Early Language and Communication Development of Infants Later Diagnosed with Autism Spectrum Disorder

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ABSTRACT. It is well recognized that delayed “first words” is among the most common presenting symptoms of autistic spectrum disorders (ASD). However, data on earlier language and communication development in children with ASD are limited to retrospective reports from parents and from home videos. In this study, we prospectively collected parent report data on early communication and language development in 97 infant siblings of children with ASD and 49 low-risk controls. Parents completed the MacArthur Communicative Development Inventory—Infant Form at 12 and 18 months. Analysis compared 3 groups defined on the basis of diagnostic assessment at 24 months: (1) siblings with ASD (n = 15), (2) siblings not meeting diagnostic criteria for ASD (n = 82), and (3) low-risk controls, none of whom had ASD (n = 49). Children with ASD showed delays in early language and communication compared with non-ASD siblings and controls. At 12 months, the ASD group was reported to understand significantly fewer phrases and to produce fewer gestures. At 18 months, they showed delays in their understanding of phrases, comprehension and production of single words, and use of gestures. Siblings not diagnosed with ASD also used fewer play-related gestures at 18 months than low-risk controls, even when children with identified language delays were excluded. Overall, this prospective study confirms that delays in communication and language development are apparent early in life in children with ASD, and emphasizes that developmental surveillance should include monitoring for delays in gesture, which may be among the earliest signs of ASD. J Dev Behav Pediatr 27:69–78, 2006. Index terms: autism, language, communication, gestures, infant behavior.

The developmental challenges associated with autism arise from a unique constellation of features spanning social communication and language, and behavioral adaptation. The predominant features of autism-related developmental disorders (referred to collectively as the autistic spectrum of disorders; ASD) include qualitative impairments in both verbal and nonverbal communication.1 In addition, receptive and expressive language impairments are present in most ASD subtypes. Consistent with our current understanding of ASD as a neurodevelopmental disorder, there is considerable evidence that its impacts can be evident beginning in early infancy. Parents, at least in retrospect, often describe the first year of life of their children with ASD as being characterized by extremes of temperament and behavior (ranging from marked irritability to alarming passivity), poor eye contact, and poor response to other people’s voices or attempts to play and interact.2–5 However, the most common developmental issue that first prompts parents to share concerns actively with their child’s health care provider is delay in the onset of spoken words, which is generally not evident until the child is 18 months or older.2 Unfortunately, physicians and other health care providers...
often do not recognize the manifestations of ASD earlier in life. Recent practice guidelines recommend that clinicians monitor for early signs and use ASD-specific screening tools to ensure that children with the diagnosis are identified as early as possible. However, no such tools are currently available for children 18 months and younger. In fact, many tools are not appropriate for children between 18 and 24 months of age as they are now scored.

Although speech delay is a common feature of children with ASD, there are many stages of communication development that precede spoken words and provide a foundation for the emergence of verbal language. Many of these earlier skills are also impaired in children with ASD. Gestures, for example, symbolically represent a child’s desires, the objects in their environment, and the qualities and functions of these objects. In typically developing children, gestures develop spontaneously and in tandem with early words. Not surprisingly therefore, use of early gestures is strongly associated with comprehension in early infancy and with both vocabulary comprehension and production after the first year of life. Similarly, most children demonstrate increasingly complex vocalizations and at least rudimentary language comprehension before speaking their first meaningful words. Hence, if language and communication are fundamentally impaired in ASD, then delays in gesture usage and other foundation skills (i.e., early vocalizations and receptive language) may be detectable before the expected onset of spoken words and thus may be among the earliest indicators of ASD. In fact, home videotapes taken at 1 year of age indicate that children with ASD, in comparison with typical controls, exhibit less babbling (both simple and complex) and fewer gestures (particularly pointing). As well, perhaps the most consistent finding from home video analyses is that children with ASD, at 9 to 18 months of age, do not respond reliably when their name is called. Retrospective parental reports also indicate that children with ASD understand fewer phrases than developmentally delayed or typically developing children, at least by age 24 months. In fact, apparent lack of verbal understanding may reflect more fundamental deficits in social orienting and relatedness that may be among the earliest indicators of ASD.

Taken together, these studies provide evidence that delays in language and communication skills that precede speech onset may be predictive of a later diagnosis of ASD. However, neither retrospective reports nor home videotape analyses are well suited to precisely identify the trajectories of early language and communication development that may be unique to children who eventually develop ASD. Currently, there are no prospective studies of communication and language development in children with ASD before diagnosis. Prospective studies are less subject to the biases inherent in retrospective reports and can be designed such that language and communication skills are assessed using consistent, standardized methods at multiple time points over critical periods of development. Children at high-risk of ASD can be identified through population screening for specific ASD-related deficits such as behavioral markers or delays in communication skills. However, the developmental characteristics of these samples are influenced by the content of the screening instrument and by the age range studied because data can be collected only from the time of screening onward. An alternative is to study children with known risk factors for autism who can be ascertained earlier in infancy. Perhaps most suitable in this regard are infants with an older sibling diagnosed with ASD, whose estimated recurrence risk has been reported as roughly 8%. Evidence that a family history of ASD is highly correlated with language impairment suggests that risk for language impairment is also increased in infant siblings. Thus, studying the developmental trajectories of infants who have an older sibling with ASD provides an opportunity to evaluate the nature of language impairments in children who may develop either autism and/or language impairment.

The primary purpose of this study was to examine communication and language development in children with ASD ascertained from a sample of high-risk infants, each with an older sibling with ASD, and followed longitudinally beginning at age 6 to 12 months. Siblings subsequently diagnosed with ASD were compared with non-ASD diagnosed siblings and low-risk control infants (no family history of ASD) on parent-reported communication and language abilities at 12 and 18 months using the MacArthur Communicative Development Inventory—Infant Form Words and Gestures (CDI-WG). The CDI-WG catalogs children’s understanding and production of words as well as their use of communicative and symbolic gestures and has been used extensively in research with both typically and atypically developing children. The CDI-WG has previously been shown to be an informative measure of early language and communication skills in ASD. Charman et al assessed 134 preschool children with autism using the CDI-WG and detected delays in all language and communication domains relative to population norms. Delays in word comprehension were more severe than delays in word production. Charman et al stratified their sample by chronological and nonverbal mental age when reporting CDI-WG scores to give some indication of development over time. However, it is important to emphasize that this was a cross-sectional study with no longitudinal component, in contrast with the study reported here.

We hypothesized that infant siblings who develop ASD would be significantly delayed in all CDI-WG domains compared with both non-ASD siblings and controls by age 12 months and would continue to show these delays at 18 months. Based on the increased incidence of language impairments in relatives of ASD probands, we also hypothesized that the non-ASD sibling group might have delays in early language skills when compared with controls.

METHOD

Participants

Participants included 97 infant siblings of children with autistic spectrum disorders (ASD) and 49 low-risk control infants. These infants are part of a larger cohort of siblings and controls participating in an ongoing longitudinal study of early development in ASD. This subgroup was selected on the basis of having completed follow-up to age 24 months. Siblings are recruited from the multidisciplinary autism
The CDI was designed to inventory parents’ responses to spoken language, with complete standardization data for infants and toddlers. It is used to assess the Communicative Development Inventory (CDI) and language abilities at 12 and 18 months using the MacArthur Communicative Development Inventory (CDI) Infant Form. The CDI was designed to inventory parent-reported information on the course of language and communication development in infants and toddlers. It is composed of 2 scales: the CDI Infant Form: Words and Gestures (CDI-WG) and the CDI Toddler Form: Words and Sentences. This study used only specific sections of the CDI-WG. The CDI-WG consists of 2 parts: I. Early Words and II. Actions and Gestures. Part I, Early Words, includes 4 sections. “First Signs of Understanding” inventories an infant’s first responses to spoken language. The parent is asked to indicate whether their infant seems to understand each of 3 commonly used phrases (e.g., “There’s Mommy”). “Phrases,” hereafter referred to as “Phrases Understood,” inventories an infant’s understanding of 28 phrases typically used in the context of interactions with infants (e.g., “Are you tired?” and “Time to go night-night.”). In “Starting to Talk,” parents are asked whether their infant has begun to imitate speech or to label familiar objects. The final section inventories single-word comprehension (“Vocabulary Comprehension”) and production (“Vocabulary Production”) from 19 semantic categories. A total of 396 words are inventoried for both comprehension and production. Parents are asked to mark words their child understands and/or produces.

Part II of the CDI-WG, Actions and Gestures, is composed of “Early Gestures,” which includes “First Communicative Gestures” and “Games and Routines,” and “Late Gestures,” which includes “Actions With Objects,” “ Pretending to be a Parent,” and “Imitating Other Adult Actions.” Early and Late Gestures are identified as such based on their relative onset in typical development. First Communicative Gestures catalogs gestures that reveal an infant’s first intentional communication. These gestures include showing items of interest, pointing, and waving. Games and Routines inventories an infant’s participation in common parent-child social routines. Active participation in routines such as “peek-a-boo” and “pat-a-cake” demonstrates an infant’s capacity for understanding their role in early social communicative interactions. The gestures cataloged in Actions with Objects reveal an infant’s knowledge of how objects in the environment are used. These gestures are more sophisticated than an infant’s undifferentiated “play” with objects seen earlier in development such as “banging” or “putting objects into the mouth.” This knowledge forms the foundation for the development of recognitory play gestures inventoried in the final sections: Imitating Other Adult Actions, which includes sweeping with a real or toy broom and pounding with a real or toy hammer; and Pretending to be a Parent, which catalogs the emergence of symbolic gestures and includes feeding, dressing, and bathing a stuffed animal or doll.

To summarize, 3 variables from Part I (Phrases Understood, Vocabulary Comprehension, and Vocabulary Production) and 2 variables from Part II (Early Gestures and Late Gestures) were used when reporting findings on the CDI-WG. Early Gestures includes First Communicative Gestures and gestures used in early Games and Routines; Late Gestures includes gestures used in the context of Actions with Objects, Pretending to be a Parent, and Imitating Other Adult Actions.

The CDI-WG was mailed to parents 2 to 3 weeks before their infants’ 12- and 18-month assessments, which were booked as closely as possible to these chronological ages. Parents returned the forms by mail or in person at the 12- and 18-month visits. Only the standard written instructions on the form were given. The CDI-WG is highly reliable and well validated with complete standardization data for infants. It is designed for 8 to 16 month olds, but has also been used to map the developmental trajectories of older children with ASD.

Preschool Language Scale–Third Edition and Mullen Scales of Early Learning. At 12 and 24 months, the expressive and receptive language skills of participants were assessed using the relevant subscales of the Preschool Language Scale–Third Edition (PLS-3) or the Mullen Scales of Early Learning (MSEL).

The PLS-3 is an individually administered measure of receptive and expressive language and communication abilities, which has been validated for use with children between the ages of 2 weeks and 6 years, 11 months. Internal consistency, test-retest reliability, and inter-rater reliability are excellent.

The MSEL is an individually administered measure, which evaluates 5 developmental domains (visual reception, receptive and expressive language, and fine motor). Test-retest reliability and inter-rater reliability are excellent for the MSEL. The PLS-3 was used during the first 2 years of our study, but the MSEL was subsequently adopted. The PLS-3 Expressive Communication and Auditory Comprehension subscale scores are highly correlated with analogous subscale scores of the MSEL; hence, standard scores obtained across measures are comparable for longitudinal analyses.
Table 1a. Preschool Language Scale-3 and Mullen Scales of Early Learning Standard Scores by Group at 12 Months

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>PLS-3 Auditory Comprehension</td>
<td>79.00 (7.66)</td>
<td>98.15 (10.65)</td>
<td>98.33 (9.69)</td>
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<tr>
<td>PLS-3 Expressive Communication</td>
<td>84.00 (11.58)</td>
<td>97.85 (12.61)</td>
<td>99.2 (7.93)</td>
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<td>MSEL Receptive Language</td>
<td>87.75 (17.30)</td>
<td>98.36 (12.44)</td>
<td>101.26 (13.37)</td>
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<tr>
<td>MSEL Expressive Language</td>
<td>87.38 (16.49)</td>
<td>104.91 (17.05)</td>
<td>104.40 (18.07)</td>
</tr>
</tbody>
</table>


(1) $F_{2,36} = 6.33, p < .01$; (2) $F_{2,36} = 2.72, p = .08$; (3) $F_{2,108} = 4.67, p = .01$; (4) $F_{2,108} = 5.68, p < .01$.

Table 1b. Preschool Language Scale-3 and Mullen Scales of Early Learning Standard Scores by Group at 24 Months

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>PLS-3 Auditory Comprehension</td>
<td>74.50 (10.61)</td>
<td>106.40 (18.96)</td>
<td>97.67 (6.89)</td>
</tr>
<tr>
<td>PLS-3 Expressive Communication</td>
<td>85.00 (33.94)</td>
<td>102.80 (15.80)</td>
<td>96.00 (10.33)</td>
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<tr>
<td>MSEL Receptive Language</td>
<td>63.46 (16.94)</td>
<td>106.00 (18.42)</td>
<td>118.03 (12.72)</td>
</tr>
<tr>
<td>MSEL Expressive Language</td>
<td>72.30 (20.20)</td>
<td>103.22 (16.10)</td>
<td>106.98 (19.39)</td>
</tr>
</tbody>
</table>


(1) $F_{2,15} = 3.64, p = .05$; (2) $F_{2,15} = 1.11, p = .36$; (3) $F_{2,138} = 57.85, p < .01$; (4) $F_{2,138} = 23.07, p < .01$.

Diagnostic Assessment at Twenty Months

Diagnosis at 24 months was based on the Autism Diagnostic Observation Schedule (ADOS) and best clinical judgment of an expert clinician (J.B., L.Z., or S.B.) using DSM-IV-TR (Text Revision). The ADOS is a structured play schedule consisting of several activities designed to elicit the behaviors diagnostic of ASD. The schedule provides a well-operationalized coding system for a wide range of social and communicative behaviors in children 18 months and older. Recommended cutoff scores reliably distinguish children with ASD from typical and developmentally disabled nonautistic controls.

We assessed the stability of the 24-month clinical diagnoses relative to diagnostic classification based on stringent research criteria (Autism Diagnostic Interview—Revised, ADOS, and DSM-IV-TR) in children within the smaller subsample who had been followed to at least 36 months. Diagnoses at 36 months were given by independent expert clinicians blind to the results of children’s earlier assessments. Agreement between 24- and 36-month diagnoses is very good (kappa = 0.64, $p < .01$). Relative to the 36-month diagnosis, our 24-month clinical assessment had a sensitivity of 70% and specificity of 98.4%. This indicates that although some diagnoses may be missed, “false positives” (i.e., children who were diagnosed at 24 months but not confirmed by independent assessment at 36 months) were rare. In fact, there was only 1 child who had a clinical diagnosis at age 24 months that was not confirmed at 36 months. For consistency, the entire sample is analyzed with respect to their 24-month diagnostic classification.

Analytic Plan

One-way analysis of variance (ANOVA), with post hoc pairwise comparison using Tukey’s honestly significant difference (HSD) test, was conducted to compare the 3 groups: (1) younger siblings who met diagnostic criteria for ASD at 24 months of age (hereafter referred to as “ASD sibs”), (2) younger siblings who did not meet diagnostic criteria for ASD at 24 months of age (hereafter referred to as “non-ASD sibs”), and (3) low-risk controls (none of whom had ASD).

RESULTS

Sample Description

Participants ranged in age from 11 to 15 months at the first (“12-month”) assessment and from 17 to 21 months at the second (“18-month”) assessment. Sex distribution across the 3 groups was as follows: autistic spectrum disorders (ASD) sibs (n = 15; 10 male, 5 female), non-ASD sibs (n = 82; 41 male, 41 female), and low-risk controls (n = 49; 27 male, 22 female).

Preschool Language Scale—Third Edition (PLS-3) and Mullen data at 12 and 24 months are reported in Tables 1a and 1b, respectively. At both 12 and 24 months, groups differed significantly on PLS-3 Auditory Comprehension (PLS-AC), Mullen Receptive Language (MSEL-RL), and Mullen Expressive Language (MSEL-EL) standard scores. Tukey’s post hoc analyses revealed the following significant contrasts at 12 months: ASD-sibs differed significantly from non-ASD sibs on all 3 variables (PLS-AC: mean difference = −19.15, $p < .01$; MSEL-RL: mean difference = −10.6, $p = .04$; MSEL-EL: mean difference = −17.54, $p < .01$); ASD-sibs differed from controls on PLS-AC and MSEL-RL (mean difference = −19.33 and −13.51, respectively, both $p’s < .01$). At 24 months, the following contrasts were significant: ASD-sibs versus non-ASD sibs continued to differ on all 3 variables (PLS-AC: mean difference = −31.90, $p = .04$; MSEL-RL and MSEL-EL: mean difference = −42.63 and −30.92, respectively,
both $p$’s < .01); ASD-sibs also differed from controls on both Mullen variables (mean difference = −54.57 and −34.68 for MSEL-RL and MSEL-EL, respectively, both $p$’s < .01); and non-ASD sibs differed from controls on MSEL-RL (mean difference = −11.94, $p$ < .01). Groups differed significantly on the Autism Diagnostic Observation Schedule (ADOS) scores at 24 months (all $p$’s < .01; Table 2). Post hoc analyses revealed significant differences between all groups for all domains (all $p$’s < .01) except for Play, in which the non-ASD sibs did not differ from low-risk controls (mean difference = 0.37, $p$ = .12).

**Primary Analysis**

**Significant Main Effects.** Means and standard deviations for the 5 Communicative Development Inventory (CDI) variables by group at the 12- and 18-month assessments are presented in Tables 3a and 3b, Figures 1 and 2, respectively. At the 12-month assessment, significant main effects for group were found for the number of Phrases Understood [F(2,144) = 6.12, $p$ < .01; $\eta^2$ = 0.08], Early Gestures [F(2,143) = 9.40, $p$ < .01; $\eta^2$ = 0.12] and Late Gestures [F(2,143) = 7.52, $p$ < .01; $\eta^2$ = 0.10]. At the 18-month assessment, significant main effects were found for all variables: Phrases Understood [F(2,139) = 27.39, $p$ < .01; $\eta^2$ = 0.28], Vocabulary Comprehension, [F(2,140) = 11.71, $p$ < .01; $\eta^2$ = 0.14], Vocabulary Production [F(2,140) = 4.01, $p$ = .02; $\eta^2$ = 0.05], Early Gestures [F(2,139) = 18.26, $p$ < .01; $\eta^2$ = 0.21] and Late Gestures [F(2,139) = 21.85, $p$ < .01; $\eta^2$ = 0.24].

**Post hoc Analyses.** Tukey’s honestly significant difference (HSD) test revealed that, at 12 months, the ASD group differed from both non-ASD sibs and controls on the number of Phrases Understood (mean difference = 5.45 and 5.68, respectively, both $p$’s < .01) and in Early Gestures (mean difference = 2.78 and 3.14, both $p$’s < .01) and Late Gestures (mean difference = 5.82, $p$ = .009; and mean difference = 7.89, $p$ < .01). There were no significant differences between the non-ASD sib and control groups on any of the 5 variables at the 12-month assessment.

At the 18-month assessment, children with ASD differed significantly from non-ASD sibs and controls on all variables: Phrase Comprehension (mean difference = 9.75 and 12.11 for non-ASD sibs and controls, respectively, both $p$’s < .01); Vocabulary Comprehension (mean difference = 94 and 116.9, both $p$’s < .01); Vocabulary Production (mean difference = 40.82, $p$ < .05; and mean difference = 51.24, $p$ = .02); Early Gestures (mean difference = 4.13 and 4.8, $p$’s < .01); and Late Gestures (mean difference = 9.78 and 15.15, $p$’s < .01). The non-ASD sib and control groups did not differ on any of the variables except for Late Gestures, with the non-ASD sibs producing fewer Late Gestures than controls (mean difference = 5.37, $p$ < .01).

To explore whether differences in Late Gestures between non-ASD sibs and controls might have been driven by the presence of children with delayed language in the non-ASD sib group, an exploratory analysis was conducted. The goal was to directly compare non-ASD sibs to controls while removing the potential confound of children with language delays. For this analysis, we constructed a new group of children who met the criteria for Delayed Language at 24 months of age (n = 15; 11 non-ASD sibs and 4 controls) and excluded this group from subsequent analyses. Delayed Language was defined by receptive and/or expressive scores at least 1.5 SD below the mean, as measured by the PLS-3 or the Mullen Scales of Early Learning (MSEL). Although we acknowledge that children with delays only in the expressive domain (n = 4) might be considered to be merely “late talkers,” all 4 of those who were excluded from the secondary analysis had a significant split (≥33 points) between their receptive and expressive language standard scores. We then directly compared non-ASD sibs with controls using a 1-way ANOVA and Tukey’s HSD post hoc tests.

**Significant Main Effects.** Means and standard deviations for the 5 CDI Infant Form: Words and Gestures (CDI-WG) variables were recalculated. Even with the Delayed-Language children excluded, the difference between non-ASD sibs (mean = 26.59, SD = 8.28) and controls (mean = 31.36, SD = 7.67) remained significant for Late Gestures at 18 months [F(1,103) = 8.57, $p$ < .01; $\eta^2$ = 0.08]. No other significant effects emerged.

**DISCUSSION**

Parents of children with autism, upon retrospective interview, almost always recall early signs of atypical development before receiving a diagnosis of autistic spectrum disorders (ASD)."
also evident in reviews of early home videos.\textsuperscript{17–21} The present study sought to prospectively document parent-reported communication and language abilities in infants with an older sibling with autism to determine whether signs of atypical development are evident as early as 12 months of age in infants who go on to develop ASD. We also examined the nature of these communication and language differences to understand more about the language trajectories of children with ASD.

As expected, and consistent with retrospective reports and analyses of early home videos, our prospective data derived from parent reports implicate delays in the very early language and communicative development of children diagnosed with ASD. Specifically, relative to both non-ASD siblings and typical controls, the ASD group was reported to understand significantly fewer phrases and to produce fewer Early and Late Gestures by 12 months. Items inventoried in the Phrases Understood domain do not evaluate children’s understanding of the appropriate reproduction of this article is prohibited.

The Late Gestures domain of the CDI-WG inventories communicative gestures, effectively representing a child’s knowledge of the appropriate use of real and toy objects (“Eat with a spoon,” “Put telephone to ear”) and emerging symbolic gestures (representing pretend play). Atypical play with toys\textsuperscript{3} and limited spontaneous imitation of others’ actions\textsuperscript{3} are well documented in children with autism. Not unexpectedly then, by as early as 12 months, children with ASD are reported to produce fewer recognitory and symbolic gestures than children in the non-ASD and control

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### Table 3a. Means (Standard Deviation) and Ranges for Age and MacArthur Communicative Development Inventory Variables (Raw Scores) by Group at 12 Months

<table>
<thead>
<tr>
<th></th>
<th>ASD Sibs (n = 15)</th>
<th>Non-ASD Sibs (n = 82)</th>
<th>Controls (n = 45)</th>
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<tr>
<td></td>
<td>Mean (SD) Range</td>
<td>Mean (SD) Range</td>
<td>Mean (SD) Range</td>
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<tr>
<td>Chronological age at assessment (months)</td>
<td>13.00 (1.0) 11–15</td>
<td>12.77 (0.9) 11–15</td>
<td>12.45 (0.68) 11–14</td>
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<tr>
<td>Phrases Understood</td>
<td>7.40 (5.32) 0–19</td>
<td>12.85 (6.18) 1–27</td>
<td>13.08 (5.32) 3–23</td>
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<tr>
<td>Vocabulary Comprehension</td>
<td>55.0 (55.9) 5–228</td>
<td>70.79 (53.80) 2–244</td>
<td>64.02 (46.4) 3–207</td>
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<tr>
<td>Vocabulary Production</td>
<td>2.20 (3.19) 0–12</td>
<td>8.93 (13.93) 0–99</td>
<td>6.41 (7.00) 0–28</td>
</tr>
<tr>
<td>Early Gestures</td>
<td>7.33 (2.35) 4–13</td>
<td>10.11 (2.48) 4–16</td>
<td>10.47 (2.58) 4–17</td>
</tr>
<tr>
<td>Late Gestures</td>
<td>7.40 (4.39) 1–17</td>
<td>13.22 (7.08) 0–29</td>
<td>15.29 (7.18) 1–27</td>
</tr>
</tbody>
</table>

ASD indicates autistic spectrum disorders; ASD-sibs, younger siblings who met diagnostic criteria for ASD at 24 months of age; non-ASD-sibs, younger siblings who did not meet diagnostic criteria for ASD at 24 months of age.

(1) $F_{2,144} = 3.33, p = .04$; (2) $F_{2,144} = 6.12, p < .01$; (3) $F_{2,144} = 0.70, p = .50$; (4) $F_{2,144} = 2.66, p = .07$; (5) $F_{2,143} = 9.40, p < .01$; (6) $F_{2,143} = 7.52, p < .01$.

### Table 3b. Means (Standard Deviation) and Ranges for Age and MacArthur Communicative Development Inventory Variables (Raw Scores) by Group at 18 Months

<table>
<thead>
<tr>
<th></th>
<th>ASD Sibs (n = 17)</th>
<th>Non-ASD Sibs (n = 80)</th>
<th>Controls (n = 45)</th>
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<td>Mean (SD) Range</td>
<td>Mean (SD) Range</td>
<td>Mean (SD) Range</td>
</tr>
<tr>
<td>Chronological age at assessment (months)</td>
<td>18.65 (0.86) 18–20</td>
<td>18.49 (0.79) 17–21</td>
<td>18.71 (0.90) 17–21</td>
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<tr>
<td>Phrases Understood</td>
<td>12.00 (7.80) 0–28</td>
<td>21.75 (5.81) 3–28</td>
<td>24.11 (4.85) 9–28</td>
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<tr>
<td>Vocabulary Comprehension</td>
<td>92.76 (74.43) 1–260</td>
<td>186.77 (88.40) 25–390</td>
<td>209.76 (84.32) 29–359</td>
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<tr>
<td>Vocabulary Production</td>
<td>21.12 (34.10) 0–130</td>
<td>61.94 (60.08) 0–356</td>
<td>72.36 (77.74) 1–320</td>
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<tr>
<td>Early Gestures</td>
<td>9.18 (4.07) 2–16</td>
<td>13.31 (2.47) 5–18</td>
<td>13.98 (2.98) 3–18</td>
</tr>
<tr>
<td>Late Gestures</td>
<td>16.24 (9.46) 8–35</td>
<td>26.01 (8.16) 5–43</td>
<td>31.39 (7.39) 13–46</td>
</tr>
</tbody>
</table>

ASD indicates autistic spectrum disorders; ASD-sibs, younger siblings who met diagnostic criteria for ASD at 24 months of age; non-ASD-sibs, younger siblings who did not meet diagnostic criteria for ASD at 24 months of age.

(1) $F_{2,139} = 1.04, p = .36$; (2) $F_{2,139} = 27.39, p < .01$; (3) $F_{2,140} = 11.71, p < .01$; (4) $F_{2,140} = 4.01, p = .02$; (5) $F_{2,139} = 18.26, p < .01$; (6) $F_{2,139} = 21.85, p < .01$. 

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FIGURE 1. MacArthur Communicative Development Inventory (CDI) subscale scores at 12 months by clinical diagnosis at 24 months. ASD indicates autistic spectrum disorders.
FIGURE 2. MacArthur CDI subscale scores at 18 months by clinical diagnosis at 24 months.
groups. Notably, we provide prospective evidence that by 12 months, children with ASD use fewer gestures, as indexed by the constructs of Early and Late Gestures.

No significant differences were found among the 3 groups for either Vocabulary Comprehension or Production at 12 months. Floor effects may have contributed to the null group effects for Vocabulary Production at 12 months, as typically developing children are expected to produce only 2 to 11 words at this age. However, it is unlikely that such effects account for the nonsignificant group finding for Word Comprehension. At 12 months, children are expected to understand an average of 28 to 112 words. Although not evident initially (i.e., at 12 months), at 18 months, the ASD group was reported to understand and produce fewer words than either the non-ASD siblings or the controls. Moreover, the group effects in Phrases Understood and Early and Late Gestures observed at 12 months remained. Thus, with the exception of Phrases Understood, which, as discussed above, may index social responsiveness rather than true language comprehension, the present findings indicate that delays in gestural use may be detected before delays in language in children with ASD. These findings are consistent with evidence of a strong relationship between the use of early gestures and the development of vocabulary comprehension and production. Future studies might explore the putative relationship between the two in children with ASD by systematically examining the developmental changes in word comprehension and production at intervals between 12 and 18 months.

The non-ASD siblings did not differ from controls at 12 months on any of the variables measured. However, at 18 months, the non-ASD siblings produced fewer Late Gestures than controls. We initially wondered if this group difference resulted from the presence of children with language delays in the non-ASD sib group, given that this is a known risk in siblings of children with ASD. Therefore, we performed an additional analysis with children with delayed language (as indexed by the Preschool Language Scale—Third Edition [PLS-3] or the Mullen Scales of Early Learning [MSEL] at 24 months) excluded from both groups. Unexpectedly, the group effect remained; hence, delays in the production of Late Gestures in siblings of children with ASD were, at least to some extent, independent of the presence of ASD or overall language delays. Although such findings require further systematic study and replication, it may be that some younger siblings of children with ASD show early indications of a “broader phenotype” that includes nonverbal communication delays. Ongoing longitudinal follow-up of our sample will allow us to investigate whether late gesture usage at age 24 months is predictive of later social-communicative functioning among the siblings who are not diagnosed with ASD.

Evidence that signs of communication and language delays can be present as early as 12 months in infants subsequently diagnosed with ASD has potentially important clinical implications. Clinicians may not become immediately concerned when a child presents with delays in language at this young age largely because of the wide range of typical development expected at 12 months.

Our findings suggest that it may be prudent to monitor more closely infants who are at high risk for developing ASD. Specifically, given that understanding and production of words did not differentiate the ASD group until 18 months, gesture development may actually be more informative than word production and comprehension in high-risk infants before 18 months. To evaluate the potential utility of monitoring early gestures at 12 months, we examined all scores that fell more than 1.5 SD below the mean (relative to published norms) for Early Gestures at 12 months. Five of 15 sibs who received an ASD classification at 24 months fell below that cutoff, versus only 3 of 82 sibs who were not classified as ASD at 24 months. Therefore, using this criterion (−1.5 SD) as a potential predictor of ASD in this high-risk sample, the sensitivity is 33.3% (5 of 15) and specificity is 96.3% (79 of 82). The relative risk of ASD given early gestures below this cutoff at 12 months is 5.6 (95% confidence interval [CI] = 2.5−12.3). Although sensitivity is too low to rely on this alone as a screening strategy, clinicians should monitor for delays in gesture usage as part of routine developmental surveillance because these delays may be among the earliest signs of ASD. Moreover, evidence suggests that gestures serve as a “bridge” for later word production.

It is likely that other developmental domains including play, imitation, and motor skills are relevant to risk for ASD in high-risk infants. We would propose that intervention should be initiated as soon as significant developmental concerns are identified, which, based on the current findings, may be long before a diagnosis is confirmed.

The present findings are limited by the uncertain stability in diagnostic status of children aged 24 months. A small proportion may be misclassified as having ASD, and, conversely, we anticipate that some of the children designated as non-ASD at 24 months will be diagnosed subsequently with ASD. As we follow the remainder of our infant sibling cohort to age 3, we will be able to address this issue more directly and provide additional data on the communication and language developmental trajectories of this unique sample. In the meantime, this prospective study has identified communication and language delays as early as 12 months of age in infants who subsequently receive a diagnosis of ASD, thus confirming retrospective parent reports. Future research is warranted to document more systematically the early developmental trajectories of children at high risk for either ASD or language impairment to draw more definitive conclusions about the communication and language profiles that distinguish them from both typical children and those with other developmental disorders.

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