Linking Infant-Directed Speech and Face Preferences to Language Outcomes in Infants at Risk for Autism Spectrum Disorder

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Purpose: In this study, the authors aimed to examine whether biases for infant-directed (ID) speech and faces differ between infant siblings of children with autism spectrum disorder (ASD) (SIBS-A) and infant siblings of typically developing children (SIBS-TD), and whether speech and face biases predict language outcomes and risk group membership.

Method: Thirty-six infants were tested at ages 6, 8, 12, and 18 months. Infants heard 2 ID and 2 adult-directed (AD) speech passages paired with either a checkerboard or a face. The authors assessed expressive language at 12 and 18 months and general functioning at 12 months using the Mullen Scales of Early Learning (Mullen, 1995).

Results: Both infant groups preferred ID to AD speech and preferred faces to checkerboards. SIBS-TD demonstrated higher expressive language at 18 months than did SIBS-A, a finding that correlated with preferences for ID speech at 12 months. Although both groups looked longer to face stimuli than to the checkerboard, the magnitude of the preference was smaller in SIBS-A and predicted expressive vocabulary at 18 months in this group. Infants’ preference for faces contributed to risk-group membership in a logistic regression analysis.

Conclusion: Infants at heightened risk of ASD differ from typically developing infants in their preferences for ID speech and faces, which may underlie deficits in later language development and social communication.

Key Words: autism spectrum disorder, speech perception, high-risk infants
directed (AD) speech (Cooper & Aslin, 1990; Fernald, 1985). Infants’ heightened interest in ID speech may play an important functional role in their linguistic and socioemotional development. On the linguistic front, the heightened prosodic structure of ID speech is thought to facilitate processing in domains such as word segmentation (Thiessen, Hill, & Saffran, 2005) and word learning (Graf-Estes, 2008). It can also enhance the learning of associations between speech and faces. For example, infants readily learn to associate even unfamiliar ID speech with a face but do not associate speech lacking ID characteristics with a face (Kaplan, Bachorowski, Smoski, & Hudenko, 2002; Kaplan, Jung, Ryther, & Zarlingo-Strouse, 1996). Caregivers’ use of ID speech may facilitate language acquisition (Jusczyk, 1997; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Wright Cassidy, 1989; Kuhl et al., 1997; see also Snow, 1977) over the course of infant development (Fernald, 1992; Hayashi, Tamekawa, & Kiritani, 2001) and across a variety of cultures (Fernald et al., 1989).

ID speech is also thought to facilitate emotional development. Specifically, ID speech has been linked with the transmission and reciprocity of emotional affect (Fernald, 1985; Fernald & Simon, 1984). Although caregivers’ production of ID speech may express their positive emotional state (Fernald & Simon, 1984), infants’ reactions to ID speech may reflect their own positive emotional response. Werker and McLeod (1989) found that infants ages 4–5 and 7–9 months demonstrated greater affective responsiveness while watching a recording of ID speech than when presented with AD speech. Moreover, a person’s use of ID speech may further signal his or her status as the infant’s potential caregiver. An unfamiliar adult who uses ID speech in his or her initial interaction is more likely to have a high level of interest in infant interaction and caregiving than someone who initially uses AD speech, which typically addresses the adult (e.g., Fernald, 1992). Consistent with this, Schachner and Hannon (2011) found that 5-month-old infants look longer at an image of the face of a person who had just used ID speech than at an image of a novel person, but not when that person had used AD speech; instead, they preferred the novel person. Thus, ID speech may play an important role in maintaining parent–infant interactions and may provide infants with a cue for selecting appropriate social partners.

Despite the role of ID speech in linguistic and emotional development, attention to ID speech changes over the course of development. Hayashi et al. (2001) followed infants from ages 4 to 10 months and found that infants showed a U-shaped developmental shift in attentional biases for ID speech across three stages. At ages 4–5 months, infants attended to ID speech significantly longer than to AD speech. In a similar way, infants demonstrated the same reliable preference for ID speech at ages 9–10 months. However, between ages 7 and 9 months, infants’ preference for ID speech over AD speech decreased, with some infants demonstrating a preference for listening to AD speech. We speculated that these changes in ID speech preference reflected three distinct stages of development: (a) an initial preference driven by innate emotional arousal elicited by prosodic and rhythmic characteristics, (b) a subsequent decrease, and (c) a renewal of interest in concert with infants’ speech perception abilities. We argue that the ID speech preference returns at the same time as infants show awareness that speech signals have distinct linguistic structures. In particular, ID speech may more clearly exhibit the structure of the infant’s native speech, such as highlighting word boundaries; thus, a preference for ID speech may be favorable during this period of linguistic development.

Preferenc for Faces in Typically Developing Infants

In addition to attention to ID speech, attention to faces is integral to social development, interaction, and communication. Infants learn much about the social world from the faces of others. They begin to recognize identity (Pascalis, de Haan, Nelson, & De Schonen, 1998), recognize and prefer faces from their own race (Kelly et al., 2005), perceive affect (Cohn & Tronick, 1983; Tronick, 1989), and follow gaze (Corkum & Moore, 1998; Scaife & Bruner, 1975). The ability to use the social and emotional information conveyed in faces and to respond to it discriminatively may have been critical for the evolution of social communication (Andrew, 1963; Ekman, 1992; Ekman & Oster, 1979).

To extract socially and emotionally relevant information from faces, however, infants must first attend to them. Even newborns show a generalized bias to attend to faces and facelike stimuli (Farroni et al., 2005; Johnson et al., 1991; Macchi Cassia, Turati, & Simion, 2004; Simion, Macchi Cassia, Turati, & Valenza, 2001). Thus, faces are salient and preferred stimuli for TD infants in early development (e.g., Bushnell et al., 1989).

Is Preference for ID Speech and/or Faces Attenuated in Children Developing Atypically?

A lack of preference for speech and faces may reflect atypical development. Indeed, while children with typical development and those with developmental delays prefer listening to their mother’s ID speech over listening to a noisy overlay composed of many voices and environmental noise, children ages 4–6 years with ASD showed no preference (Klin, 1991). Moreover, children with ASD do not show a preference for ID speech versus nonspeech analogues (Kuhl et al., 2005), and those children with ASD who prefer listening to nonspeech over ID speech are more likely to exhibit deficits in expressive language ability (Kuhl et al., 2005). A recent study examining ID speech preference in 6-month-old infants at risk for ASD, because they have an older sibling diagnosed with ASD, found that some infants in the group at risk displayed a clear, atypical preference to listen to AD speech (Nadig, Ozonoff, Singh, Young, & Rogers, 2007). These findings suggest that, although TD children and children with developmental delays prefer listening to ID speech, children with ASD do not demonstrate similar preferences and that these atypical preferences may arise in early development.

A preference for faces might also develop atypically in children with ASD. Recent studies show that children with
ASD demonstrate decreased attention to faces (Osterling, Dawson, & Munson, 2002), impairments in face recognition (Dawson et al., 2002; Klin et al., 1999; Marcus & Nelson, 2001), and deficits in understanding and using facial information in social contexts (Baren-Cohen, 1994; Hobson, 1989). A failure to develop attentional biases toward faces in children with ASD may negatively affect the development of social communication and, in particular, language abilities.

In recent prospective studies of developmental trajectories, SIBS-A show early difficulties in cognitive and language development and in social engagement (ElSabbagh & Johnson, 2007; Orsmond & Seltzer, 2007; Yirmiya & Ozonoff, 2007). Twin and family studies have shown that unaffected family members of individuals with ASD demonstrate subclinical features characteristic of ASD (for a review, see Gerdts & Bernier, 2011). Both parents and siblings of children with autism show a raised incidence of language delays, difficulties with sensory integration, and potential difficulties with emotion regulation and communication (for a review, see Bailey, Palferman, Heavey, & LeCouteur, 1998; Yirmiya, Shaked, & Erel, 2001). Thus, poor language outcomes may be part of the subclinical phenotype seen in family members of children diagnosed with ASD and part of the broader autism spectrum.

**The Current Study**

The purpose of this study was to investigate whether early speech and face preferences differ in infants at risk of ASD and to what extent early differences may predict language delays and risk-group membership. To investigate early species-typical attention to faces and ID speech and its relationship to language development, we examined preferential attention to speech and face information in two populations of infants: infant siblings of children with autism spectrum disorder (SIBS-A) and infant siblings of typically developing children (SIBS-TD). Specifically, we tested infants’ preferences to ID speech and faces in the first year and a half of life and the extent to which infants’ attentional biases predicted language outcome and risk group membership at age 18 months. We predicted that although SIBS-TD would orient longer to ID speech and faces throughout development, SIBS-A would demonstrate atypical preferences: either no attentional biases or preferences for AD speech and a nonface visual display (a checkerboard). If SIBS-A do not display the same preferences as SIBS-TD by either attending longer to AD speech and the checkerboard or by demonstrating no preference for ID speech or faces at all, they may be at risk for language delay and/or a language disorder. Thus, it is important to investigate early attentional biases to faces and speech and the extent to which such biases predict language development and risk group membership.

**Method**

**Participants**

Participants were recruited at age 6 months and consisted of 36 healthy full-term infants with at least one older sibling. High-risk infants with an older sibling diagnosed with ASD (SIBS-A; \( n = 14 \)) were recruited from local ASD treatment agencies and pediatric clinics in all four quadrants of the city of Calgary, including the Early Child Development Team through Alberta Health Services, the Society for Treatment of Autism, Renfrew Educational Services, Parent-Link, and other local service organizations. Individuals working at these agencies referred families to our study and posted flyers in their offices and information about our study on the agency website. Low-risk infant siblings (SIBS-TD; \( n = 22 \)) of children with no diagnosis were recruited from the Child and Infant Learning and Development (Ch.I.L.D.) Research Group at the University of Calgary. All infants resided in the southern region of Alberta in North America. Longitudinal data were collected from infants at ages 6, 8, 12, and 18 months. Although a larger sample size was recruited for this study, only those infants who participated at all four visits were included in the analysis (see Table 1 for the number of participants who contributed data). Exclusionary criteria included the presence of a neurological disorder of known etiology, significant sensory or motor impairment, major physical abnormalities, and history of serious head injury and/or neurological disease. Hearing status of the infants was confirmed using an otocoustic emissions screening procedure at each session. No infants were unable to be tested because of impaired hearing status.

The primary language of the sample for this experiment was English. Those parents who reported speaking two or more languages in the home environment indicated that English was the primary language, spoken equal to or greater than 80% of the time. Second languages reported by parents were Arabic (\( n = 1 \)), Cantonese (\( n = 1 \)), Farsi (\( n = 1 \)), Ilokano (\( n = 1 \)), Tagalog (\( n = 1 \)), Spanish (\( n = 2 \)), and French (\( n = 8 \)). Educational backgrounds of parents included a high school diploma (maternal \( n = 3 \); paternal \( n = 6 \)), college or technical degree (maternal \( n = 15 \); paternal \( n = 10 \)), some university (maternal \( n = 1 \); paternal \( n = 1 \)), university degree (maternal \( n = 10 \); paternal \( n = 11 \)), and postgraduate degree (maternal \( n = 7 \); paternal \( n = 8 \)). Although we did not collect additional demographic information, consistent with other studies from the Speech Development Lab at the University of Calgary, the sample was likely to be predominantly middle class and of European American descent and represent the cultural demographic in Calgary. Specifically, 22.2% of the population in Calgary consists of visible minorities (Statistics Canada, 2007), including Chinese (6.2%), South Asian (5.4%), Aboriginal (2.5%), Filipino (2.4%), Black (2.0%), Latin American (1.3%), Southeast Asian (1.5%), Arab (1.1%), West Asian (0.6%), Korean (0.6%), Japanese (0.4%), and visible minorities not included in census questionnaires (0.2%).

Participants were given a t-shirt or toy as a thank-you gift but were otherwise not compensated for their participation. This study was reviewed and approved by the University of Calgary Ethics Review Committee. Informed consent was obtained in person by trained research staff at the first lab visit.
Apparatus

Testing took place in a 2.74 m × 1.82 m sound-attenuated room, which was dimly lit by overhead lighting. Infants sat on a parent’s lap facing a Smartboard monitor (122 cm wide × 91.5 cm high) mounted on the wall that was approximately 1.5 m away. Images were projected onto the Smartboard via a NEC LT245 projector. The audio stimuli were delivered at 65 dB ± 5 dB, over a BOSE 101 speaker, located directly below the monitor. Infant behavior was recorded using a Sony DCRDVD92 digital video camera. As a masking control during testing, the parent wore Bose True Noise-cancellation headphones over which vocal music was played from a Teac CD-P1250 CD player. Habit X 1.0 (Cohen, Atkinson, & Chaput, 2004) run on a Macintosh Power PC G5 was used to present stimuli and collect looking time data.

Procedure

At each visit, infants participated in a sequential looking preference procedure (Cooper & Aslin, 1990, 1994; Pegg, Werker, & McLeod, 1992). Parents were asked to keep infants centered and oriented forward. The experimenter, who was blind to the auditory stimuli, monitored infants’ looking times via a closed-circuit television system from an adjacent testing room. The experiment began with a pretest control trial in which infants heard classical music paired with a checkerboard to direct infants’ attention to the monitor. Infants were then exposed to the speech passages paired with a checkerboard or face visual display. A full trial consisted of tokens separated by 300 to 450 ms of silence, for 40 s. The presentation of visual and auditory stimuli was counterbalanced across participants. Coders, who were blind to the experimental conditions, coded infants’ looking time from the video to determine reliability. Looking time to the visual stimulus in each condition was measured in seconds.

Stimuli

Two sets of speech stimuli were used to test for auditory preference. The stimuli consisted of two 40-s samples of ID speech and two 40-s samples of AD speech recorded by a female, native-English-speaking adult. The ID speech samples described scenes from a child’s picture book while the AD speech samples described a personal event (travel to a foreign country).

Overall pitch measurements were taken from each sample every 8 s using Praat (Boersma & Weenink, 2012). The mean pitch for AD speech was 212.0 Hz (range = 75.2–498.3 Hz) and for ID speech was 293.2 Hz (range = 81.5–524.7 Hz). The pitch differed significantly for the two speech types (equal variance not assumed), t(11.85) = 8.97, p < .001.

There were 19 sentences across the two 40-s AD speech samples and 10 sentences across the two 40-s ID samples. The number of words per sentence differed significantly between the AD (M = 15.58, SD = 7.99) and the ID (M = 10.22, SD = 4.85) speech (equal variance not assumed), t(29.92) = 2.02, p = .05.

Each auditory stimulus sample was paired with either a photograph of a neutral black-and-white female face (NimStim face set; Tottenham et al., 2009) or a black-and-white checkerboard. Infants were presented with four trials: two AD speech and two ID speech trials, each paired with either a face or a checkerboard.

Language Questionnaire: Communicative Development Inventory

Parents completed the MacArthur–Bates Communicative Development Inventories: Words and Gestures (CDI:WG) at ages 12 and 18 months (Fenson et al., 1993). This is a standardized parental report measure of

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Table 1. Means and SDs for the CDI Expressive Language Score, for the MSEL Total Composite Score, and for the experimental tasks.

<table>
<thead>
<tr>
<th>Variable</th>
<th>SIBS-TD</th>
<th>SIBS-A</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>CDI Expressive Language Score&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>20</td>
<td>8.2</td>
<td>7.8</td>
</tr>
<tr>
<td>Raw score</td>
<td>51.2</td>
<td>22.1</td>
<td>52.4</td>
</tr>
<tr>
<td>Percentile score</td>
<td>82.1</td>
<td>78.7</td>
<td>29.3</td>
</tr>
<tr>
<td>18 months</td>
<td>21</td>
<td>36.6</td>
<td>31.1</td>
</tr>
<tr>
<td>Raw score</td>
<td>12</td>
<td>104.8</td>
<td>11.0</td>
</tr>
<tr>
<td>Percentile score</td>
<td>19.8</td>
<td>3.6</td>
<td>22.1</td>
</tr>
<tr>
<td>MSEL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 months</td>
<td>22</td>
<td>17.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Experimental tasks between ages 6 and 18 months</td>
<td>19</td>
<td>14.2</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Note. CDI = MacArthur–Bates Communicative Development Inventories; MSEL = Mullen Scales of Early Learning; ID = infant-directed; AD = adult-directed.

<sup>a</sup>Later-born siblings tend to have lower CDI Expressive Scores than firstborn children (Fenson et al., 2007).
vocabulary development of children between ages 8 and 37 months. For this study, we focused on the Expressive Language Score, which includes only words that were both understood and produced by the child.

**Overall Functioning: Mullen Scales of Early Learning**

Global cognitive development was assessed using the Mullen Scales of Early Learning (MSEL; Mullen, 1995) at age 12 months. The MSEL is a comprehensive assessment of language, motor, and perceptual abilities for children of all ability levels. T scores, percentile ranks, and age equivalents are computed for the five subscales separately (Motor, Visual Reception, Fine Motor, Expressive Language, and Receptive Language), and for a composite score based on four subscale scores (Motor, Visual Reception, Expressive Language, and Receptive Language) and standardized for children ages 0–90 months. Groups did not differ on MSEL composite score—SIBS-TD: M = 104.8, SD = 10.9; SIBS-A: M = 101.7, SD = 12.8; F(1, 33) = 0.59, p = .448. Of note, one SIBS-A infant could not complete a subtest from the MSEL that contributed to the composite score; therefore, this infant’s composite score was not considered in the analysis.

**Results**

**Does attention to speech/AD speech and face checkerboard differ between risk groups?** We first examined infants’ looking behavior with a 2 (speech type: ID speech, AD speech) × 2 (visual stimuli: face, checkerboard) × 4 (ages: 6, 8, 12, 18 months) × 2 (risk group: SIBS-TD, SIBS-A) mixed-factor analysis of variance (ANOVA). Because not all infants completed the task at each age, our complete sample size was 36 (SIBS-TD: n = 22; SIBS-A: n = 14). Our findings yielded a main effect of speech type, F(1, 34) = 12.38, p < .001, ηp² = .267, and visual stimulus, F(1, 34) = 180.33, p < .001, ηp² = .841. We further found a Visual Stimulus × Risk Group interaction, F(1, 34) = 7.05, p = .012, ηp² = .172; an Age × Risk Group interaction, F(3, 102) = 2.82, p = .043, ηp² = .077; and a Speech Type × Age interaction, F(3, 102) = 4.85, p = .003, ηp² = .125. No other factors or interactions were significant; however, there was a trend toward an effect of risk group, F(1, 34) = 3.41, p = .073, ηp² = .091. We next examined each of the interactions in turn.

To understand the source of the Visual Stimulus × Risk Group interaction, pairwise comparisons were conducted, comparing looking times to the visual stimuli collapsed across ages. The SIBS-TD group looked longer when the visual stimulus was a face rather than a checkerboard [face: M = 23.34, SD = 3.48; checkerboard: M = 14.16, SD = 4.50; t(21) = 12.78, p < .001, r = .94] as did the SIBS-A group [face: M = 24.27, SD = 3.96; checkerboard: M = 18.12, SD = 5.02; t(13) = 7.00, p < .001, r = .89]. Thus, both SIBS-TD and SIBS-A looked significantly longer at the face stimuli than at the checkerboard, but the magnitude of the difference was greater for the SIBS-TD. Specifically, SIBS-A looked significantly longer at the checkerboard than did the SIBS-TD, F(1, 34) = 6.07, p = .019, r = .39, whereas there was no difference in looking time to faces between the SIBS-A and SIBS-TD groups, F(1, 34) = 0.553, p = .462, r = .13.

The Age × Risk Group interaction demonstrated that the SIBS-A group’s overall looking time (8 months: M = 23.11, SD = 4.93; 18 months: M = 22.52, SD = 6.33) was greater than that of the SIBS-TD group (8 months: M = 18.81, SD = 5.52; 18 months: M = 17.52, SD = 5.96) at 8 months of age, F(1, 34) = 5.62, p = .023, r = .38, and 18 months of age, F(1, 34) = 5.73, p = .022, r = .38. There were no significant differences between risk groups’ looking times at ages 6 and 12 months.

We next examined the Speech Type × Age interaction. Our findings revealed that infants show a trend for looking longer at ID speech than AD speech at 8 months [ID speech: M = 21.12, SD = 5.62; AD speech: M = 19.85, SD = 6.39; t(35) = 1.812, p = .078, r = .29], and looking significantly longer at ID speech than at AD speech at 12 months [ID speech: M = 20.85, SD = 6.09; AD speech: M = 19.27, SD = 5.78; t(35) = 2.78, p = .009, r = .43] and at 18 months [ID speech: M = 21.52, SD = 7.47; AD speech: M = 17.41, SD = 7.15; t(35) = 3.71, p = .001, r = .53]. There were no reliable differences at 6 months [ID speech: M = 19.23, SD = 5.12; AD speech: M = 18.34, SD = 5.38].

We predicted that our risk groups would differ in their preferences for speech, with SIBS-A showing atypical looking behavior. Our SIBS-TD group showed a trend for looking longer during the ID speech sample than the AD sample at 8 months [ID: M = 19.66, SD = 4.88; AD: M = 17.97, SD = 6.69; t(21) = 2.04, p = .054, r = .41], and 12 months [ID: M = 20.86, SD = 5.34; AD: M = 19.5, SD = 5.85; t(21) = 1.97, p = .062, r = .39], and reliably longer to ID at 18 months [ID: M = 19.3, SD = 6.96; AD: M = 15.74, SD = 6.71; t(21) = 2.49, p = .021, r = .48]. The SIBS-A group showed a trend for looking longer during the ID speech sample than the AD sample at 12 months [ID: M = 20.83, SD = 7.35; AD: M = 18.91, SD = 5.85; t(13) = 1.9, p = .08, r = .47], and reliably longer at 18 months [ID: M = 25.01, SD = 7.09; AD: M = 20.02, SD = 7.27; t(13) = 2.77, p = .016, r = .61].

**Does language outcome differ between risk groups?** Using only those infants whose scores were included in the ANOVA above and for whom we had CDI scores (12 months: N = 34; 18 months: N = 33), we next examined CDI expressive language scores at ages 12 and 18 months. SIBS-TD scored significantly higher on the CDI at age 18 months compared with SIBS-A, F(1, 32) = 5.05, p = .032, r = .37. There were no differences in CDI scores at age 12 months, F(1, 32) = 0.38, p = .542, r = .11. However, infants’ CDI scores at age 12 months significantly correlated with CDI scores at age 18 months, r(31) = .698, p < .001.

Does attention to speech and faces in the first year correlate with language outcome (CDI scores) at age 18 months? We next explored whether overall looking behavior between ages 6 and 12 months was correlated with later expressive language by looking at CDI scores at age 18 months. Again, we only included those infants who had
looking data at all time points in our analysis and CDI scores (N = 33). Our findings revealed that CDI scores were negatively correlated with overall looking time to the checkerboard image at age 18 months, \( r(33) = -0.429, p = 0.013 \), and negatively correlated with overall looking time to AD speech at age 18 months, \( r(33) = -0.511, p = 0.002 \). However, when we explored these correlations by risk group, we found that this correlation held only for the SIBS-TD group: SIBS-TD CDI scores at age 18 months were negatively correlated with overall looking time to AD speech, \( r(21) = -0.573, p = 0.007 \), but, interestingly, their CDI scores negatively correlated with looking time to faces, rather than checkerboards, between ages 6 and 12 months, \( r(21) = -0.524, p = 0.015 \). SIBS-A showed no significant correlations.

Does preference for ID speech and faces in the first year correlate with language outcome (CDI scores) at 18 months? We further examined whether a relative preference for ID speech versus AD speech and a relative preference for faces versus checkerboards between ages 6 and 12 months was predictive of CDI scores at age 18 months. We averaged the looking time to ID across ages and visual stimuli, and we averaged the looking time to AD across ages and visual stimuli. In a similar way, we averaged the looking time to faces across ages and speech type and averaged the looking time to checkerboards across ages and speech type. Preference for speech type was then determined by subtracting looking time to AD speech from looking time to ID speech, and preference for visual stimuli was determined by subtracting looking time to the checkerboard from looking times to the face. A positive difference score in both cases would demonstrate a preference for ID speech and faces. Our findings revealed that a relative preference for ID speech between ages 6 and 12 months predicted CDI scores at age 18 months, \( r(33) = 0.511, p = 0.045 \). There was no correlation observed for faces and CDI scores. We next looked at each risk group individually. We again found that a relative preference for ID speech predicted CDI scores for SIBS-TD, \( r(21) = 0.504, p = 0.020 \) but not for SIBS-A. However, we now observed that, for SIBS-A, a relative preference for faces over checkerboards between ages 6 and 12 months predicted CDI scores at age 18 months, \( r(12) = 0.642, p = 0.024 \). There were no other significant correlations.

Does preference for ID speech and/or faces predict risk group membership? To examine whether ID speech or face preferences might predict risk group, we conducted a binary logistic regression using data from ages 6 to 18 months. We entered into the model the difference scores used as a measure of preference for ID speech (subtracting looking time to AD speech from looking time to ID speech) and faces (subtracting looking time to the checkerboard from looking times to the face) and the risk-group membership status. We found that only the preference for faces significantly improved the model's ability to predict group membership (see Table 2). Whereas the constant alone correctly classified 51% of cases, the inclusion of the face preference information improved classification to 62% of cases. This finding suggests that infants' preference for faces contributes to group membership.

### Discussion

Early attention to speech and faces is crucial for the acquisition of linguistic and social skills. The goal of this study was to investigate early preferences for ID speech and faces in both typically developing and at-risk populations and determine the extent to which they predict language development and risk-group membership. Overall, both SIBS-A and SIBS-TD infants preferred looking at faces over checkerboards, with a greater difference in looking time in SIBS-TD than in SIBS-A. With regard to speech preferences, we found that although SIBS-TD trended toward a more reliable preference for ID speech prior to age 12 months, SIBS-A did not demonstrate a clear preference until age 18 months. Furthermore, we observed that SIBS-TD exhibited higher expressive language scores at age 18 months than did SIBS-A. Collapsed across groups, language outcomes correlated with early speech preferences, suggesting that a preference for ID speech early in development may facilitate later expressive language. When we explored this effect by group, we found that a relative preference for ID speech predicted CDI scores for SIBS-TD but not for SIBS-A. Interestingly, for SIBS-A, a relative preference for faces over checkerboards in early development predicted CDI scores at age 18 months. Finally, infants' preference for faces—but not ID speech—contributed to determining group membership.

Expressive language ability at ages 12 and 18 months. SIBS-A had significantly lower CDI scores at age 18 months than SIBS-TD. This suggests that, overall, our SIBS-A do

### Table 2. Results of the binary logistic regression analysis.

<table>
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<tr>
<th>Variable</th>
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<th>Wald’s ( \chi^2 )</th>
<th>df</th>
<th>( p )</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
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<td>Included</td>
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<tr>
<td>Constant</td>
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<td>.013</td>
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<tr>
<td>Face–checkerboard</td>
<td>-0.18* (0.07)</td>
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<td>.73</td>
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<tr>
<td>ID speech–AD speech</td>
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<td>2.67</td>
<td>1</td>
<td>.102</td>
<td>.72</td>
</tr>
</tbody>
</table>

*Note.* For the beta and \( \chi^2 \) columns, SDs appear in parentheses. \( R^2 = 0.12 \) (in Hosmer & Lemeshow, 1989), 0.15 (in Cox & Snell, 1989), 0.20 (in Nagelkerke, 1991). Model \( \chi^2(2) = 10.4, p < .01 \). *\( p < .01 \).
not have typical productive vocabularies. This finding is consistent with studies examining the language abilities of infant siblings—that is, there are increased incidents of language delay in siblings of children with ASD (see Gamliel et al., 2009). It is possible that poor language outcomes or delays may be part of the broader phenotype seen in family members of children diagnosed with ASD. Indeed, consistent with our findings, there is a 15% probability of cognitive or language difficulties in siblings of children with ASD (Elsabbagh & Johnson, 2007; Ritvo et al., 1989; Zwaigenbaum et al., 2005). As a group, and given the large variability in CDI scores in the general population (Fenson et al., 2007), our participants would not necessarily qualify for early intervention. However, a follow-up with the CDI at age 24 months—when atypical development might be more reliably identified—might be warranted.

Attention to speech and faces in the first year correlates with language outcome in SIBS-TD. Overall looking time to AD speech and checkerboards negatively correlated with CDI scores at age 18 months. However, it appears that the SIBS-TD were driving the negative correlation between AD speech and CDI scores. This suggests that greater overall attention to AD speech is associated with lower expressive language in a typically developing population. Given the early preference for ID speech (Pegg et al., 1992), this could be an indicator of atypical language development in the general population. Interestingly, longer looking times to faces also correlated negatively with CDI scores in the SIBS-TD. Attention to visual and auditory information may compete such that attention to species-specific visual information detracts infants’ attention from speech information. Thus, within the typically developing population, greater attention to AD and face stimuli might affect typical language development.

Visual preferences in infants at risk for ASD and language outcomes. Despite evidence indicating that children with ASD demonstrate decreased attention to faces relative to TD children (Osterling et al., 2002), our results demonstrate that both high- and low-risk infants looked equally at faces and preferred to look at faces than at the checkerboard. However, SIBS-TD exhibited a greater relative preference for faces than did SIBS-A. This suggests that, although still reliable, our SIBS-A group’s preference for faces over checkerboards is not as robust as in the SIBS-TD group. Indeed, SIBS-A tended to look longer at the checkerboard than did SIBS-TD. Of note, face preference in the SIBS-A group predicted CDI scores at age 18 months, and face preference was a significant predictor of group membership. Thus, differential face processing in SIBS-A has implications for language development and potential for identifying ASD status.

We speculate that information transmitted through the face becomes more salient to infants as they begin to integrate speech signals with other sensory input (e.g., facial expressions, joint attention, eye gaze; Fernald, 1992). Thus, TD infants preferentially attend to faces as they learn about socioemotional meaning, which may be supported through the preference for the emotionally laden, highly prosodic ID speech. However, in our SIBS-A group, attentional biases to faces appear to better support later language development. This suggests that, although a preference for ID speech may facilitate language development in SIBS-TD, attentional biases for faces may facilitate language development in SIBS-A. Although attending to ID speech sets the stage for finding words to attach to meanings generating larger vocabularies in typically developing infants, infants who do not exhibit the same early ID speech preferences may rely on other sources of information to learn about language. In the case of infants at risk for ASD, attending to faces may partly compensate for a lack of a preference for ID speech and facilitate mappings between words and referents in the environment. That is, some interest in species-specific social information—in this case, faces (e.g., Johnson et al., 1991)—may compensate for other delayed or nonexistent biases.

Preference for ID speech predicts language outcomes in typically developing infants. Data from the speech analyses revealed that although SIBS-TD trended toward a preference for ID speech at ages 8, 12, and 18 months, SIBS-A did not exhibit a clear preference for ID speech over AD speech until age 18 months, possibly reflecting a delay in the development of an ID speech bias in SIBS-A. Consistent with this interpretation, our findings indicated that as looking time to ID speech increased, so did scores on the expressive CDI for the SIBS-TD. However, SIBS-A did not show a correlation between looking time to ID speech and CDI scores. This may be because SIBS-A scores were uniformly lower than SIBS-TD scores and did not present enough variability for a correlation to emerge. Nevertheless, if the role of ID speech in linguistic and emotional development changes throughout early development (Hayashi et al., 2001), then a delay in showing a preference for ID speech could influence learning in siblings who are at risk for ASD.

Determining group membership based on early preferences for faces, not speech type. Infants’ preference for faces but not speech type contributed to determining group membership, although this only improved classification by 11%. This may be explained by the heterogeneous nature of the SIBS-A risk group (e.g., Ritvo et al., 1989), whose individual outcomes are still unknown. It may be the case that infants in the SIBS-A group will neither develop a language disorder nor receive a diagnosis of ASD. Indeed, preference for ID speech may be more important to language development than to face processing. However, risk-group membership may still be helpful for determining which high-risk individuals may benefit from intervention prior to any outcome diagnosis. Following infants until a diagnosis may be made would further validate the risk-group membership results of the logistic regression analysis.

Limitations of the Current Study

The longitudinal, rather than cross-sectional, design of this study has limitations as well as strengths. The population that we examined is specific, thus making it difficult to enroll a large sample size, which resulted in small subgroups. We enrolled participants at age 6 months, and visits occurred at
ages 8, 12, and 18 months. As a result, infants did not always complete all of the tasks, and, at times, parents failed to complete or return the CDI forms. This resulted in missing data and a relatively small final sample.

The use of a parental report of language development may have been problematic in this specific population. The reports of parents of children with ASD regarding an unaffected sibling may be biased to either maximize or minimize any potential language difficulties because of having a child with ASD as a reference. This bias is unlikely to be manifested in the SIBS-TD group, introducing potential differences in reliability between groups.

Finally, it is important to note that although the purpose of this study was to examine language development in high-risk infants, future studies could explore early ASD symptomatology. Participants in this study were not yet of an age where ASD diagnosis could be made. However, the likelihood of infants in our high-risk group receiving an ASD diagnosis is approximately 19% (Ozonoff et al., 2011), suggesting that, of our 14 infants, roughly two or three infants will receive a diagnosis. Following a larger sample until age 3 years when diagnoses could typically be made would allow us to look at the relationships between (a) preferences for speech and/or faces and (b) ASD diagnosis (Mandell, Novake, & Zubritsky, 2005; Ozonoff et al., 2009). The small sample size and young age of the participants make it difficult to draw any conclusions about how preferences for speech and/or faces may predict ASD diagnosis.

Conclusions

Despite these limitations and the small sample size, some significant and interesting findings emerged. The current study sheds light on how preferences for species-relevant information, such as speech and faces, relate to language development in the siblings of children diagnosed with ASD. These results provide some evidence that lack of attending to ID speech and faces may be related to later delays in language development and may be helpful for determining which high-risk individuals would benefit from intervention prior to any outcome diagnosis.

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