in infant social smiling for either group.

This study of HR-infants will allow examination of how naturally occurring variation in maternal interactive behavior relates to infant social smiling at the age at which ASD symptoms may be beginning to manifest (i.e., for those who develop ASD). Researchers have theorized that maternal behaviors that scaffold child social development may promote social engagement and potentially attenuate ASD symptom development for high-risk infants (Dawson, 2008). The purpose of this study is to identify specific parenting behaviors that facilitate growth in social engagement in infants at high risk for ASD.

## **Method**

### **Participants**

Informed consent was obtained from parents prior to participation in the research procedures. The sample reported in this paper was drawn from a longitudinal study investigating the social and emotional development of HR-infants and LR-infants at the University of Washington and Vanderbilt University. For inclusion in the study, HR-infants were required to have an older sibling with a community diagnosis of ASD confirmed via administration of the Autism Diagnostic Observation Scale (Lord et al., 2000) and a DSM-IV-TR-informed clinical diagnosis (American Psychiatric Association [APA], 2000). LR-infants were required to have a typically developing older sibling as verified by parental information and with a cut-off score lower than 9 (indicating no presence of ASD) on the Social Communication Questionnaire (SCQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999), as well as no reported family history of

ASD in 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup> degree relatives. Inclusion criteria for both groups included: (1) the absence of severe sensory or motor impairments, (2) the absence of identified metabolic, genetic, or progressive neurological disorders, (3) gestational age  $\geq 37$  weeks, (4) birth weight at least 2500 grams, and (5) older sibling  $\geq 36$  months of age upon study entry. Infants were enrolled in the study at 6, 9, or 12 months of age. HR-infant participants were recruited through research centers, clinics, and the greater community, while LR-infant participants were recruited from county and statewide databases of birth records.

The original sample ( $N = 60$ ) included 36 HR-infants and 24 LR-infants. Twelve participants were excluded from the present study for the following reasons: the father participated in lieu of the mother ( $n=10$ ), a nanny participated in lieu of her mother ( $n=1$ ), and the family was Spanish speaking and translation services were unavailable ( $n=1$ ). The final sample ( $N = 48$ ) included 30 HR-infants (18 males) and 18 LR-infants (12 males). Demographic characteristics of the participants are presented in Table 1; there were no significant group differences for race or years of maternal education. Also, there were no significant group differences for infant gestation age,  $t(45) = -1.68, p = .10$ , birth weight,  $t(45) = -.25, p = .81$ , or cognitive functioning,  $t(44) = -1.43, p = .16$ , as measured at 12 months by the Mullen Scales of Early Learning Early Learning Composite score (Mullen, 1995).

## **Procedure**

HR- and LR-infants and their mothers came to the laboratory when the infants were 6, 9, 12, 15, and 18 months of age to participate in an evaluation that included direct observation and parental report measures. ASD diagnostic assessments were administered at 24 and 36 months. This study is based on observations of maternal and infant behaviors at their 9, 12, 15, and 18 month visits, during the Parent-Child Free Play (PCFP) procedure. The PCFP is a 5-minute

laboratory observation during which the infant and the infant's mother are in a room with a standard set of developmentally appropriate toys (e.g., a ball, a pop-up toy, a teddy bear, etc.). The mother is instructed to, "play with your child as you normally would at home." The PCFP has been used in previous ASD studies as a naturalistic paradigm to assess parent-child interactions and child social, communication, and play behaviors (e.g., Ruble, McDuffie, King, & Lorenz, 2008; Yoder & Warren, 1999). This procedure was filmed in the laboratory using two cameras in order to ensure that both the infant's face ('baby view') as well as the mother's face ('side view') were captured on film.

## **Measures**

### *Maternal Responsiveness and Directiveness*

Maternal responsiveness and directiveness were coded at 9 months during the PCFP procedure using a modified version of the Maternal Behavior Rating Scale (MBRS; Mahoney, 2008). For the purposes of this study the MBRS was expanded from a 5 to a 9-point scale to capture greater variability in maternal behavior. Both maternal responsiveness and directiveness were coded globally on this scale, with scores ranging from "Very Low" (1) to "Very High" (9). Maternal behaviors were rated independently by a trained team of research assistants and undergraduate students who were blind to participant risk group status. Maternal behaviors were coded individually (i.e., responsiveness and directiveness were not coded at the same time). Interrater agreement was measured by the blind coding of 38% of the study sample video clips by the first author or a Master's level Research Assistant who supervised the coding team. Intraclass correlation coefficients were in the good to excellent range: maternal directiveness (.84-.98) and responsiveness (.72-.76).

For the purposes of this study, maternal responsiveness was defined as “the supportiveness of the mother’s responses to the child’s social, emotional, communicative, and play behaviors, which serve to support the child’s activities, whether overt (e.g., comments, requests, vocalizations and gestures) or subtle (e.g., facial expressions and signs of discomfort.” (Mahoney, 2008). An example of “Very High” responsive behavior included consistently monitoring and labeling the child’s interests and activities; an example of “Very Low” responsive behavior included a consistent lack of awareness and response to the child’s overt initiations. Several guiding questions (e.g., “Do the mother’s actions lead to continuation of child play and/engagement?”) were developed to assist the coder in determining a single rating for maternal responsiveness for each free play interaction.

Maternal directiveness was defined as “the frequency with which the mother requests, commands, suggests, or physically prompts in order to direct the child’s immediate attention or behavior” (Mahoney, 2008). An example of “Very High” directive behavior included consistently directing the child’s play (e.g., instructing the child to play with a particular toy); an example of “Very Low” directive behavior included consistently following the child’s lead in play (e.g., allowing the child to play without providing suggestions or instructions). Several guiding questions (e.g., “When the child is already engaged with a toy/activity, is the mother constantly making suggestions, requests, commands, etc.?”) were also developed to assist the coder in determining a single rating for maternal directiveness for each interaction.

### *Infant Social Engagement*

Infant social engagement was measured as the rate per minute of social smiling, operationally defined as the coordination of eye contact directed towards the mother’s face and smiling. Social smiling was coded during the PCFP procedure at 9, 12, 15, and 18 months using

ELAN, a multimodal digital annotation tool (Wittenburg, Brugman, Russel, Klassmann, & Sloetjes, 2006). PCFP sessions were viewed using ELAN at  $\frac{3}{4}$  speed to ensure accuracy of timing and observations. Based on the coding system used by Nichols et al. (2013), social smiles were coded when the infant was observed to laugh or smile within 1/10 of a second (either before or after) making eye contact directed to the mother's face. Social smiling was coded only when: (1) the "smile" could be differentiated from the child's overall expressions surrounding the act in question, and (2) the child's expression was considered to reflect a positive affective state (Nichols et al., 2013). Coding was conducted in two passes. In the first pass, instances of eye contact were annotated, and in the second pass, the annotated segments were coded for the presence of a smile.

Social smiling was coded by an undergraduate student, a research assistant, and a graduate student who were blind to risk group status. Interrater agreement was measured through the blind coding of 62% of the study sample video clips by the first author. Intraclass correlation coefficients were in the good to excellent range (.73-.95). As there was some variability in the length of the PCFP interactions, rate per minute of social smiling was calculated by dividing the frequency of infant social smiles by the duration of the PCFP interaction. There were no significant differences in duration of PCFP interactions between HR-infants and LR-infants at 9, 12, 15, or 18 months.

### **Overview of Analyses**

Preliminary analyses were conducted to: (1) examine group differences in maternal responsiveness and directiveness at 9 months and infant social smiling at 9, 12, 15, and 18 months, and (2) identify the relation between the two maternal behaviors. Hierarchical linear modeling (HLM) was used to examine: (1) the growth trajectory of infant social smiling; (2)

whether maternal responsiveness and directiveness at 9 months individually predicted growth in infant social smiling between 9 and 18 months; (3) whether risk group was a predictor of growth in social smiling and whether there were any interactions between maternal behaviors and risk group. HLM parsimoniously models developmental trajectories and adjusts for missing data in longitudinal designs. The sample of 48 infants at four assessment ages was adequate for HLM (Kreft & Leeuw, 1998; Maas & Hox, 2005; Snijders & Bosker, 1999). Full Maximum Likelihood was used in the estimation of parameters. Intercept and slope were left to freely vary. Final models were built using theory and deviance statistics to indicate which level-1 and level-2 predictors improved the fit of the model when entered. The intercept as well as linear and quadratic representations of growth were examined as level-1 predictors within infants. Linear and quadratic representations of growth were modeled as random effects if they exhibited significant variance between infants (Singer & Willett, 2003).

## Results

***Preliminary Analyses.*** Independent t-tests indicated significantly higher levels of maternal directiveness at 9 months for HR-infants compared to LR-infants,  $t(46) = 2.1, p = .04$ , Cohen's  $d = 0.64$  (See Table 2). No group differences were found for level of maternal responsiveness at 9 months,  $t(46) = -1.15, p = .26$ , Cohen's  $d = -0.34$  (See Table 2). Maternal responsiveness and directiveness were not significantly correlated ( $r = -0.19; p = 0.19$ ). Independent t-tests also indicated no significant group differences in the rate of social smiling at 9, 12, 15, or 18 months, all  $ps > .05$

***Main Analyses.*** HLM was used to examine whether maternal responsiveness and/or directiveness at 9 months individually predicted growth in infant social smiling between 9 and 18 months, and whether associations were moderated by risk group status. With regard to social

smiling, the final level-1 HLM model indicated that the growth trajectory of social smiling was best modeled with a random intercept and linear slope. When maternal responsiveness was included as a level-2 predictor it significantly predicted linear growth in social smiling such that higher levels of responsiveness were associated with increased growth in infant social smiling. Group status was not a significant level-2 predictor; however, there was a trend ( $p = 0.07$ ) in that HR-infants displayed increased growth compared to LR-infants. There was no interaction between group and maternal responsiveness in predicting linear growth (See Figure 1 and Table 3). When maternal directiveness was included as a level-2 predictor it significantly predicted linear growth in social smiling such that higher levels of directiveness were associated with slower growth in infant social smiling. Group status was a significant level-2 predictor such that LR-infants had slower growth in social smiling than HR-infants. There was no interaction between group and maternal directiveness in predicting linear growth (See Figure 2 and Table 4). None of the predictors significantly predicted the intercept.

In sum, maternal responsiveness and directiveness were unique predictors of growth in social smiling. Higher maternal responsiveness was associated with increased growth in infant social smiling for HR- and LR-infants, while higher maternal directiveness was associated with slower growth in social smiling across both groups. Furthermore, when included in a model with directiveness, risk group status was also a unique predictor of rate of growth in infant social smiling in that infants at low risk for ASD had slower growth in social smiling compared to infants at high risk for ASD. There was no interaction between risk group and maternal responsiveness or directiveness. These findings suggest that maternal responsiveness and directiveness may have differential impacts on social engagement for infants at both high and low risk for ASD.

### **Discussion**

The purpose of the study was to examine maternal predictors of social smiling in infants at high and low risk for ASD. This area of research is important, as it has been proposed that maternal behaviors that promote engagement and reciprocity may attenuate ASD symptom development over time for infants at high risk for developing ASD (Dawson, 2008). The first hypothesis was that higher rates of maternal responsiveness at 9 months would predict increased growth in social smiling between 9 and 18 months for both HR- and LR-infants. Furthermore, it was hypothesized that this association would be stronger for HR-infants, as researchers have theorized that infants at risk for developmental challenges are particularly sensitive to their rearing environment (e.g., Belsky et al., 2007; Ellis et al., 2011).

The first hypothesis was confirmed, in that higher rates of maternal responsiveness at 9 months were associated with increased growth in social smiling between 9 and 18 months for both groups. This finding is consistent with existing literature which indicates that maternal responsiveness is associated with a host of positive outcomes for children at risk for developmental challenges (e.g., Kim & Mahoney, 2004; Landry et al., 2006; Siller & Sigman, 2002; Yoder & Warren, 1998, 2004; Tamis-LeMonda et al., 2001). Mothers who are highly responsive are sensitive to their infant's subtle initiations, requests, and shifts in interest, which perhaps fosters more opportunities for engaging their child and sharing positive affect. This finding has important implications for interventions targeting social development in infants at high risk for ASD, and indicates that maternal responsiveness should be an active intervention component for this population.

Drawing upon the differential susceptibility hypothesis, we proposed that this association might be particularly important for infants at risk for ASD, as their social interest and

engagement may be more limited. Contrary to our second hypothesis, there was no difference in the strength of this association between HR- and LR-infants; thus our findings did not support the differential susceptibility hypothesis suggesting that it may not be an appropriate model for examining parent-child interactions and infant social smiling in a HR-infant sample.

In contrast to previous research (Wan et al., 2012), we found no group differences in levels of maternal responsiveness between HR- and LR-infants. However, research results have been mixed, with other studies reporting no group differences in levels of responsiveness between mothers of children with ASD or who are later diagnosed with ASD and mothers of typically developing children (e.g. Baker et al., 2010; Van Ijzendoorn et al., 2007). Differences in study samples and procedures may account for these discrepant findings.

Other studies (Baker et al., 2010; Wan et al., 2012) coded maternal behavior during a parent-child free play interaction with children with, or at-risk for, ASD using a paradigm similar to the one used in the present study. The duration of the free play interaction procedures in these studies was similar to those used in the current study. In the Baker et al. (2010) study the free play interaction was five minutes, while in the Wan et al. (2012) study the interaction was six minutes in duration. However, it is possible that in all these studies, the free play interactions were too brief to yield an accurate measure of infant behavior, leading to less reliable results and inconsistent findings between studies.

Studies of maternal responsiveness in high-risk infants have differed in the measures used to rate maternal responsiveness. Wan et al. (2012) developed the Manchester Assessment of Caregiver-Infant Interaction (MACI) for their study. It comprises seven items on which maternal and infant behaviors are rated on a scale ranging from 1-7. The authors reported high internal consistency ( $\alpha = 0.84$ ) and moderate inter-rater reliability (ICC= 0.66) (Wan et al., 2012).

Maternal sensitive responsiveness, which was represented by one item, was correlated with other maternal and infant behaviors across risk groups, including maternal non-directiveness, infant positive affect, and infant attentiveness (Wan et al., 2012). In contrast, Baker et al. (2010) employed a multidimensional construct of maternal sensitivity (that includes responsiveness) using the parenting behavior subscales of the NICHD Early Child Care Network scales (e.g., 1999), a five-item measure in which maternal behaviors are rated on a scale ranging from 1-7. For the purposes of the study, three maternal behaviors (maternal responsiveness, positive regard, and respect for autonomy) were averaged to create a composite emotional supportiveness rating, which was then averaged with maternal structuring to form an overall maternal sensitivity rating. The maternal sensitivity rating demonstrated high internal consistency ( $\alpha = .93$ ) and interrater reliability for the individual subscales ranged from .74 (responsiveness) to .87 (respect for autonomy). In the current study, we chose to use an adapted version of the Maternal Behavior Rating Scale (MBRS; Mahoney, 2008) because of its demonstrated research utility with parents of infants with developmental challenges, including ASD (Kim & Mahoney, 2004; Mahoney & Perales, 2003).

The lack of consistency in the findings across studies could be a result of the different approaches to measuring the construct of responsiveness, as well as the reliance on single items, which can limit the rigor of the measure. For example, in Baker et al. (2010) responsiveness is encompassed under sensitivity along with respect for autonomy and structuring which could be interpreted as variations of maternal directiveness. It is possible that the ratings are tapping into different constructs of maternal behavior which would affect to the generalizability of findings across studies. In addition, it is possible that age differences may contribute to some of the inconsistent findings across studies. The infants in the Wan et al. (2012) study were slightly

younger (6-10 months;  $M = 7.9$  months) than the sample in the present study (9 months), while the Baker et al. (2010) sample was older (18 months). As infants grow and develop, the parent-child dynamic changes. Older infants are more active and independent, and they display more behaviors for parents to respond to and potentially redirect. Therefore, maternal responsiveness may have a different presentation at various stages of development. Further research on maternal responsiveness should: 1) ensure that the duration of the free-play procedure is long enough to be representative of the infant's behavior; and, most importantly, 2) develop a clear definition of the construct that is being measured and examine its construct validity.

No a priori hypothesis was made regarding the association between maternal directiveness at 9 months and growth in infant social smiling between 9 and 18 months, due to a lack of consensus in the literature about the effects of maternal directiveness on infant outcomes. Results of our analyses indicated that higher levels of maternal directiveness were associated with slower growth in infant social smiling for both groups. This finding lends support to other research studies that have found higher levels of maternal directiveness to be associated with less optimal child social outcomes (e.g. Landry et al., 2001); however, it contradicts findings from some studies that revealed a positive correlation between mothers' use of more directive behaviors and increased social engagement in children with ASD (e.g. Doussard-Roosevelt, Joe, Bazhenova, & Porges, 2003).

In interpreting our findings, it is also important to note that mothers of HR-infants displayed significantly higher levels of maternal directiveness at 9 months than mothers of LR-infants. This finding is consistent with previous research investigating maternal directiveness in a sample of HR-infants ages 6-10 months (Wan et al., 2012). It is possible that, as a result of their child's limited social initiations, mothers of HR-infants are using more directive behaviors in an

effort to elicit responses from their child.

The divergent findings in the field with regard to the effects of maternal directiveness on child outcome may be due to many different factors, including how directiveness is operationally defined, the nature and focus of the parent-child interaction, and the age of the child. There is variability in how directiveness is operationally defined across studies (Green, Caplan, & Baker, 2013). When maternal directiveness includes elements of intrusive and overly controlling behavior, it is associated with poorer child outcomes (e.g. Green et al., 2103; Marfo, 1992; Moore, Saylor, & Boyce, 1998). However, when it is operationalized as behavior that scaffolds the child's behavior and sensitively supports the child's needs, it has been demonstrated to have neutral to positive effects on child outcome (e.g. Doussard-Roosevelt et al., 2003; Green at al., 2013; Marfo, 1992).

Effort was made in the current study to ensure that there was no negative valence associated with our operationalized definition of directiveness. Though the current study and the Wan et al. (2012) study found group differences in maternal directiveness between HR- and LR-infants, it should be noted that the operational definition of directiveness used by Wan et al. (2012) included elements of intrusiveness. Had we coded maternal intrusiveness in the current study, our results may have provided a more nuanced understanding about which facets of maternal directive behavior are associated with slower growth in infant social smiling. Future studies may consider using the coding scheme employed by Green and colleagues (2013), which differentiated between 'supportive directiveness' and 'interfering,' as it may prove useful to determine whether directiveness, when isolated from intrusiveness, is facilitative of any aspects of development for HR-infants.

In further considering our findings with regard to maternal directiveness and infant social

smiling, it is possible that, as has been proposed in the literature, maternal directiveness may play a differential role depending on the focus of the parent-child interaction (McCathren et al., 1995). Perhaps maternal directiveness is useful when teaching children new skills, but less adaptive when trying to promote social engagement. One can find support for this argument by considering different types of ASD interventions. For example, Discrete Trial Training methods are adult-directed in nature and are typically used to target the acquisition of new skills. Conversely, child-directed interventions such as incidental teaching are designed to be responsive to the child's initiations, and are used to increase engagement. Therefore, it is possible that higher levels of maternal directiveness may promote growth in some domains of child development but may hinder other areas. Though results from the present study suggest that maternal directiveness is associated with slower growth in infant social smiling, there may be circumstances in which directiveness is facilitative of growth in other aspects of development for HR-infants. These findings suggest that the relation between maternal directiveness and infant social smiling warrants further investigation, particularly for HR-infants.

Contrary to existing research (e.g., Nichols et al., 2013; Ozonoff et al. 2010), we found no group differences in rate per minute of social smiling between HR- and LR-infants. These results are surprising, and are perhaps attributable to procedural differences. In previous studies, infant social smiling was coded during structured assessments with an examiner (Nichols et al., 2013; Ozonoff et al., 2010), while in the current study social smiling was coded during a parent-child free-play interaction. Nichols et al. (2013) coded social smiling during the Screening Tool for Autism in Toddlers (STAT; Stone, Coonrod, Turner, & Pozdol, 2004) and found a significant main effect for risk group status, in that at a mean age of 15 months (range = 12-23 months) HR-infants displayed a significantly lower rate per minute of social smiling ( $M_s = 0.25 - 0.36$ ,

depending on their later diagnosis) than LR-infants ( $M = 0.53$ ). Similarly, Ozonoff et al. (2010) coded social smiling during the Mullen Visual Reception subtest (Mullen, 1995) and found that HR-infants who later received a diagnosis of ASD displayed a significantly lower rate per minute of social smiling at both 12 ( $M = 0.28$ ) and 18 months ( $M = 0.23$ ) compared to LR-infants at 12 ( $M = 0.32$ ) and 18 months ( $M = 0.38$ ). When comparing the results of these studies to the current study, at 12 months HR-infants ( $M = 0.37$ ) and LR-infants ( $M = 0.57$ ) displayed a rate per minute of social smiling similar to the rates reported in Nichols et al. (2013) and Ozonoff et al. (2010). However, at 18 months, results were divergent. In the current study, rate per minute of social smiling was relatively higher for HR-infants ( $M = 0.47$ ) and relatively lower for LR-infants ( $M = 0.28$ ) when compared to the rates reported in Nichols et al. (2013) and Ozonoff et al. (2010).

The lack of consistency in findings across studies could perhaps be attributed to inherent differences in infant behavior that naturally occurs during a parent-child free play interaction versus that which occurs during a standardized assessment with an examiner. Perhaps group differences in social smiling are not present during free play interactions, because infants are accustomed to interacting with their mothers. However, for HR-infants, limitations in social engagement may become apparent during standardized assessments with an unfamiliar examiner. Furthermore, in future studies, the duration of the parent-child free play interaction may need to be extended in order to allow more time for the targeted behaviors to occur. It is possible that a longer interaction would allow for more variability in infant behavior and therefore greater ability to detect group differences.

Future research is warranted to investigate whether the differential susceptibility hypothesis is an appropriate theoretical model for examining parent-child interactions in a HR-

infant sample. In the present study, the association between maternal responsiveness and growth in infant social smiling was not stronger in HR-infants. It is possible that our small sample size did not allow for detection of this association. Additionally, there is great variability in the outcomes of HR-infants, as approximately 20% of HR-infants receive an ASD diagnosis (Ozonoff et al., 2011). It is possible that the differential susceptibility hypothesis can better account for differences between infants who later receive an ASD diagnosis and infants with typical development, as differences in their functioning may be more pronounced (e.g., Baker et al., 2010). However, it may not be sensitive enough to identify differential associations in a sample of HR- and LR-infants due to the high level of variability within the HR group. Lastly, it is also possible that the differential susceptibility hypothesis is not a suitable model for examining the social development of infants at risk for ASD, though it may be better suited for examining other infant outcomes (e.g., cognitive, behavioral, etc.).

### **Limitations and Directions for Future Research**

Research surrounding the early manifestation of ASD is still in its infancy compared to other areas of ASD research. This study contributes to our understanding of early social smiling as well as parenting styles that can increase these behaviors over time to achieve the best child outcomes. The current study is the first of its kind to examine the development of infant social smiling longitudinally over a 9 month period during a mother-infant free play interaction. However, this study is not without limitations.

The primary limitation of the current study is that it included a small sample size. Not every infant in the study had complete data at each time point (9, 12, 15, 18 months), as there were multiple enrollment time points at 6, 9, and 12 months. As a result, infants who were enrolled in the study at 12 months did not have 9 month maternal responsiveness and

directiveness data and therefore were not included in this sample. Therefore our data set was limited to the families who completed a 9 month visit. Missing time points were not problematic for social smiling, as HLM analyses accounts for missing data. Data collection and behavioral coding are continuing and will allow for a larger sample of high- and low-risk infants. Furthermore, a larger sample size will allow for examination of how different ‘parenting profiles,’ characterized by high or low levels in both responsiveness and directiveness, are associated with growth in infant social smiling. This information will provided a more comprehensive understanding of the parenting behaviors associated with the most optimal child outcomes for HR-infants.

It is also important to note that, due to the time-intensive nature of behavioral coding, maternal behaviors were not coded at 12 or 15 months. Future studies should code maternal and infant behavior at all concurrent time points (9, 12, 15, 18 months) in order to examine potential child influences on maternal behavior, to further clarify the bidirectional processes inherent in parent-child interactions. Coding both parent and child behavior at additional time points may allow for a more sophisticated analysis of the transactional nature of parent-child interactions over time.

Consideration should also be given to the specific behaviors selected for capturing infant social engagement. For example, social smiling may not be the most robust indicator of infant social engagement, especially given that it occurred at a relatively low frequency between both groups. It is possible that other variables, such as infant social responses and initiations during free play, are richer and more frequently occurring indicators of infant social engagement that should be considered in future studies.

Furthermore, as maternal and infant behaviors were coded in the same setting, in future studies it will be important to determine the extent to which this brief lab-based procedure is representative of parenting styles and infant behaviors across different contexts (e.g., in the home) and over longer durations. Future research should attempt to address these limitations in an effort to better examine the associations between early maternal behaviors and social smiling in HR-infants.

In sum, it is important to identify the maternal behaviors that may be more and less facilitative of social development across different domains and within different contexts for infants at high risk for ASD. This study has contributed to this knowledge by providing information about maternal behaviors that are associated with growth in infant social smiling for HR-infants. Results of the study revealed that maternal responsiveness was a unique predictor of growth in social smiling, in that high maternal responsiveness was associated with increased growth in infant social smiling across infants at high and low risk for ASD. Maternal directiveness was also a unique predictor of growth in social smiling, in that high maternal directiveness was associated with slower growth in infant social smiling across both groups. Future research should focus on further quantifying aspects of maternal responsiveness and directiveness in order to inform interventions for children at high risk for ASD, whose social initiations may be more limited than those of other children.

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Table 1

*Demographic Characteristics of High-Risk and Low-Risk Samples*

Characteristic	<u>High-Risk Infants</u> #(%)	<u>Low-Risk Infants</u> #(%)
<b>Infant Race</b>		
White/Caucasian	21(70%)	16(89%)
Asian	2(7%)	0
Biracial/Multiracial	7(23%)	2(11%)
<b>Maternal Education</b>		
High School Only	1(3%)	0
Some College	7(23%)	2(11%)
2-4 Year College	14(47%)	8 (44.5%)
Advanced Degree	8(27%)	8(44.5%)

Table 2

*Maternal Behaviors for High-Risk and Low-Risk Infants*

<i>Variable</i>	<i>High-Risk Infants</i>		<i>Low-Risk Infants</i>		<i>Cohen's d</i>	<i>p</i>
	<i>n</i>	<i>M (SD)</i>	<i>n</i>	<i>M (SD)</i>		
Maternal Responsiveness (9 mo)	30	5.03 (2.04)	18	5.78 (2.39)	-.34	.26
Maternal Directiveness (9 mo)	30	6.03 (2.44)	18	4.44 (2.68)	.62	.04

Figure 1

*Maternal Responsiveness at 9 Months as a Predictor of Growth in Infant Social Smiling between 9 and 18 Months by Group*

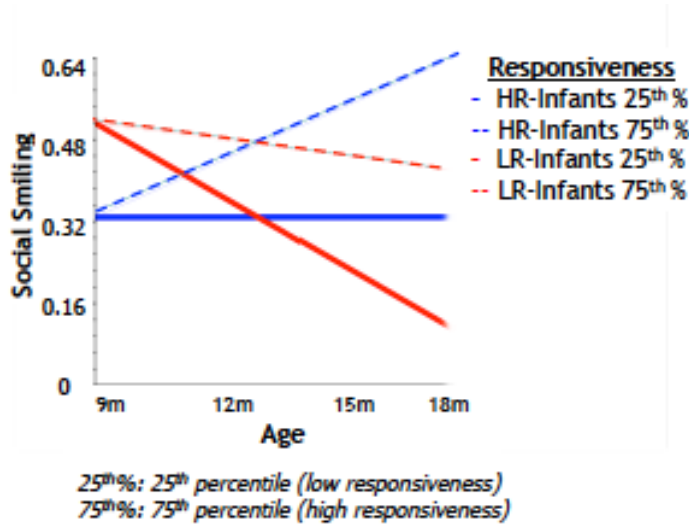


Table 3

*Final Model of Linear Growth for Responsiveness as a Predictor of Growth in Social Smiling*

Predictor	B	SE B	p
Maternal Responsiveness 9m	0.01	0.01	0.04
Group	-0.05	0.02	0.07
Maternal Responsiveness 9m*Group	-0.01	0.01	0.28

Figure 2

*Maternal Directiveness at 9 Months as a Predictor of Growth in Infant Social Smiling between 9 and 18 Months by Group*

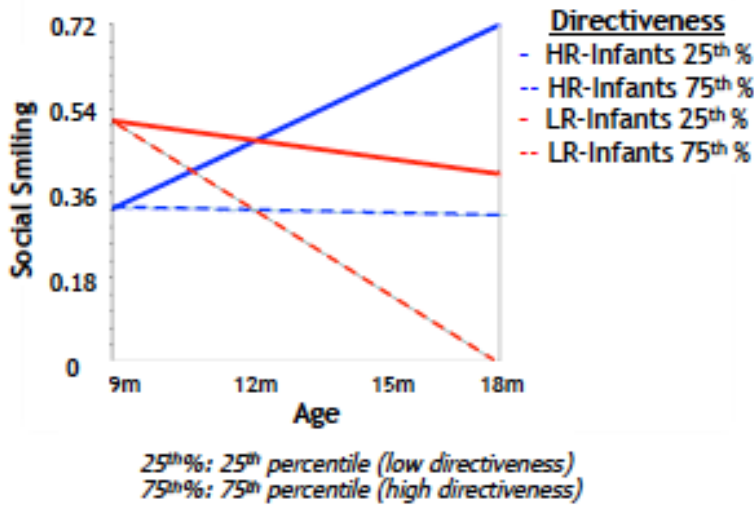


Table 4

*Final Model of Linear Growth for Directiveness as a Predictor of Growth in Social Smiling*

Predictor	B	SE B	p
Maternal Directiveness 9m	-0.01	0.004	0.02
Group	-0.06	0.02	0.02
Maternal Directiveness 9m*Group	0.004	0.007	0.5