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The Development of Anticipatory Smiling in Infants at Risk for Autism

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THE DEVELOPMENT OF ANTICIPATORY SMILING IN INFANTS AT RISK FOR AUTISM

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THE DEVELOPMENT OF ANTICIPATORY SMILING IN INFANTS AT RISK FOR AUTISM

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Infant-initiated joint attention (IJA) typically emerges during the first year of life and is an important precursor of later social competence. Children with Autism Spectrum Disorders (ASD) have impairments in referential communication, such as IJA, that involve sharing experiences with others through gaze and gesture. A specific pattern of smiling occurring during IJA, anticipatory smiling, may communicate preexisting positive affect to a social partner through looking at an object, smiling, and then turning the smile toward a social partner. In typically developing infants, anticipatory smiling increases from eight to 12 months of age. The current study compared the development of anticipatory smiling at eight, 10, and 12 months of age between infant siblings of children with ASD (high-risk siblings), who are at heightened risk for ASD, and infant siblings of children without ASD (low-risk siblings). While there were no risk group differences in reactive smiling and no smiling, high-risk siblings produced less anticipatory smiling between eight and 12 months than low-risk siblings. These findings indicate that communicating preexisting positive affect may be a specific early impairment in children at risk for developing ASD, with possible implications for social and emotional outcomes.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER ONE

INTRODUCTION

The development of the capacity to socially refer to objects and events, which typically begins during the first year of life, is an important precursor of later social competence (Mundy et al., 2007). This referential communication is central to typical development of social and language abilities and tends to be impaired in children with symptoms of an Autism Spectrum Disorder (ASD; Dawson et al., 2004; Mundy et al., 2007). Joint attention is a form of referential communication, and infant-initiated joint attention (IJA) is a standard type of referential communication common in the first two years of life. When infants combine a smile with IJA, it may provide additional information regarding the communication of positive affect (Venezia, Messinger, Thorp, & Mundy, 2004). Early anticipatory smiling during IJA relates to later social outcomes (Parlade et al., 2009). IJA is a particular area of impairment in children with an ASD, and specific deficits in anticipatory smiling could have unique implications for later social competencies. This study examined anticipatory smiling in infants at high and low risk for ASD.

Joint Attention and Affect

Joint attention is the coordination of attention between social partners regarding an object or event to share an experience (Bakeman & Adamson, 1984). Typically developing infants begin to initiate joint attention through the use of gaze and gesture to direct the attention of a social partner to a shared experience by 12 months of age (Mundy et al., 2007). Displays of positive affect (i.e., smiling) are likely to occur during an infant's communicative gestures (e.g., offers) with the mother, particularly if the gestures

involve a gaze at the mother (Messinger & Fogel, 1998). Infants also tend to produce more smiling when there is an attentive audience (e.g., the caregiver) for their smiling signal (Jones, Collins, & Hong, 1991; Jones & Hong, 2005; Jones & Raag, 1989). When observed in mother-child play settings, infants tend to display more smiles with accompanying gazes when they are engaged in active toy play and when their mother (Jones & Hong, 2005) or another social partner (Jones & Raag, 1989) is attentive and gives a social response to the infant's gaze. Some factors have been found to decrease the likelihood of infants displaying positive affect during joint attention behaviors, including lower-quality maternal caregiving behaviors, or behaviors lower in sensitivity and higher in intrusiveness (Hane & Fox, 2006).

Smiles can occur at varying times in the course of an IJA episode with respect to the gaze at the social partner, indicating different smiling types within IJA. Reactive smiles occur when an infant turns a gaze from an object to a social partner and then smiles (i.e., the smile is in "reaction" to gazing at the partner). Anticipatory smiles, on the other hand, occur when an infant first gazes at an object, smiles, then turns that smile to a social partner (i.e., the smile "anticipates" the gaze in time) (Parlade et al., 2009). Anticipatory smiles have been studied in typically developing infants and have been found to emerge between six and 12 months of age (Jones, Collins, & Hong, 1991; Jones & Hong, 2001; Jones & Hong, 2005; Parlade et al., 2009; Venezia et al., 2004). Evidence suggests that anticipatory smiles may be voluntary communicative signals of preexisting positive affect (Venezia et al., 2004), rather than simply responses to the sight of a social partner. In addition, infants are more likely to display anticipatory smiles if

they also exhibit other communicative behaviors, such as gestures and vocalizations, in a different setting (Jones & Hong, 2001).

A developmental change in anticipatory smiling behavior has been observed in infants, with older infants using anticipatory smiles more frequently. Venezia and colleagues (2004) examined typically developing infants at eight, 10, and 12 months of age in an infant-examiner assessment for joint attention behaviors (Early Social Communication Scales; ESCS; Mundy et al., 2003). Though the overall proportion of infant smiles occurring during IJA episodes did not change with age, there was a change in the timing in which infants' smiles tended to occur with respect to the gaze at the examiner. Infants' use of anticipatory smiles increased from eight to 10 months and then stabilized between 10 and 12 months. This developmental pattern was unique to anticipatory smiles; the frequency of reactive smiles and overall IJA episodes did not change over time. A similar developmental pattern was found in another study by Parlade and colleagues (2009). They found an increase in typically developing infants' use of anticipatory smiles, with greater anticipatory smiling shown at 12 months than at nine months. Again, there was no change found in infants' use of reactive smiles.

Associations between anticipatory smiling in the first year and later social and emotional outcomes have also been found in typically developing children (Parlade et al., 2009). Early anticipatory smiling was positively related to emotional expressivity and parent-reported social competence at 30 months. However, reactive smiling and overall IJA frequency were not similarly associated with social competence. These findings suggest that anticipatory smiling specifically is an important form of IJA in infants that relates uniquely to later social competencies.

Autism Spectrum Disorders and IJA

Autism Spectrum Disorders (ASD) are characterized by social and communication impairments, as well as the presence of restricted or stereotyped patterns of behavior, interests, and activities. Joint attention impairments are a core deficit of ASD (Dawson et al., 2004), with children diagnosed with ASD displaying fewer instances of IJA than typically developing children or children with developmental delay. IJA impairments in children who go on to be diagnosed with ASD are usually evident by the time the child reaches the end of the first year (Dawson et al., 2004; Toth, Munson, Meltzoff, & Dawson, 2006). Deficits in IJA have been associated with poorer outcomes, including social and language difficulties in those with ASD (Dawson et al., 2004; Mundy et al., 2007). However, IJA with anticipatory smiling has not been well-studied in the context of ASD, despite its implications for social and emotional outcomes.

Younger siblings of children diagnosed with an ASD (high-risk siblings) have a greater likelihood of developing an ASD or demonstrating sub-clinical ASD deficits or atypical development than children in the general population (Landa & Garrett-Mayer, 2006; Goldberg et al., 2005; Yirmiya et al., 2006; Yoder, Stone, Walden, & Malesa, 2009). Recent estimates of the sibling recurrence rate of ASD indicate that 18.7% of high-risk siblings go on to develop an ASD (Ozonoff et al., 2011). Since ASD is typically not diagnosed until around three years of age, prospective studies of high-risk siblings allow for the examination of early development and potential markers for ASD. In studies comparing the development of high-risk siblings and siblings of children with no evidence of ASD (low-risk siblings), high-risk siblings have been found to produce fewer joint attention behaviors than low-risk siblings (e.g., Cassel et al., 2007; Goldberg

et al., 2005; Presmanes, Walden, Stone, & Yoder, 2007; Rozga et al., 2011; Yirmiya et al., 2006). IJA with anticipatory smiling may be an important early marker of social and emotional functioning in high-risk siblings.

Hypotheses

This study examined the development of anticipatory smiling, comparing development in high-risk and low-risk infant siblings to understand the behavior in the context of ASD risk. Anticipatory smiling was examined within the context of infant-initiated joint attention episodes during the Early Social Communication Scales (ESCS) at eight, 10, and 12 months of age. IJA with reactive smiling and IJA with no smiling were also examined. Group differences in anticipatory smiling were expected, with high-risk siblings producing fewer anticipatory smiles than low-risk siblings at all ages. High-risk siblings were expected to show a delay in the development of anticipatory smiling, with the greatest differences (in comparison to low-risk siblings) in anticipatory smiling at eight months.

CHAPTER TWO

METHOD

Participants

Participants were the infant siblings of children with a diagnosed Autism Spectrum Disorder (ASD; high-risk siblings *n* = 56, 36 male) or children with no evidence of ASD (low-risk siblings *n* = 26, 12 male) who were enrolled in a larger longitudinal study of child development, the Sibling Studies Measuring Infant Learning and Emotion (Sib SMILE) Project. High-risk siblings had at least one older sibling with a community diagnosis of an ASD, which was confirmed upon study enrollment by administration of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and clinical diagnosis by a licensed clinical psychologist. Low-risk siblings had older siblings with no evidence of an ASD. The current study included infants' data from the Early Social Communication Scales at eight, 10, and 12 months of age. At eight months, 51 infants had ESCS data, 57 had ESCS data at 10 months, and 67 had ESCS data at 12 months (see Figures 1.1 and 1.2).

Procedure

This study examined IJA smiling types (i.e., anticipatory smiling, reactive smiling, and no smiling) within the ESCS, which was administered at infants' eight, 10, and 12 month visits.

Measures

Early Social Communication Scales (ESCS). The ESCS (Mundy et al., 2003) is a semi-structured assessment of infants' nonverbal communication abilities, including joint attention, behavioral requesting, and social interaction behaviors. The present study

focused on infant-initiated joint attention (IJA) episodes in the ESCS. During the ESCS protocol, an infant is seated on the caregiver's lap across from an examiner, who presents the infant with a series of toys, creating opportunities for the infant to initiate joint attention behaviors. After presenting a toy, the examiner remains attentive and responds to the infant's joint attention bids briefly.

Coding

IJA. The current study focused on IJA episodes previously coded during the ESCS. Instances of the IJA with the examiner (e.g., the infant making eye contact, pointing, and showing) are coded by coders trained to reliability and blind to infants' risk group status. Descriptive statistics for total IJA are presented in Table 1.

IJA Smiling Types. IJA smiling types were assessed within the context of IJA episodes during the ESCS. IJA episodes (those including gaze) from coded ESCS assessments at eight, 10, and 12 months were examined and coded for smiling behavior. Each episode was examined to determine if a smile occurred, using Facial Action Coding System (FACS; Ekman & Friesen, 1978) criteria to determine smiles (presence of Action Unit 12, raised lip corners). For episodes with a smile, the timing of the smile within the IJA episode was assessed. Videos of the assessments were viewed in slow motion and frame by frame to allow for more accurate coding. For this study, a smile was coded if the gaze and smile overlapped in time, and was then categorized as either an anticipatory or reactive smile. Anticipatory smiles (AS) were coded when the infant first gazed at the object, smiled while looking at the object, then gazed at the examiner with the already smiling face (i.e., the smile clearly preceded the gaze). Reactive smiles (RS) were coded when an infant gazed at an object, gazed up to the examiner (without a smile present),

and then smiled after establishing gaze with the examiner. If the infant did not smile during the gaze portion of the interaction, a code of no smile (NS) was given. Smiles were coded by a primary coder blind to infants' risk group status, and 22% of tapes were also coded by a second coder for reliability; reliability assessments yielded 89% mean agreement with a mean *kappa* = .78.

As ESCS assessments are not uniform in length and infants did not display the same number of total instances of IJA, proportions were used in analyses. This procedure controlled for varying ESCS length (and therefore potential opportunities to produce IJA) and the varying numbers of instances of IJA produced by infants. Proportions for each smiling behavior were calculated by dividing the total number of AS, RS, and NS by the total number of instances of IJA. Similar results were also obtained with an alternative model in which variables were calculated as rates per minute (the total number of instances of AS, RS, and NS divided by the length of the ESCS in minutes).

CHAPTER THREE

RESULTS

Analytic Approach

Hierarchical linear modeling (Raudenbush & Bryck, 2002; Singer & Willett, 2003) was used to examine the development of IJA smiling types (anticipatory smiling, reactive smiling, and no smiling) in infancy in both high-risk and low-risk siblings from eight to 12 months of age and to compare group differences in these joint attention behaviors. This model nested age within individuals, predicting IJA smiling type using group status (high-risk group or low-risk group) as a predictor of IJA smiling type at the individual level and age (i.e., linear, quadratic) as a predictor of IJA smiling type at the observation level. Group status was coded such that low-risk = 0 and high-risk = 1. The linear age variable (*time*) was referenced to eight months (first observation age), and assigned values such that age = 0, 1, 2 corresponded to ages eight months, 10 months, and 12 months. The quadratic age variable ($time^2$) was calculated by squaring the centered linear age variable. Descriptive statistics for AS, RS, and NS frequencies are presented in Table 2 and for rate per minute variables in Table 3. Descriptive statistics for AS, RS, and NS proportions (used in analyses), are presented in Table 4 and Figures 2-4, and group trajectories are presented in Figures 5-7.

In order to test for effects of gender on IJA smiling type, additional models were tested with gender included as a predictor of individual variance in mean observed IJA smiling type (gender was coded such that male = 0 and female = 1).

Level 1 Model

$$\gamma_{ti} = \pi_{0i} + \pi_{1i}(time) + \pi_{2i}(time^2) + e_{ti}$$

The intraindividual, or within subjects, variance in IJA smiling types (anticipatory, reactive, and no smiling) from eight to 12 months was modeled at Level 1. Y_{ti} is the observed IJA smiling type for the ith child at the tth observation. e_{ti} represents the residual error in IJA smiling type for the ith individual at the tth observation, controlling for the effect of age.

Level 2 Model

$$\pi_{0i} = \beta_{00} + \beta_{01}(group) + r_{1i}$$

$$\pi_{1i} = \beta_{10} + \beta_{11}(group) + r_{2i}$$

$$\pi_{2i} = \beta_{20} + \beta_{21}(group) + r_{3i}$$

Level 2 modeled the interindividual, or between subjects, variance in IJA smiling type. Group status (group; high-risk and low-risk) was included as a predictor of individual variance in mean observed IJA smiling type, the linear effect of age, and the quadratic effect of age.

π_{0i} represents the expected IJA smiling type of the ith individual at eight months of age. π_{1i} represents the expected change in IJA smiling type for the ith individual given a one unit (i.e., two month) increase in age. π_{2i} represents the expected change in the slope of IJA smiling type of the ith individual given a one unit increase (i.e., two month) in age.

β_{00} represents the average IJA smiling type at eight months, controlling for group status. β_{01} represents the change in average IJA smiling type due to high-risk group membership. r_{1i} represents the residual of the average IJA smiling type, controlling for group status.

β_{10} represents the average change in IJA smiling type given a one unit increase (i.e., two month) in age, controlling for group status. β_{11} represents the change in slope in IJA smiling type given a one unit increase (i.e., two month) in age due to high-risk group membership. r_{2i} represents the residual of the average change in IJA smiling type given a one unit increase (i.e., two month) in age, controlling for group status.

β_{20} represents the average quadratic change in IJA smiling type, controlling for group status. β_{21} represents the quadratic change given a one-unit increase (i.e., two month) in age due to high-risk group membership. r_{3i} represents the residual of the quadratic change in IJA smiling type given a one unit increase (i.e., two month) in age.

IJA with Anticipatory Smiling. IJA with anticipatory smiling was first examined using an unconditional model to assess within-subject variability. The unconditional model (Model 1a) indicated significant variability within participants, $\chi^2(80, n = 81) = 144.79$, $p < .001$, with 43% of the variance due to variation between individuals (necessitating a multilevel model; see Table 5). Linear and quadratic age were then introduced into the model to examine the within-subject change in anticipatory smiling over time (Model 1b). There were effects of both linear and quadratic age, indicating that the proportion of IJA with anticipatory smiling changes over time (see Table 5). A difference test indicated that model fit was improved from the empty model, $\chi^2(7, n = 81) = 31.29$, $p < .001$. Group status was next introduced into the model at the intercept (Model 1c). There was an effect of group status at the intercept (see Table 8), and the model including this predictor fit significantly better than the model not including status, $\chi^2(1, n = 81) = 5.78$, $p = .015$. Status was introduced into the model at linear and quadratic age to examine the effect of group status on the growth of IJA with anticipatory

smiling (Model 1d). There were no significant effects of group status at linear or quadratic age (see Table 5); thus, group status was removed from the model at linear and quadratic age, and the previous model was retained (see Table 8 for final model summary).

For anticipatory smiling, there was no effect of gender when included as a predictor of the intercept, $\beta = .03$, $SE = .03$, $t(79) = .99$, $p = .33$, and the model including gender did not fit better than a model not including gender, $\chi^2(1, n = 81) = .89$, $p > .50$.

IJA with Reactive Smiling. IJA with reactive smiling was also examined with an unconditional model to assess within-subject variability (Model 2a), with 35% of the variance due to variation between individuals (necessitating a multilevel model; see Table 6). The unconditional model indicated significant variability within participants, $\chi^2(3, n = 80) = 123.78$, $p = .001$. Linear and quadratic age were then introduced into the model (Model 2b). There were effects of both linear and quadratic age (see Table 8), indicating that the proportion of IJA with reactive smiling changes over time. A difference test indicated improved model fit from the empty model, $\chi^2(7, n = 81) = 24.36$, $p < .001$. Group status was next introduced into the model at the intercept (Model 2c); there was no effect of group status at the intercept (see Table 6). The model including status as a predictor at the intercept did not fit better than the model not including status, $\chi^2(1, n = 81) = .38$, $p > .500$, thus the previous model was retained (see Table 8 for final model summary).

There was no effect of gender for reactive smiling when included as a predictor of the intercept, $\beta = .02$, $SE = .03$, $t(79) = .82$, $p = .41$, and the model including gender did not fit better than a model not including gender, $\chi^2(1, n = 81) = .66$, $p > .50$.

IJA with No Smiling. IJA with no smiling was first examined with an unconditional model (Model 3a), which indicated significant variability within participants, $\chi^2(3, 80) = 127.12$, $p < .001$, with 36% of the variance due to variation between individuals (necessitating a multilevel model; see Table 7). Linear and quadratic age were introduced into the model (Model 3b); there were effects of both linear and quadratic age (see Table 8), indicating how IJA with no smiling changes over time. A difference test indicated that this model fit significantly better than the empty model, $\chi^2(7, n = 81) = 14.46$, $p = .04$. There was no effect of group status at the intercept when introduced into the model (Model 3c; see Table 7); the model including status as a predictor did not fit better than the model not including status, $\chi^2(1, n = 81) = 1.31$, $p = .25$, and therefore the previous model was retained (see Table 8 for final model summary).

For IJA with no smiling, there was no effect of gender as a predictor of the intercept, $\beta = -.05$, $SE = .04$, $t(79) = -1.07$, $p = .29$, and the model including gender did not provide better fit than a model not including gender, $\chi^2(1, n = 81) = 1.08$, $p = .30$.

CHAPTER FOUR

DISCUSSION

Impairments in infant-initiated joint attention (IJA) are a core feature of ASD and have been found in infant siblings at high risk for ASD (e.g., Cassel et al., 2007; Dawson et al., 2004; Goldberg et al., 2005; Presmanes et al., 2007; Rozga et al., 2011; Toth et al., 2006; Yirmiya et al., 2006). In typically developing children, early IJA with anticipatory smiling (a specific IJA smiling type) in the first year has been associated with later social and emotional outcomes (Parlade et al., 2009). This study examined the development of IJA smiling types, including anticipatory smiling, from eight to 12 months of age in infants at both high and low risk for ASD.

In both high- and low-risk infants, there was a developmental change in anticipatory smiling from eight to 12 months of age. Anticipatory smiling increased with age from eight to 10 months, and the rate of change decreased between 10 and 12 months. This developmental pattern is similar to that found previously in typically developing children (Parlade et al., 2009; Venezia et al., 2004). No differences were found between groups in the trajectory of anticipatory smiling across time; high-risk siblings initially began with lower levels of anticipatory smiling than low-risk siblings, and these differences persisted over time with both groups showing relative increases in the behavior with age.

High-risk infants exhibited lower levels of anticipatory smiling than low-risk infants. In the final model for anticipatory smiling, these group differences were found in baseline (eight month) levels of anticipatory smiling. This effect did not change with age, indicating a persistent difference between groups across time. On the other hand,

there were no differences between high- and low-risk siblings in baseline levels of either reactive smiling or no smiling. This lack of group differences suggests that anticipatory smiling may be an especially important form of IJA in the context of ASD risk, and these infants may have difficulties coordinating affect and gaze to share affective experiences.

The current study found a developmental increase in reactive smiling in both high- and low-risk infants. While Venezia et al. (2004) did not find such an increase in reactive smiling, infants in the study who did not display the behavior at adjacent ages were excluded from analyses of change in reactive smiling rates between ages. Another study by Parlade et al. (2009) also found no increase in reactive smiling, though initial rates of reactive smiling at eight months were similar to those in the current study. The proportion of IJA involving no smiling in the current study decreased across ages in both groups, indicating that overall, smiling (regardless of timing of the smile) increased with age in both groups.

In both risk groups, the most common type of IJA produced by infants was IJA with no smiling. At all ages, IJA with no smiling showed the highest levels of the IJA smiling types. Given the relative infrequency of smiling during instances of IJA, differences in these IJA smiling types may be difficult to observe outside the more structured setting of the assessments examined in this study.

No gender differences were found for any IJA smiling type. As male siblings are at greater risk for ASD than female siblings, it was possible that anticipatory smiling, which differed by risk group status, would have also differed by gender. However, the current findings appear to reflect differences in overall risk status and are consistent with

a lack of gender differences in previous studies of anticipatory smiling in typically developing infants (e.g., Jones & Hong, 2001).

Infants often display positive affect while attending to a social partner and while in joint engagement with mothers (regarding an object), with the amount of affective expression during joint engagement increasing with age (Adamson & Bakeman, 1985). Children with ASD have been found to display less frequent positive affect during instances of joint attention (Kasari, Sigman, Mundy, & Yirmiya, 1990), indicating a possible difficulty in sharing positive affect in ASD. As IJA can involve the capacity to coordinate and share affective experiences (Mundy, Kasari, & Sigman, 1992), IJA smiling types defined with respect to the timing of infants' positive affect displays may have unique implications for social and emotional development. These specific IJA smiling types may be important to further refining the more general IJA deficits seen in children with ASD and high-risk infant siblings. When IJA smiling types were examined in the current study with regard to the timing of positive affect displays, ASD risk was associated with unique deficits in anticipatory smiling. Anticipatory smiling, which involves not only the sharing of an object or experience with a social partner, but also the communication of one's preexisting positive affect to that partner, was uniquely affected by ASD risk. Deficits in anticipatory smiling are particularly concerning given their unique association with later social and emotional competencies in typically developing children (Parlade et al., 2009). Sharing preexisting positive affect with another person (as in anticipatory smiling) may be indicative of an infant's developing understanding that one's emotional experiences can be shared with others. Early differences in the

communication of positive affect may relate to lower social and emotional competencies or higher social communication-related ASD symptomatology in high-risk siblings.

The current study was limited with regard to the range of ages included in analyses. In order to obtain a more complete picture of the development of IJA smiling types, and to determine if these apparent deficits in anticipatory smiling continue to persist through later ages, IJA smiling types could be examined from six through 18 months of age. Additionally, not all participants had an ESCS at all three ages in the current study. However, Full Information Maximum Likelihood was used in modeling, which allowed participants with less than complete information to contribute to the estimation of parameters.

This study examined anticipatory smiling in a specific examiner-child interaction, the ESCS, which is designed to elicit joint attention behaviors and other types of referential communication. Future studies could examine anticipatory smiling in other contexts, as well, to examine whether group differences persist across social partners. Earlier predictors of anticipatory smiling could also be examined in high-risk infants. In typically developing infants, early smiling at six months of age in the Face-to-Face/Still-Face Procedure predicts later anticipatory smiling (Parlade et al., 2009). Given the group differences found in anticipatory smiling in the current study, this association could be examined in high-risk infants. Relationships between anticipatory smiling and genetic factors related to affect (e.g. serotonin transporter gene, 5-HTTLPR) could also be examined, to determine if genetic components play a role in this behavior.

Group differences in anticipatory smiling should be examined in relation to later social and emotional outcomes, to determine if early levels of anticipatory smiling predict

these competencies (e.g. parent-reported and observed social and emotional competence). These relations would suggest that difficulties in anticipatory smiling may be an early marker of social-emotional developmental differences in these children, and could help identify those at risk for later social and emotional problems, including ASD. Differences in early anticipatory smiling could also be examined as a predictor of diagnostic outcome. Anticipatory smiling levels in the first year may predict ASD diagnosis or continuous ASD severity outcomes, informing our understanding of early ASD-related deficits and possible targets for intervention.

High-risk siblings exhibited a deficit in early anticipatory smiling in the current study. These siblings are at increased risk for developing an ASD, sub-clinical ASD deficits, or atypical development. As children with ASD tend to have impairments in IJA, and also tend to display less positive affect during joint attention, specific deficits in anticipatory smiling (involving communicating and sharing one's preexisting positive affect with a social partner) may be indicative of ASD-related developmental difficulties in high-risk siblings and predictive of related ASD symptomatology.

REFERENCES

Adamson, L. B., & Bakeman, R. (1985). Affect and attention: Infants observed with mothers and peers. Child Development, 56(3), 582-593. doi:10.2307/1129748

Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother–infant and peer–infant interaction. Child Development, 55(4), 1278-1289. doi:10.2307/1129997

Cassel, T. D., Messinger, D. S., Ibanez, L. V., Haltigan, J. D., Acosta, S. I., & Buchman, A. C. (2007). Early social and emotional communication in the infant siblings of children with autism spectrum disorders: An examination of the broad phenotype. *Journal of Autism and Developmental Disorders*, 37(1), 122-132. doi:10.1007/s10803-006-0337-1

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology*, 40(2), 271-283. doi:10.1037/0012-1649.40.2.271

Ekman, P., & Friesen, W. V. (1978). *Facial action coding system.* Palo Alto, CA: Consulting Psychologist Press.

Goldberg, W. A., Jarvis, K. L., Osann, K., Laulhere, T. M., Straub, C., Thomas, E., & ... Spence, M. (2005). Brief report: Early social communication behaviors in the younger siblings of children with autism. *Journal of Autism and Developmental Disorders*, 35(5), 657-664. doi:10.1007/s10803-005-0009-6

Hane, A., & Fox, N. A. (2006). Ordinary variations in maternal caregiving influence human infants' stress reactivity. *Psychological Science*, 17(6), 550-556. doi:10.1111/j.1467-9280.2006.01742.x

Jones, S. S., Collins, K., & Hong, H. (1991). An audience effect on smile production in 10-month-old infants. *Psychological Science*, 2(1), 45-49. doi:10.1111/j.1467-9280.1991.tb00095.x

Jones, S. S., & Hong, H. (2001). Onset of voluntary communication: Smiling looks to mother. *Infancy*, 2(3), 353-370. doi:10.1207/S15327078IN0203_4

Jones, S. S., & Hong, H. (2005). How some infant smiles get made. *Infant Behavior & Development*, 28(2), 194-205. doi:10.1016/j.infbeh.2005.02.003

Jones, S. S., & Raag, T. (1989). Smile production in older infants: The importance of a social recipient for the facial signal. *Child Development*, 60(4), 811-818. doi:10.2307/1131021

Kasari, C., Sigman, M., Mundy, P., & Yirmiya, N. (1990). Affective sharing in the context of joint attention interactions of normal, autistic, and mentally retarded children. Journal Of Autism And Developmental Disorders, 20(1), 87-100. doi:10.1007/BF02206859

Kuroki, M. (2007). The effect of positive emotion on infants' gaze shift. *Infant Behavior & Development*, 30(4), 606-614. doi:10.1016/j.infbeh.2007.03.008

Landa, R., & Garrett-Mayer, E. (2006). Development in infants with autism spectrum disorders: a prospective study. *Journal of Child Psychology and Psychiatry*, 47(6), 629-638. doi:10.1111/j.1469-7610.2006.01531.x

Lord. C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., DiLavore, P. C., Pickles, A., & Rutter, M. (2000). The autism diagnostic observation schedule-generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*, 205-223.

Messinger, D. S., & Fogel, A. (1998). Give and take: The development of conventional infant gestures. *Merrill-Palmer Quarterly: Journal of Developmental Psychology*, 44(4), 566-590.

Mundy, P., Block, J., Delgado, C., Pomares, Y., Van Hecke, A., & Parlade, M. (2007). Individual differences and the development of joint attention in infancy. *Child Development*, 78(3), 938-954. doi:10.1111/j.1467-8624.2007.01042.x

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Siebert, J. (2003). *A manual for the abridged Early Social Communication Scales (ESCS)*. Coral Gables, FL: University of Miami, Department of Psychology.

Mundy, P., Kasari, C., & Sigman, M. (1992). Nonverbal communication, affective sharing, and intersubjectivity. Infant Behavior & Development, 15(3), 377-381.

Ozonoff, S., Young, G. S., Carter, A., Messinger, D., Yirmiya, N., Zwaigenbaum, L., . . . Stone, W. L. (2011). Recurrence risk for autism spectrum disorders: A baby siblings research consortium study. *Pediatrics, 128*(3), e488-e495. doi:10.1542/peds.2010-2825

Parlade, M., Messinger, D. S., Delgado, C. F., Kaiser, M., Van Hecke, A., & Mundy, P. C. (2009). Anticipatory smiling: Linking early affective communication and social outcome. *Infant Behavior & Development*, 32(1), 33-43. doi:10.1016/j.infbeh.2008.09.007

Presmanes, A. G., Walden, T. A., Stone, W. L., & Yoder, P. J. (2007). Effects of different attentional cues on responding to joint attention in younger siblings of children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 37(1), 133-144. doi:10.1007/s10803-006-0338-0

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods, 2nd edition*. Thousand Oaks, CA US: Sage Publications, Inc.

Rozga, A., Hutman, T., Young, G. S., Rogers, S. J., Ozonoff, S., Dapretto, M., & Sigman, M. (2011). Behavioral profiles of affected and unaffected siblings of children with autism: Contribution of measures of mother–infant interaction and nonverbal communication. *Journal of Autism and Developmental Disorders*, 41(3), 287-301. doi:10.1007/s10803-010-1051-6

Singer, J. D., & Willett, J. B. (2003). *Applied longitudinal data analysis: Modeling change and event occurrence*. New York, NY US: Oxford University Press.

Toth, K., Munson, J., Meltzoff, A. N., & Dawson, G. (2006). Early predictors of communication development in young children with autism spectrum disorder: Joint attention, imitation, and toy play. *Journal of Autism and Developmental Disorders*, 36(8), 993-1005. doi:10.1007/s10803-006-0137-7

Venezia, M., Messinger, D. S., Thorp, D., & Mundy, P. (2004). The development of anticipatory smiling. *Infancy*, 6(3), 397-406. doi:10.1207/s15327078in0603_5

Yirmiya, N., Gamliel, I., Pilowsky, T., Feldman, R., Baron-Cohen, S., & Sigman, M. (2006). The development of siblings of children with autism at 4 and 14 months: Social engagement, communication, and cognition. *Journal of Child Psychology and Psychiatry*, 47(5), 511-523. doi:10.1111/j.1469-7610.2005.01528.x

Yoder, P., Stone, W. L., Walden, T., & Malesa, E. (2009). Predicting social impairment and ASD diagnosis in younger siblings of children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 39(10), 1381-1391. doi:10.1007/s10803-009-0753-

Figure 1.1

Number of high-risk siblings with data at 1, 2, or 3 time points.

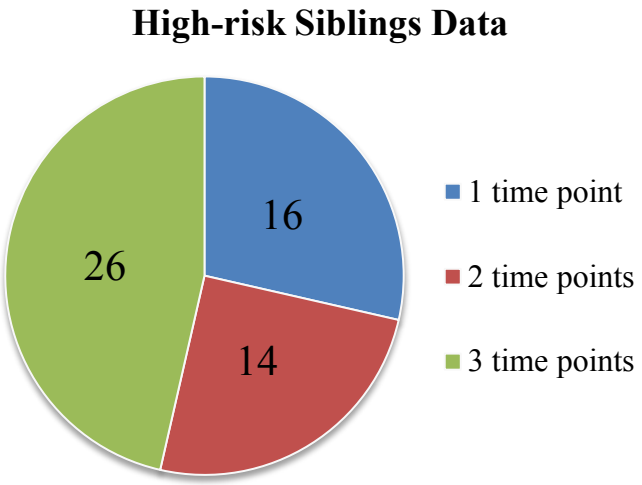

Figure 1.2

Number of low-risk siblings with data at 1, 2, or 3 time points.

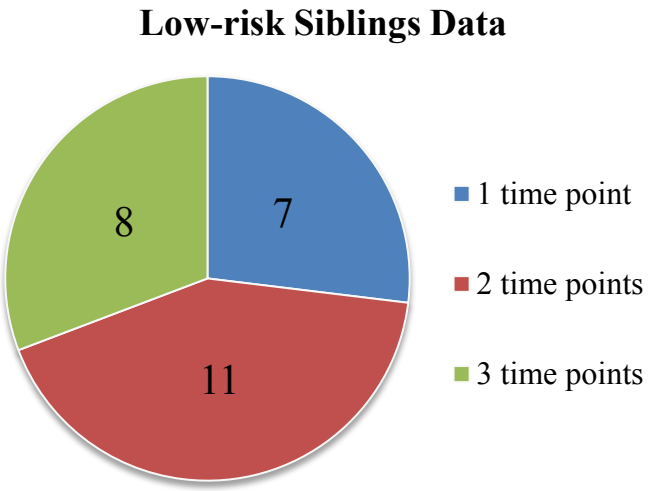

Figure 2

Histograms of anticipatory smiling proportions by age.

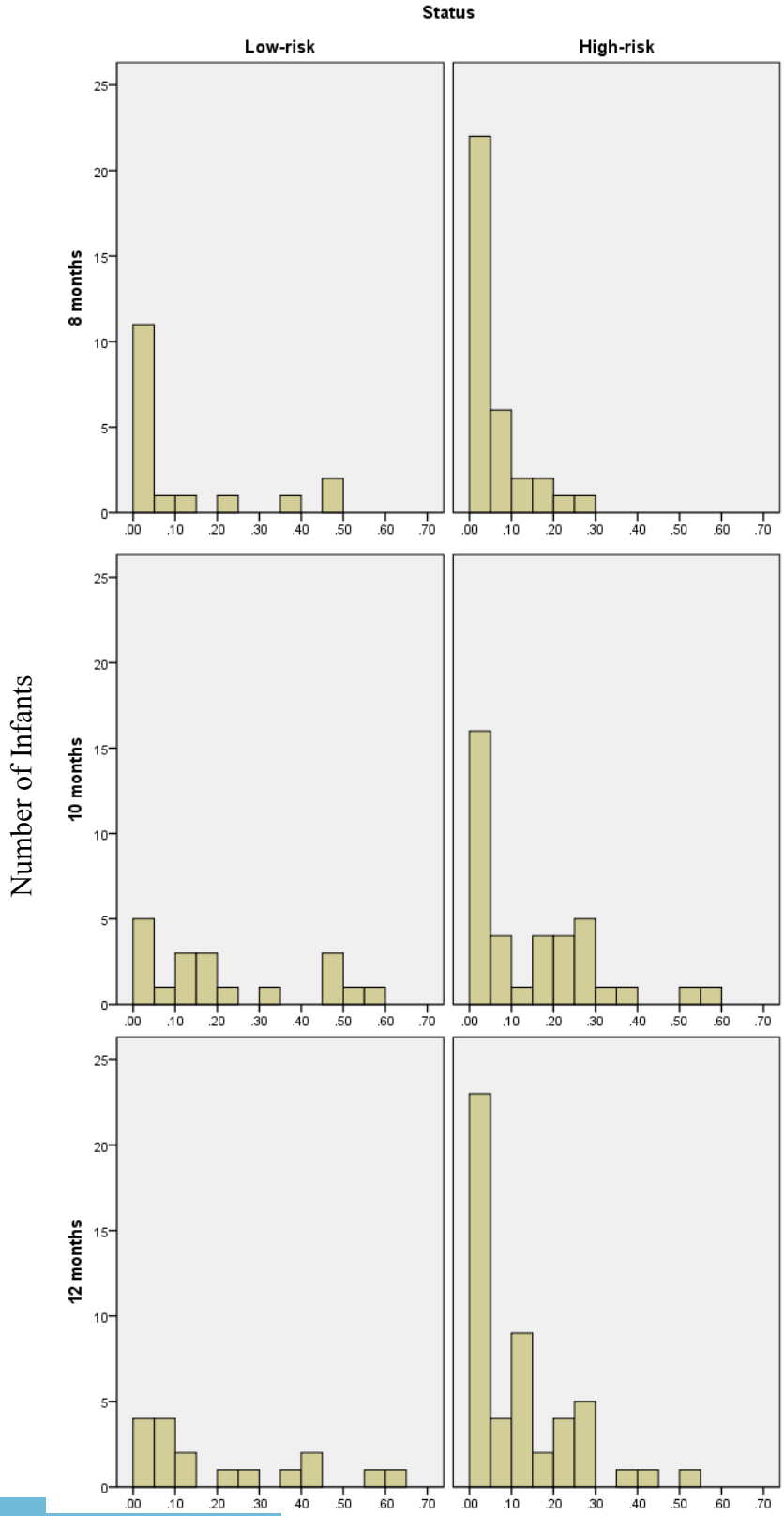

Figure 3

Histograms of reactive smiling proportions by age.

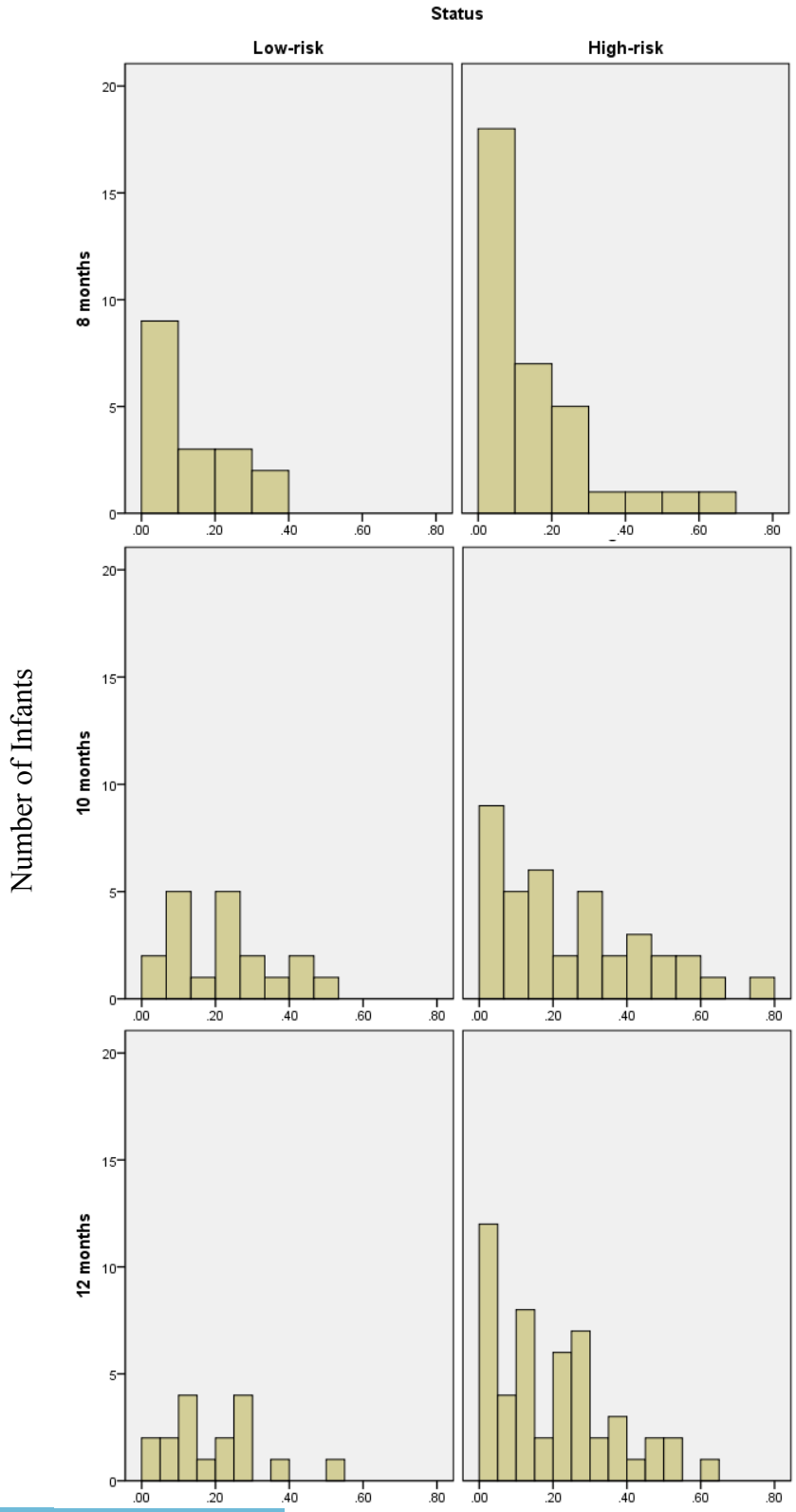

Figure 4

Histograms of no smiling proportions by age.

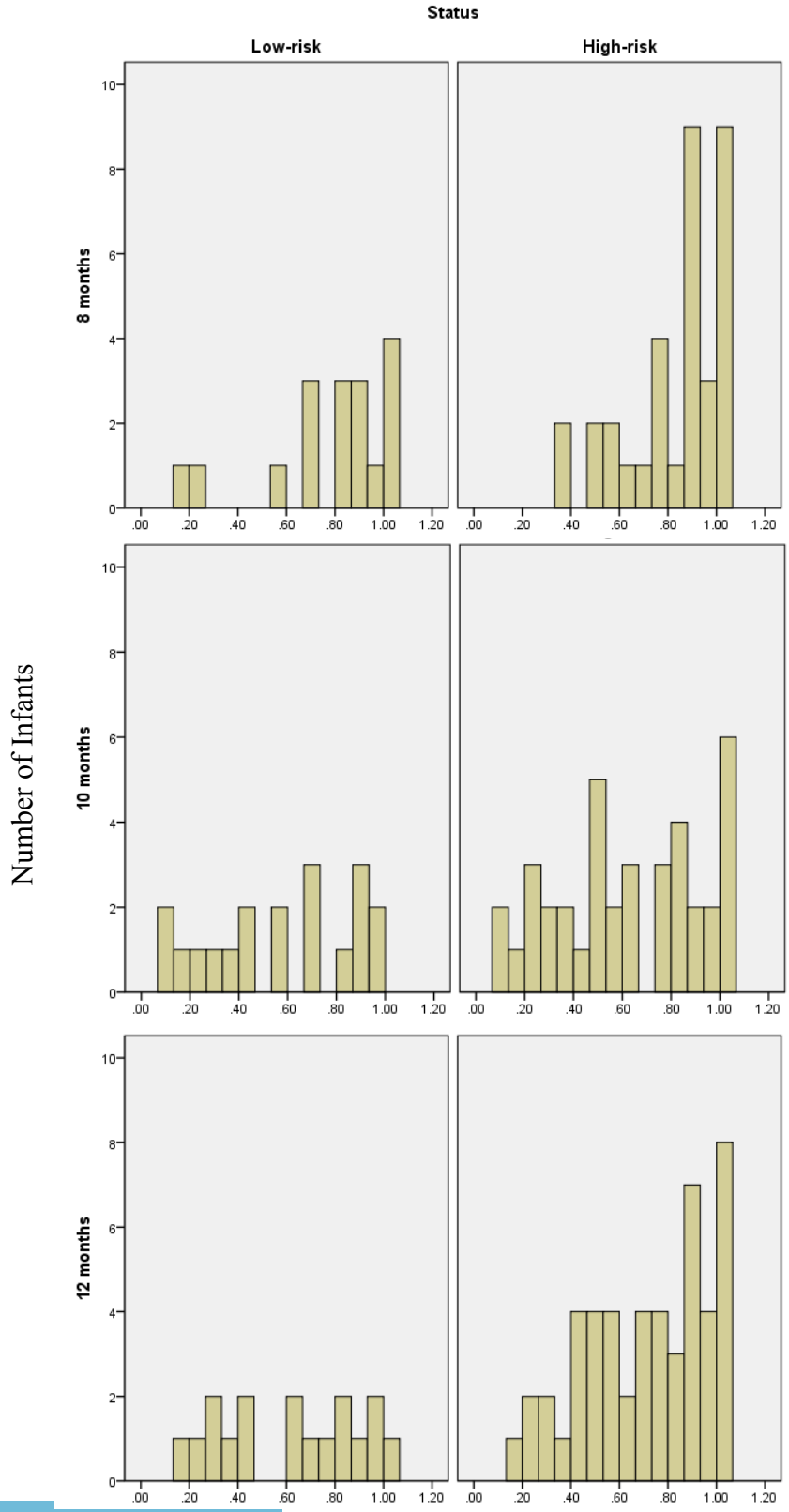

Figure 5

Mean proportion of IJA with anticipatory smiling over time by group.

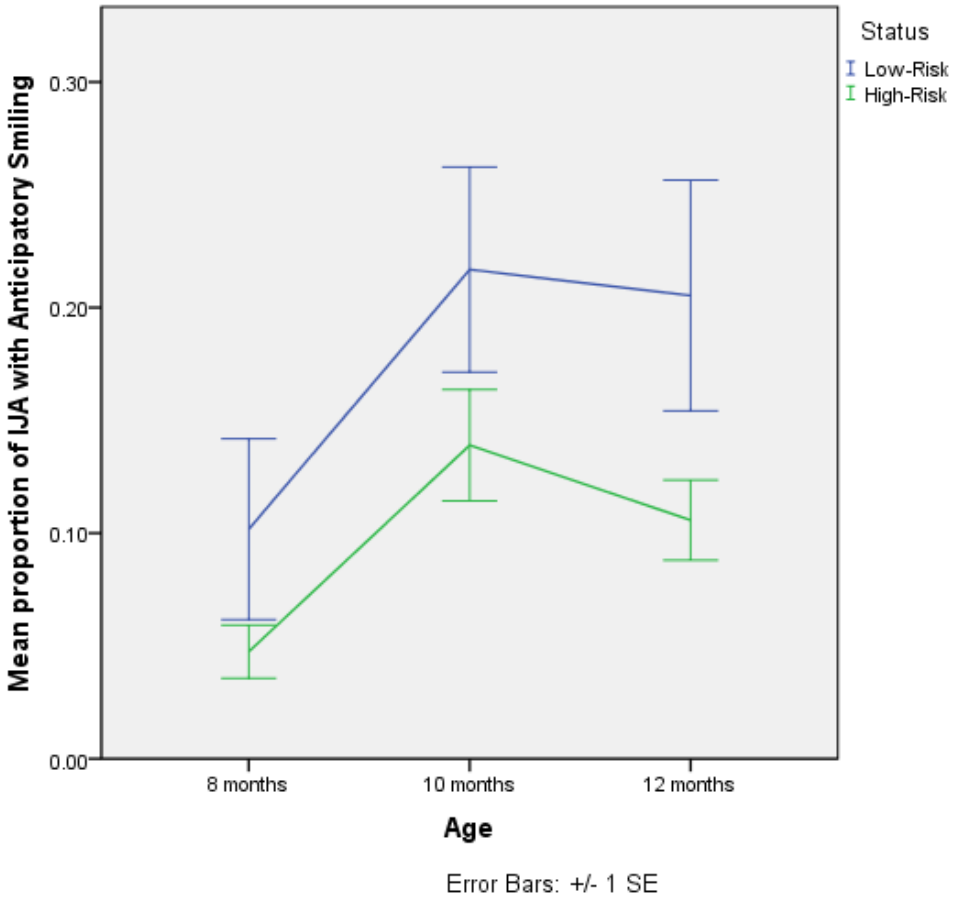

Figure 6

Mean proportion of IJA with reactive smiling over time by group.

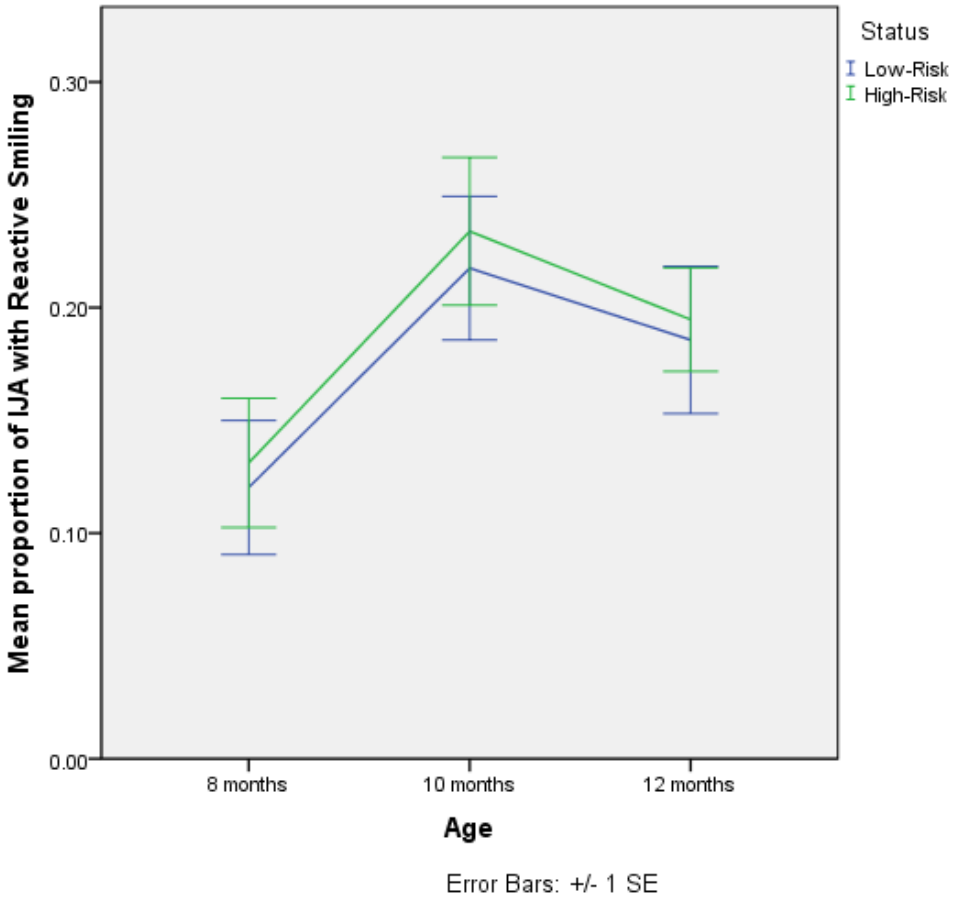

Figure 7

Mean proportion of IJA with no smiling over time by group.

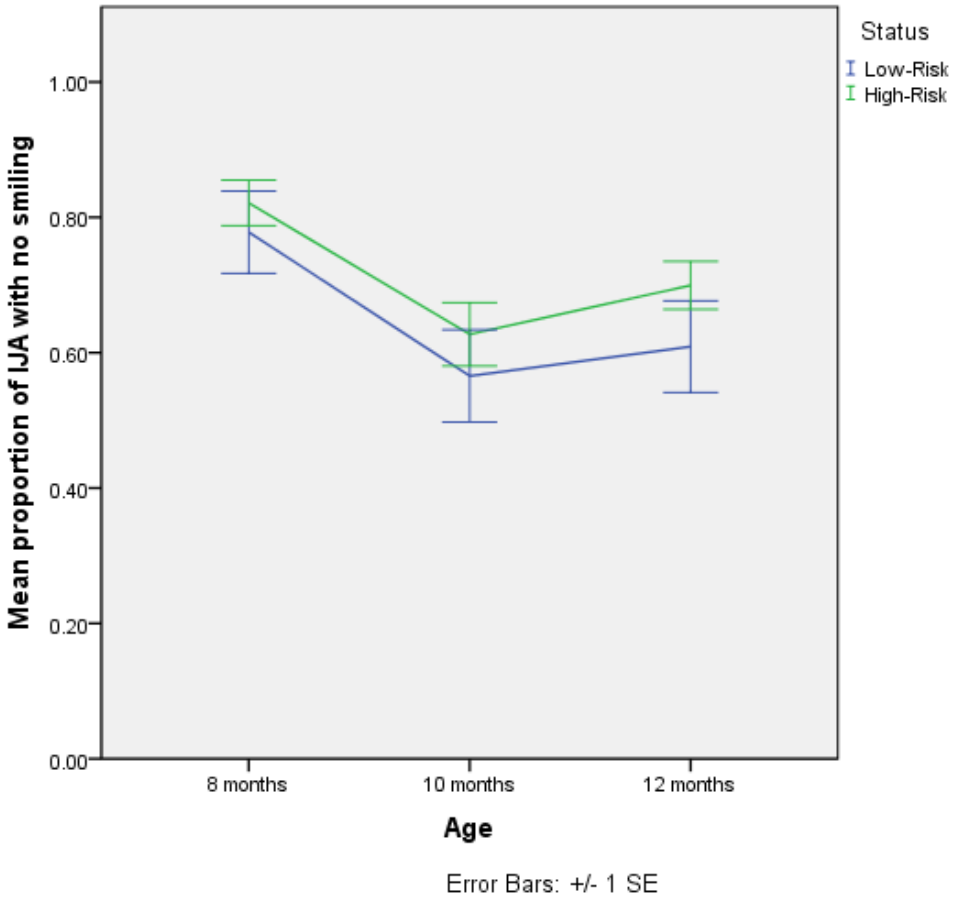

Table 1. *Descriptive statistics for total IJA.*

	Low-risk Mean (SD)	High-risk Mean (SD)
Frequency		
8 month	25.35 (12.53)	17.26 (12.42)
10 month	34.74 (12.86)	24.71 (14.41)
12 month	21.76 (8.81)	21.64 (10.96)
Rate per minute		
8 month	1.34 (0.63)	0.93 (0.57)
10 month	1.81 (0.66)	1.26 (0.66)
12 month	1.25 (0.50)	1.17 (0.61)

Table 2. *Descriptive statistics for IJA smiling types frequencies.*

	Low-risk Mean (SD)	High-risk Mean (SD)
Anticipatory Smiling		
8 month	2.76 (5.37)	0.85 (1.23)
10 month	7.21 (7.50)	3.21 (3.75)
12 month	4.00 (3.94)	2.24 (2.93)
Reactive Smiling		
8 month	3.59 (3.94)	2.09 (3.05)
10 month	7.53 (7.12)	5.47 (5.60)
12 month	4.06 (3.15)	4.16 (4.88)
No Smiling		
8 month	19.00 (11.67)	14.32 (10.29)
10 month	20.00 (12.52)	16.03 (12.40)
12 month	13.71 (9.45)	15.24 (10.51)

Table 3. *Descriptive statistics for IJA smiling types as rates per minute.*

	Low-risk Mean (SD)	High-risk Mean (SD)
Anticipatory Smiling		
8 month	0.16 (0.31)	0.04 (0.06)
10 month	0.34 (0.34)	0.16 (0.18)
12 month	0.23 (0.22)	0.12 (0.16)
Reactive Smiling		
8 month	0.19 (0.22)	0.10 (0.14)
10 month	0.39 (0.39)	0.28 (0.27)
12 month	0.24 (0.19)	0.22 (0.28)
No Smiling		
8 month	0.99 (0.54)	0.79 (0.52)
10 month	1.08 (0.69)	0.83 (0.61)
12 month	0.78 (0.54)	0.82 (0.58)

Table 4. *Descriptive statistics for IJA smiling types as proportions of total instances of IJA.*

	Low-risk Mean (SD)	High-risk Mean (SD)
Anticipatory Smiling		
8 month	0.10 (0.17)	0.05 (0.07)
10 month	0.22 (0.20)	0.14 (0.15)
12 month	0.21 (0.21)	0.11 (0.13)
Reactive Smiling		
8 month	0.12 (0.12)	0.13 (0.17)
10 month	0.22 (0.14)	0.23 (0.20)
12 month	0.19 (0.13)	0.19 (0.16)
No Smiling		
8 month	0.78 (0.25)	0.82 (0.20)
10 month	0.57 (0.30)	0.63 (0.29)
12 month	0.61 (0.28)	0.70 (0.25)

Table 5. *Coefficient Estimates for Intermediate Models of Anticipatory Smiling.*

Coefficients	β	*SE*	*t*	*df*	*p*
Model 1a (Empty Model)					
Level 1 (Observations)					
β_{00} (Intercept)	0.12	0.01	9.07	80	<0.001
Model 1b (Age)					
Level 1 (Observations)					
β_{00} (Intercept)	0.06	0.02	4.10	80	<0.001
β_{10} (Linear Time)	0.16	0.04	3.70	80	<0.001
B_{20} (Quadratic Time)	-0.06	0.02	-2.88	80	0.01
Model 1d (Group Status)					
Level 1 (Observations)					
β_{00} (Intercept)	0.09	0.03	3.49	79	<0.001
β_{10} (Linear Time)	0.17	0.08	2.27	79	0.03
B_{20} (Quadratic Time)	-0.05	0.04	-1.41	79	0.16
Level 2 (Subjects)					
β_{01} (Group Status)	-0.04	0.03	-1.32	79	0.19
β_{11} (Group Status)	-0.02	0.09	-0.17	79	0.86
β_{21} (Group Status)	-0.01	0.04	-0.24	79	0.81

Table 6. *Coefficient Estimates for Intermediate Models of Reactive Smiling.*

Coefficients	β	*SE*	*t*	*df*	*p*
Model 2a (Empty Model)					
Level 1 (Observations)					
β_{00} (Intercept)	0.19	0.01	13.03	80	<0.001
Model 2c (Group Status)					
Level 1 (Observations)					
β_{00} (Intercept)	0.12	0.03	4.30	79	<0.001
β_{10} (Linear Time)	0.15	0.05	3.29	80	<0.01
B_{20} (Quadratic Time)	-0.06	0.02	-2.79	80	0.01
Level 2 (Subjects)					
β_{01} (Group Status)	0.02	0.03	0.62	79	0.54

Table 7. *Coefficient Estimates for Intermediate Models of No Smiling.*

Coefficients	β	*SE*	*t*	*df*	*p*
Model 3a (Empty Model)					
Level 1 (Observations)					
β_{00} (Intercept)	0.69	0.02	29.92	80	<0.001
Model 3c (Group Status)					
Level 1 (Observations)					
β_{00} (Intercept)	0.77	0.04	18.02	79	<0.001
β_{10} (Linear Time)	-0.31	0.08	-4.12	80	<0.001
B_{20} (Quadratic Time)	0.12	0.04	3.39	80	<0.01
Level 2 (Subjects)					
β_{01} (Group Status)	0.05	0.05	1.16	79	0.25

Table 8. *Coefficient Estimates for the Final Models of IJA Smiling Types.*

Coefficients	β	*SE*	*t*	*df*	*p*
Anticipatory Smiling (Model 1c)					
Level 1 (Observations)					
β_{00} (Intercept)	0.10	0.02	4.63	79	<0.001
β_{10} (Linear Time)	0.16	0.04	3.66	80	<0.001
B_{20} (Quadratic Time)	-0.06	0.02	-2.83	80	0.01
Level 2 (Subjects)					
β_{01} (Group Status)	-0.06	0.03	-2.50	79	0.02
Reactive Smiling (Model 2b)					
Level 1 (Observations)					
β_{00} (Intercept)	0.13	0.02	6.41	80	<0.001
β_{10} (Linear Time)	0.15	0.05	3.27	80	<0.01
B_{20} (Quadratic Time)	-0.06	0.02	-2.76	80	0.01
No Smiling (Model 3b)					
Level 1 (Observations)					
β_{00} (Intercept)	0.80	0.03	26.92	80	<0.001
β_{10} (Linear Time)	-0.31	0.07	-4.15	80	<0.001
B_{20} (Quadratic Time)	0.12	0.03	3.43	80	<0.001