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# Predicting language and social outcomes at age 5 for later-born siblings of children with autism spectrum disorders

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## Abstract

The relation between early joint attention (in which a child coordinates attention between another person and an object or event) and later language and social outcomes was examined in younger siblings of children with autism spectrum disorder (Sibs-ASD) and younger siblings of children with typical development (Sibs-TD). Initial levels of joint attention (at a mean age of 15 months) as well as growth in levels of joint attention (between 15 months and 34 months) were used as potential predictors of outcomes at age 5. The results revealed that initial levels of initiating joint

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attention (IJA) were associated with language skills at outcome. In addition, growth of responding to joint attention (RJA) was associated with social skills at age 5. These patterns of associations were not significantly different between the Sibs-TD and Sibs-ASD groups. Although the Sibs-ASD group had lower joint attention scores than the Sibs-TD group at younger ages, significant group differences were not found for most measures at age 5.

### Keywords

joint attention, social skills, language, longitudinal, younger siblings of children with ASD

Autism spectrum disorders (ASD) are considered among the most heritable of neurodevelopmental disorders, with early twin studies estimating heritability as high as 90% (Bailey et al., 1995). Although a more moderate role for genetic heritability has been found in a recent study (Hallmayer et al., 2011), concordance rates are high even among dizygotic twins, who share only 50% of their genes. Estimates of recurrence rates for autism in non-twin siblings of children with ASD have historically ranged between 3% and 20% (e.g., Yirmiya and Charman, 2010; Zwaigenbaum et al., 2009), and a recent large-scale, multi-site prospective-longitudinal study found a recurrence rate of 18.7% (Ozonoff et al., 2011). Although the relative contributions of genetic and environmental factors (and their interaction) are not yet completely clear, the elevated risk of ASD in later-born siblings of children with ASD has led to a wave of longitudinal research examining children at elevated genetic risk from infancy to early preschool age, when the diagnosis of ASD achieves stability (Turner and Stone, 2007). This methodology of attempting to index behavioral features of ASD *before* a diagnosis is made affords a prospective examination of specific developmental pathways and risk factors potentially tied to particular aspects of the broader ASD phenotype, including social and language skill development and impairment.

Family members of individuals with ASD are not only at elevated risk for ASD, but also for milder expressions of ASD (e.g., Bolton et al., 1994). When contrasted with siblings of typically developing children (Sibs-TD), siblings of children with ASD (Sibs-ASD) as a group have been found to demonstrate a number of early behavioral differences (see Rogers 2009 for a comprehensive review), with joint attention differences among the most replicated findings. Joint attention refers to a triadic exchange in which a child coordinates attention between a social partner and an aspect of the environment (Mundy and Stella, 2000). *Initiating* joint attention (IJA) is a type of expressive communication involving use of eye contact, gesture, and/or vocalization to spontaneously share interest or enjoyment in an object or event with another person (e.g., pointing to or showing an object while looking back and forth from this object to a social partner) (Mundy and Stella, 2000; Seibert et al., 1982). *Responding to* joint attention (RJA) involves following the attentional cues initiated by others, such as looking in the direction that a social partner is pointing. In typical development, both of these skills emerge during the first year of life (Carpenter et al., 1998).

Joint attention differences may have important developmental consequences because early joint attention has been found to predict later language and social outcomes in children with typical development (TD), as well as those with ASD and other disorders. Empirical evidence suggests that IJA abilities are linked predictively to language skills in TD and ASD (e.g., Charman et al., 2003; Mundy and Gomez, 1998; Stone and Yoder, 2001; Ulvand and Smith, 1996). Predictive relations have also been found for RJA and later language in TD and ASD (e.g., Carpenter et al., 1998; Morales et al., 2000), and preliminary support for a predictive relation in Sibs-ASD was obtained by Sullivan and colleagues (2007). Empirical evidence also indicates that early IJA and RJA

abilities are both predictively associated with greater social competence and fewer externalizing problems in infants with TD (Van Hecke et al., 2007) and in cocaine-exposed infants (Sheinkopf et al., 2004). Longitudinal relations between RJA and social outcomes have also been found in Sibs-ASD (Yoder et al., 2009). In that study, RJA ability at a mean age of 15 months predicted degree of social aptness at a mean age of 34 months. Moreover, the *growth rate* of a measure of initiating communication was also associated with social outcomes.

The relation between joint attention and later language development may be attributable to the communicative function of joint attention. Engaging in joint attention may indicate a desire to share mental states or experiences with others (Mundy, 1995), which has been described as the primary motivation to learn to talk (Bloom, 1993). Similarly, the relation between joint attention and social development may reflect the inherently social nature of joint attention; that is, children who show increased desire and capacity to engage in positive social interactions may have increased opportunities for learning the subtle rules and expectations that guide social exchanges. In addition, joint attention has been described as a precursor to social cognition, and as an early step in the process of perceiving and understanding others' intentions and cognitions (e.g., Tomasello, 1995), such as is required for Theory of Mind.

Despite initial support for predictive relations between early joint attention and later social and language functioning in Sibs-ASD (Sullivan et al., 2007; Yoder et al., 2009), most infant sibling research has yet to follow cohorts of children beyond the preschool years. To date only one group (Gamliel et al., 2007; Gamliel et al., 2009) has reported on the developmental trajectory of Sibs-ASD past 4 years of age. They found that Sibs-ASD who showed early differences from Sibs-TD in language continued to exhibit some language differences at 54 months (Gamliel et al., 2007). Moreover, at age 7, increased numbers of Sibs-ASD showed language deficits relative to Sibs-TD (Gamliel et al., 2009), suggesting that school age may be a period when language difficulties become more apparent in the face of academic demands.

The purpose of the present study was to examine the extent to which initial levels and growth trajectories of RJA and IJA during the toddler to preschool years predict later social and language outcomes in Sibs-ASD and Sibs-TD. We expected that both IJA and RJA would be positively related to language and social outcomes across groups. In addition, we predicted group differences in social and communicative abilities at age 5, as these differences have been reported at younger ages.

The present study offers a unique contribution to the literature on the development of Sibs-ASD in three ways. First, it examines the developmental trajectory of Sibs-ASD over a longer time span in development and to a later chronological age than has been investigated previously in all but one study (i.e., Gamliel et al., 2009). As a result, this study provides critical information about the developmental trajectory and longer-term outcome of Sibs-ASD who are identified at early ages as showing characteristics related to autism symptomatology. Second, the present study uses a longitudinal approach (growth modeling) to account for the considerable effect that individual differences in initial status and growth rates of joint attention have on developmental course and for variations in developmental outcomes. Finally, this study examines predictive relations between different types of early joint attention skills (RJA and IJA) and later language and social outcomes, thus exploring the potential implications of early differences in the development of each skill for later outcomes.

## Method

### *Participants*

Participants were recruited from a previous study examining social orienting that included 54 later-born Sibs-ASD and 31 later-born Sibs-TD (see Yoder et al., 2009 for original recruitment and

**Table 1.** Mean (SD) chronological ages at each evaluation

Measurement period	Sibs-ASD n = 36	Sibs-TD n = 23
T1	14.81 (2.77)	16.26 (3.48)
T2	18.86 (2.97)	20.30 (3.31)
T3	23.06 (2.99)	24.18 (3.43)
T4	27.31 (3.13)	28.52 (3.98)
T5	33.57 (3.18)	34.73 (4.09)
Follow-up	63.56 (8.60)	65.65 (5.25)

eligibility criteria). In the original study, children participated in 5 visits (T1-T5), and IJA and RJA measures were administered every 4–6 months between the (mean) ages of 15 and 34 months (see Table 1). All participants were invited to return for a follow-up evaluation at age 5. Sixty-one families (72%) returned for the follow-up evaluation; this number included 38 (70%) Sibs-ASD and 23 (75%) Sibs-TD. Because our research questions involved growth trajectories, only children who participated in a minimum of three research visits in the original study were included in these analyses. This requirement excluded two participants from the Sib-ASD sample, resulting in a sample size of 36 for this group.

No significant differences were found for children who did and did not participate in the follow-up study for gender, T1 or T5 cognitive ability (the only time points it was measured), or T5 diagnosis,  $p$  values  $> .05$ . The only group differences found between returners and non-returners were the number of visits completed in the original study,  $\chi^2 = 13.70$ ,  $p = .001$  (wherein returners completed a higher proportion of original visits), and maternal education level,  $\chi^2 = 10.29$ ,  $p = .04$  (wherein mothers of returners had more schooling).

Participants in this study ranged from age 4 to age 7 ( $M = 5.36$ ,  $SD = .62$ ) at outcome. Thirty-five (59%) of the participants were male and 24 (41%) were female. Fifty-three (90%) were Caucasian, one (2%) was African American, one (2%) was Hispanic, and four (7%) were multi-racial. This sample overlapped with others reported on previously (75–86%; Presmanes et al., 2007; Stone et al., 2007; Yoder et al., 2009), but this report represents a longer follow-up period and has different aims.

The Sibs-ASD and Sibs-TD groups did not differ on gender,  $\chi^2 = .543$ ,  $p = .46$ , odds ratio = .67, or race,  $\chi^2 = 1.49$ ,  $p = .60$ . In addition, groups did not differ on chronological age (CA) at any time point (T1 CA,  $t = -1.78$ ,  $p = .08$ , Cohen's  $d = -.46$ , T2 CA,  $t = -1.73$ ,  $p = .08$ , Cohen's  $d = -.46$ , T3 CA,  $t = -1.29$ ,  $p = .20$ , Cohen's  $d = -.35$ , T4 CA,  $t = -1.26$ ,  $p = .21$ , Cohen's  $d = -.34$ , T5 CA,  $t = -1.19$ ,  $p = .24$ , Cohen's  $d = -.32$ ).

## Procedure

This study was approved by the university's institutional review board, and informed consent was obtained from parents before participation. Study data were managed using REDCap electronic data capture tools hosted at Vanderbilt University (Harris et al., 2009). Follow-up evaluations included parent and teacher reports and direct assessment of children's cognitive, language, and diagnostic status. Diagnostic assessment consisted of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and the Autism Diagnostic Interview-Revised (ADI-R; Lord et al.,

1994) in combination with DSM-IV-informed clinical diagnosis from an experienced, research-reliable clinician (i.e., meeting certification requirements). The ADOS and ADI-R were used for diagnostic purposes only and were not used as outcome measures given that they do not provide standard scores and that the purpose of the current study was to examine predictors of later language and social impairment relative to the performance expected for the child's age.

### *Predictive measures*

*Initiating Joint Attention (IJA).* IJA was indexed via the Screening Tool for Autism in Two-year-olds (STAT; Stone et al., 2000; Stone et al., 2004; Stone et al., 2008). The STAT contains 12 examiner-initiated activities, including four presses designed to elicit joint attention. Up to three trials are given for each item, and a pass/fail score is based on the child's best performance and determined according to specific criteria. Passing scores include behaviors such as pointing at an object and looking at the examiner, commenting about an event, or holding up and showing an object. The number of passes (0–4) was used as the variable of analysis. Inter-observer reliability was estimated using absolute-agreement intra-class correlation coefficients (ICC) based on independent codings from videotape of an average of 22% (SD = .01) randomly selected sessions per time period. The average ICC was .90 (SD = .13, range = .67–1.00) across both groups and all time points.

*Responding to Joint Attention (RJA).* During this task, children were provided with 20 opportunities to respond to the examiner's attempts to direct their attention to one of eight objects in an assessment room (see Presmanes et al., 2007). Ten different types of attention-eliciting prompts involving combinations of verbal and nonverbal cues (e.g., pointing with gaze-shift, calling the child's name and gaze-shift) were used. Each type of prompt was presented to the child twice, yielding a total of 20 RJA trials. The accuracy with which children located the target was coded by trained observers blind to both the examiner's cues and the designated target. A summary score for accuracy in looking at the target was derived and used in data analyses. Absolute-agreement ICCs were based on independent codings of an average of 21% (SD = 4.7) randomly selected sessions from each time period. The average ICC was .94 (SD = .06, range = .81–1.00) across both groups and all time points.

### *Outcome measures*

*Clinical Evaluation of Language Fundamentals – Preschool (CELF-P; Wiig et al., 2004); CELF- Fourth Edition (CELF-4; Semel et al., 2003).* The CELF is an individually administered measure assessing aspects of language that are fundamental to the development of effective communication skills (e.g., semantics, morphology, syntax, and auditory memory). The CELF-P was given to children between 4 and 6 years old ( $n = 57$ ), and the CELF-4 was given to the two children who were 7 years old. For both versions, the Core Language Score (CLS:  $M = 100$ ;  $SD = 15$ ) was the metric of general language ability used in analyses.

*Differential Ability Scales – Second Edition (DAS-II; Elliott, 2007).* The DAS-II is an individually administered measure of cognitive ability including verbal, nonverbal, and spatial domains. The Verbal Ability score ( $M = 100$ ;  $SD = 15$ ) was used in the current study to measure basic verbal skills, which primarily consisted of one-word expressive vocabulary and the ability to follow simple oral language commands.

*Social Skills Rating System (SSRS; Gresham and Elliott, 1990).* The SSRS is a norm-referenced scale that was completed by the child's parent and teacher. The preschool form was used for children under 5 and the elementary level form was used for children 5 and older. Respondents answered 40 questions using a 3-point response format based on how often the child displays a given behavior (0 = never, 1 = sometimes, 2 = very often). The SSRS provides a Total Social Skills Scale standard score ( $M = 100$ ,  $SD = 15$ ), which was used in the present study.

*Social and language aggregates.* Social and language measures were combined to form two separate aggregates (one for each construct) for use in analyses. Aggregates were formed to reduce the number of significance tests and improve the validity of the outcome variables. The use of aggregates of multiple measures reduces measurement error and allows a more valid and reliable assessment of the constructs being studied (Rushton et al., 1983). The Language aggregate comprised the CELF CLS and the DAS-II Verbal Ability score,  $r = .83$ ,  $p < .001$ . The Social aggregate comprised the SSRS Parent and Teacher questionnaires,  $r = .52$ ,  $p = .001$ . Aggregates were formed by averaging the standardized scores, creating z-scores, and transforming the aggregated scores to have a mean of 100 and a standard deviation of 15. SSRS Parent forms were available for 95% ( $n = 56$ ) of the sample, and SSRS Teacher forms were available for 64% ( $n = 38$ ). When both forms were not available, the Social construct was represented by a single SSRS score; aggregates were used for 64% ( $n = 38$ ) of the sample and individual scores were used for 31% ( $n = 18$ ). No SSRS outcome scores were available for the remaining 5% ( $n = 3$ ).

## Results

Two children in the Sibs-ASD group received a diagnosis of ASD at follow-up, and none of the Sibs-TD received a clinical diagnosis. Sibs-ASD with a diagnosis of ASD were included in analyses, as the primary goal of this study involved predicting social and language status of children at risk for ASD, and those who are ultimately diagnosed with ASD represent an important part of the continuum of potential outcomes for Sibs-ASD. However, primary analyses were also conducted excluding the two children with ASD to ensure that they were not contributing disproportionate amounts of the variance in initial or outcome variables, thus biasing the results as a whole. Importantly, all significant main findings described below remained significant in follow-up analyses when the two children with ASD were excluded; thus these children are included in all analyses reported.

### *Descriptive statistics for predictor and outcome variables*

Means and SDs for the predictor variables (i.e., IJA and RJA) are presented in Table 2. In general, the means for IJA and RJA demonstrate growth over time in both groups. Group differences were found for IJA at T1,  $t = 2.62$ ,  $p = .01$ ,  $d = .70$ , and for RJA at T1,  $t = 2.69$ ,  $p = .01$ ,  $d = .81$ , T3,  $t = 2.24$ ,  $p = .01$ ,  $d = .62$ , and T4,  $t = 2.63$ ,  $p = .01$ ,  $d = .74$ , with Sibs-TD displaying stronger skills than Sibs-ASD at each time point. Means and SDs for the outcome aggregates and the individual variables they include are presented in Table 3, along with ADOS and ADI-R scores that offer information to help characterize the extent of ASD-related symptoms in each group. Aggregate social and language scores did not differ between Sibs-ASD and Sibs-TD groups. Additional information about outcomes for this sample is reported by Warren et al. (2012).

**Table 2.** Means and SDs for predictor variables from time T1 to T5

Variable	Sibs-ASD			Sibs-TD		
	M	SD	n	M	SD	n
<b>IJA</b>						
T1*	0.89	0.95	36	1.57	0.99	23
T2	1.56	1.21	36	2.09	1.13	23
T3	2.06	1.37	34	1.91	1.38	22
T4	2.06	1.33	35	2.52	1.33	21
T5	2.50	1.23	36	2.73	1.08	22
<b>RJA</b>						
T1*	3.82	2.82	36	5.88	2.97	23
T2	5.05	3.20	36	6.35	3.47	23
T3*	5.65	3.38	34	7.61	2.93	22
T4*	5.44	3.03	33	7.63	2.90	21
T5	6.83	3.30	32	8.30	2.25	22

\*indicates group differences,  $p < .05$

**Table 3.** Means and SDs for outcome measures at age 5

Measure	Sibs-ASD			Sibs-TD			t-tests*	
	M	SD	n	M	SD	n	t	p
CELF CLS <sup>a</sup>	101.78	17.19	36	108.57	12.14	23		
DAS Verbal <sup>a</sup>	103.39	19.66	35	113.39	11.40	23		
SSRS-Parent <sup>b</sup>	100.75	15.28	36	101.85	13.81	20		
SSRS-Teacher <sup>b</sup>	108.60	13.23	20	110.79	13.74	14		
Social Aggregate	98.90	15.82	36	101.98	13.55	20	.73	.47
Language Aggregate	97.53	17.24	36	104.36	10.39	23	1.71	.09
ADOS-1 Total <sup>c</sup>	18.00	n/a	1	n/a	n/a	0		
ADOS-3 Total <sup>c</sup>	3.69	2.73	35	2.30	1.69	23		
ADI-R Total <sup>c, d</sup>	8.03	11.46	31	0.53	1.07	17		

ADI-R: Autism Diagnostic Interview - Revised (Lord et al., 1994), ADOS: Autism Diagnostic Observation Schedule, Modules 1 and 3 (Lord et al., 2000), CELF: Clinical Evaluation of Language Fundamentals (Semel et al., 2003; Wiig et al., 2004), CLS: Core Language Score, DAS: Differential Ability Scales (Elliott, 2007), SSRS: Social Skills Rating System (Gresham and Elliott, 1990).

<sup>a</sup>Measures used in Language Aggregate.

<sup>b</sup>Measures used in Social Aggregate.

<sup>c</sup>Provided for sample characterization purposes only.

<sup>d</sup>ADI-R Total score is obtained by summing the scores in Domains A, B, and C.

\*t-test provided for outcome aggregates only given study aims.

### *Hierarchical linear model fitting for IJA and RJA*

Growth in joint attention (IJA and RJA) over five points in time (T1-T5) was estimated using HLM (a type of regression model used to fit multilevel models and individual growth models), with age centered at the average age at the first evaluation (15.37 months). Linear models were fit for both IJA and RJA with Sibs-TD and Sibs-ASD combined. Large and highly significant t statistics were

**Table 4.** Linear growth models for IJA and RJA

Variable	Fixed effects			Random effects		
	Coefficient	SE	t	Variance	$\chi^2$	Reliability
<b>IJA</b>						
Intercept	1.34	.12	11.02**	.33	97.85*	.38
Slope	.07	.01	7.69**	.001	68.23	.11
<b>RJA</b>						
Intercept	4.90	.36	13.74**	5.05	169.19**	.64
Slope	.14	.02	5.97**	.006	78.63*	.21

\* $p < .05$ ; \*\*  $p < .001$ .

obtained for the fixed effects of the estimated intercept and slope values of IJA and RJA, suggesting that both intercept and slope parameters were needed for capturing mean growth trajectories (see Table 4). Additionally, deviance statistics for respective models indicated that random intercept, random slope models exhibited a significantly better fit than less complex models, IJA:  $\chi^2(3) = 58.81$ ;  $p < .001$ ; RJA:  $\chi^2(3) = 41.07$ ;  $p < .001$ .

Quadratic and cubic growth models were also considered for both IJA and RJA. While quadratic models exhibited a significantly better fit than the linear models, addition of more complex parameters decreased the reliabilities for intercept and slope considerably, and reliability estimates for the quadratic and cubic parameters were trivial. In addition, there was no significant variance in the quadratic or cubic terms, supporting the selection of linear functions for final models. HLM assumptions were tested and both models were found to be tenable; thus, ordinary least square (OLS) estimates for intercept and slope were extracted and used in subsequent analyses involving IJA or RJA.

### *Relation of early joint attention to social and language outcomes*

Regression analyses were used to examine the relation between early joint attention and later social and language outcomes. Neither age nor gender was correlated with any outcome variable or with intercept or growth of RJA or IJA; thus, both age and gender were considered to be non-significant predictors and were not included in the model. For the purposes of examining differences in the strength of relations between groups, product terms were created for respective interactions. Before each product term was created, predictor variables (e.g., IJA intercept, RJA growth) were grand-mean centered in order to minimize multicollinearity with the product term (Aiken and West, 1991). In all cases, the group and product terms were non-significant ( $p$  values  $> .05$ ), indicating no effect of group on the outcome aggregates and no variation by risk group in the association between the predictors and outcomes. As a result, the group and product terms were dropped from the model.

To examine relations between *initial* joint attention and later language and social aggregate outcomes, regression analyses were performed using the IJA and RJA intercepts from the fitted HLM models. These analyses revealed that initial IJA and RJA were both significantly and positively correlated with the Language aggregate score,  $R^2 = .19$  and  $R^2 = .07$ , respectively. Both JA predictors were then included in a single model to examine incremental validity of each predictor. Analyses revealed that only initial IJA remained a significant predictor of the language aggregate,  $\Delta R^2 = .14$ ; initial RJA became non-significant,  $p > .05$  (see Table 5).

**Table 5.** Results of multiple regression analysis predicting language and social skills

Predictors	R <sup>2</sup>	B	SE B	β	t	p
Models predicting language						
IJA Intercept	.19	6.57	1.82	.43	3.62	.001
RJA Intercept	.07	1.39	.69	.26	2.02	.048
IJA and RJA Intercepts						
IJA	.14	5.93	1.89	.39	3.13	.003
RJA	.02	.78	.67	.14	1.16	.251
IJA Growth	.01	17.85	25.50	.09	.70	.487
RJA Growth	.00	.31	10.52	.00	.03	.977
Models predicting social skills						
IJA Intercept	.00	1.74	2.06	.01	.09	.933
RJA Intercept	.01	.60	.72	.11	.83	.410
IJA Growth	.00	17.85	25.50	.09	.70	.487
RJA Growth	.09	23.42	9.99	.30	2.23	.023

Regression analyses examining questions regarding *growth* of JA were analogous to those used for questions regarding initial JA. These analyses revealed a significant positive relation only between RJA growth and the social aggregate,  $R^2 = .09$ . Because children's initial levels of RJA may be highly correlated with growth (e.g., children with initially high skills may have less room for growth), RJA intercept was added into the model as a covariate. This relation remained significant after controlling for intercept,  $R^2 = .15$ . All other analyses yielded non-significant findings,  $p$  values  $> .05$  (see Table 5).

## Discussion

The purpose of this study was to extend our knowledge about the relation between early joint attention abilities and later social and language competence in groups of children with and without risk for ASD. The results revealed similar patterns of relations between early joint attention and later social and language outcomes in Sibs-ASD and Sibs-TD, providing additional support for the robustness of these relations reported previously for other samples (e.g., Morales et al., 2000; Stone and Yoder, 2001; Van Hecke et al., 2007). Somewhat different patterns of predictive relations were found for RJA relative to IJA in this sample, highlighting the important distinction between these two aspects of joint attention and their developmental consequences.

### Social outcomes

Social outcomes were measured with a commonly used norm-referenced questionnaire, the Social Skills Rating System (Gresham and Elliott, 1990). Although measurement of RJA at a single point in time during the toddler years was not predictive of later social competence, the rate at which RJA skills developed over an 18-month period was positively associated with individual differences in social competence two years later (at age 5) in the pooled sample (across the Sibs-ASD and Sibs-TD samples). This longitudinal relation remained significant even after controlling for initial levels of RJA. These results highlight the importance of measuring change over time (rather than using single-point measures alone) in assessing and understanding predictive relations

between developmental domains. Importantly, the predictive relation between RJA growth and social outcome did not differ between groups, and occurred despite the fact that mean SSRS scores for both groups were within the average range at age 5.

As a group, Sibs-ASD had lower initial RJA scores than did Sibs-TD; this result remained even after excluding participants in the Sibs-ASD group who later received ASD diagnoses. Results indicating a similar predictive relation between RJA and social outcome across groups and average-range SSRS scores in Sibs-ASD as a group suggest that initial group differences in RJA may not have enduring negative effects, and point to the capacity for these at-risk children to become increasingly proficient in their ability to respond to the attentional directives of others over time. Although it is unclear from this study whether intervention contributed to these improvements, the observation of continued development and typical patterns for the emergence of developmental sequelae over time is encouraging.

In contrast, neither initial levels nor growth rates of IJA contributed to the prediction of social outcomes for this sample. At first glance this finding may seem surprising in light of previous results with an overlapping Sibs-ASD sample reporting a predictive relation between growth rate of early triadic communication (which subsumes IJA) and degree of later social impairment at age 34 months (Yoder et al., 2009). However, the triadic communication measure used in the previous study was a *weighted* measure of triadic communication, in which nonverbal instances of triadic communication were given the least amount of weight and intentional communication including a word or phrase was given more weight. The fact that this type of differentiation was not made in the current study may account for the difference in findings.

### Language outcomes

The language outcome measure contained an aggregate of two standardized clinical measures (CELF and DAS-II), to maximize its validity and reliability (Rushton et al., 1983). In contrast to findings for social outcomes, *initial* levels of joint attention, rather than growth rates, were predictive of language outcomes. In particular, both initial RJA and IJA predicted language competence at age 5. However, IJA seemed to be of distinct importance for language learning as it predicted language outcome over and above RJA. It is possible that the relation found between RJA and later language (when the predictive utility of IJA and RJA were examined separately) may be attributable to the fact that RJA depends on the ability to coordinate attention between object and person (Bakeman and Adamson, 1984), a feature it shares with IJA. What is unique about IJA and, in turn, what may make IJA a stronger predictor of later language, is that it reflects a child's desire to share the contents of his or her own mind (Bloom, 1993). Thus, it may be the case that a combination of the ability to coordinate attention between object and person and an intrinsic social motivation provides an optimal platform for language learning, as well as development of communication skills more broadly. Overall, these findings replicate previous research emphasizing the importance of early IJA for later language development, including one previous study using Sibs-ASD (Sullivan et al., 2007). Moreover, the present findings extend these results over a longer developmental time frame. Again, there was no indication of different patterns of relations for the Sibs-ASD and Sibs-TD groups, which highlights the robustness of this finding across samples and over extended follow-up periods.

The specific mechanisms by which joint attention may facilitate social and language development were not assessed directly in this study, but our findings are consistent with the notion of joint attention as a learning mechanism during early development (Mundy et al., 2009). Through the process of joint attention, a child begins to integrate his or her own visual attention with external

information about others' visual attention, which offers opportunities for experience, learning, and practice in areas related to social cognition, symbolic thought, and social competence (Mundy et al., 2009). With respect to RJA, continued growth and refinement in the ability to follow another person's reference of attention may represent a recursive process that, over time and with repeated practice, leads to more sophisticated social understanding and perspective-taking skills. Specifically, children who show increased growth in the accuracy of following another person's attention between 15 and 30 months may have increased motivation and/or ability to understand the interests of others, both of which may facilitate the development of social awareness and competence. In contrast, IJA is a form of communication through which children share their own thoughts and interests with others. As such, the level of IJA established by 15 months may be critical for enabling children to benefit from the language learning opportunities that occur through shared attention to objects and events during a specific developmental period. It is also quite possible that different results may have been found had children been studied during a different developmental period.

The Sibs-ASD in this follow-up study represent a subsample (85% overlap) of those in the original study (Stone et al., 2007) who were found to differ from their low-risk peers on a number of behavior measures. Despite these early developmental differences (which did not reach clinical levels), the current findings suggest comparable performance between Sibs-ASD and Sibs-TD on most social and language domains assessed via standardized measures at age five. Although it is possible that these results may be an artifact of differences between the families who did and did not return for follow-up (e.g., higher maternal education, or other unmeasured variables), the returners did not differ from the non-returners in terms of children's cognitive levels or diagnostic outcomes. Moreover, children in the Sibs-ASD group in this sample did show weaker performance in both IJA and RJA at the initial assessment period relative to Sibs-TD. Thus, these results suggest the use of caution in interpreting early differences between high- and low-risk sibling groups, as they may not always be indicative of future impairments. Similar conclusions were obtained by Young et al. (2009), who found that preferential attention to the mouth versus eye area of the face did not predict diagnostic outcome for Sibs-ASD, but did in fact predict *stronger* language skills. Thus in some cases, early behaviors that differ from those of low-risk peers may even be adaptive for Sibs-ASD.

Strengths of the present study include a prospective-longitudinal design that enabled us to estimate individual trajectories for each child via growth modeling, and a follow-up period extending into the early school years. Our results highlight the importance of assessing children's skill development over time (in addition to measurement at single time points), the different developmental associations for responding to and initiating joint attention with regard to social and language outcomes, and the similarities in patterns of relations between young children at high-risk and low-risk for ASD. Although future research should clarify other factors that predict later difficulties as well as delineate protective factors that mediate improvements in social-communication skills in Sibs-ASD, the present findings represent an important contribution to our understanding of younger siblings of children with ASD and their complex developmental trajectory.

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