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An Expanded View of Joint Attention: Skill, Engagement, and Language in Typical Development and Autism

Lauren B. Adamson, Roger Bakeman, and Katharine Suma
Georgia State University

Diana L. Robins
Drexel University

This study provides an expanded view of joint attention and its relation to expressive language development. A total of 144 toddlers (40 typically developing, 58 with autism spectrum disorder [ASD], 46 with developmental delay [DD]) participated at 24 and 31 months. Toddlers who screened positive for ASD risk, especially those subsequently diagnosed with ASD, had poorer joint attention skills, joint engagement during parent–toddler interaction, and expressive language. Findings highlight the dynamic relation between joint attention and language development. In the ASD and DD groups, joint engagement predicted later expressive vocabulary, significantly more than predictions based on joint attention skills. Joint engagement was most severely impacted when toddlers did not talk initially and improved markedly if they subsequently began to speak.

During the middle of the 2nd year, most toddlers have accumulated a substantial expressive vocabulary. Although there is considerable variability in when they start to take this major step toward language, by 2 years of age even relatively late talkers often demonstrate ample comprehension skills and produce dozens of different words (Thal, Bates, Goodman, & Jahn-Samilo, 1997). Passing these milestones indicates that a child is on a course toward mastering language and literacy. In contrast, faltering so early raises concerns not only about a child's current skills but also about whether later milestones will be reached in a timely manner.

Toddlers with autism spectrum disorder (ASD) present a particularly puzzling picture of early language delay. Although ASD is not primarily a language disorder, word learning is almost always markedly delayed (Tager-Flusberg, Paul, & Lord, 2005). Indeed, the lack of first words is often the first developmental concern noted by parents (Herlihy, Knoch, Vibert, & Fein, 2013), and it is the most common focus of intervention begun before ASD is diagnosed (Suma et al., 2016). However, language outcome in ASD is also remarkably heterogeneous. Although by early adulthood most individuals with ASD have acquired functional speech, a substantial minority remains minimally verbal (Pickles, Anderson, & Lord, 2014).

Language heterogeneity in children with ASD is likely rooted in infancy when ASD-related deficits affect first word learning. In their comprehensive review of research related to the integrity of lexical acquisition mechanisms in ASD, Arunachalam and Luyster (2016) argued persuasively that young children with ASD likely use the same mechanisms to acquire words as their typically developing (TD) peers, but they do so less efficiently, thus hampering their intake of language input and slowing or even

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Correspondence concerning this article should be addressed to Lauren B. Adamson, Department of Psychology, Georgia State University, Atlanta, GA 30303, USA. Electronic mail may be sent to ladamson@gsu.edu.

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impeding early word acquisition. As they note, the impact of joint attention skill deficits on early word learning is an excellent example of such a negative developmental cascade. According to social interactionist theories of early word learning (e.g., Bruner, 1983), joint attention skills allow a toddler to engage with caregivers who introduce them to language during interactions that are well suited to their current interests and communication level. Typically these skills are mastered by the beginning of the 2nd year (Carpenter, Nagell, & Tomasello, 1998; Mundy et al., 2007) so that they can be deployed as word learning begins. But joint attention skill development is markedly delayed in ASD (e.g., Dawson et al., 2004; Mundy, Sigman, & Kasari, 1990), and there is growing consensus (Adamson & Dimitrova, 2014; Charman, 2003; Mundy, 2016) that this deficit plays a pivotal role in limiting interactions that are crucial to subsequent language development.

There is now strong empirical support for this developmental scenario. Most notably, there is a vast literature on joint attention skills and language outcome (see Bottema-Beutel, 2016 meta-analysis), indicating that being able to respond to a partner's input is robustly associated with language outcome in children with ASD. More specifically, the skill of responding to joint attention bids (RJA) as measured on standardized assessments such as the Early Social Communication Scales (ESCS; Mundy, Delgado, & Hogan, 2003) correlates significantly with both concurrent and subsequent measures of the acquisition of words. In contrast, the skill of initiating joint attention (IJA), which is more markedly and persistently compromised in children with ASD than RJA, is associated primarily with current language; its predictive relation to language outcome is usually weak. There have also been a few studies probing whether the extent to which young children with ASD sustain joint engagement during interactions predicts vocabulary outcome. Here too there are indications that differences in language outcome are also linked to how often children sustain periods of supported joint engagement during which they focus on shared objects and events with their parent but do not attend overtly to the parent, especially when they also attend to symbols during these periods (Adamson, Bakeman, Deckner, & Nelson, 2012; Adamson, Bakeman, Deckner, & Romski, 2009) and when they reciprocate their partner's action or collaborate with the partner during their shared activity (Bottema-Beutel, Yoder, Hochman, & Watson, 2014). In contrast, coordinated joint engagement—periods when a child actively attends to the parent as well as their shared activity—has not been found to be a significant predictor of word learning, likely because it typically occurs far less often than supported joint engagement, and it almost never occurs when children with ASD and parents interact (Adamson et al., 2009; Bottema-Beutel et al., 2014).

These studies suggest that RJA skill and supported joint engagement influence the language development of both TD toddlers and young children with ASD. However, the evidence base is still too narrow and fragmented to document the impact of joint attention deficits and language delay characteristic of ASD at the end of the 2nd year, when most TD toddlers have mastered the rudiments of joint attention skills (Mundy et al., 2007) and have begun to talk during interactions. To solidify and extend this evidence base, we sought to broaden our view of joint engagement and joint attention skills at this age and to discern how beginning to talk may both be predicted by joint attention and transform early interactions.

One major challenge is that ASD is usually diagnosed well after this crucial period of language learning. In the study reported here, we overcame this challenge by recruiting toddlers and their parents from a community-based early screening and diagnosis project that screened for risk of ASD during a well-baby 18- or 24-month pediatric checkup. As part of this project, toddlers who screened positive for ASD risk participated in a clinical evaluation that almost always resulted in the child receiving either an ASD diagnosis or the identification of non-ASD developmental delay (DD). For the current study, we also recruited a TD group of screen-negative children of the same age from the same pediatric sites. Soon after screening—but before the clinical evaluation for the children in the at-risk group—and again approximately 6 months later, parent–child interactions were systematically observed and the child's joint attention skills and expressive language were assessed.

This design allowed us to gain an unprecedented early view of the relation between joint attention skills, joint engagement, and expressive language development in children with ASD in a community-based sample. It provides an important complement to genetic risk samples of young toddlers with siblings diagnosed with ASD. Moreover, it let us observe parent–toddler interactions before ASD was diagnosed and ASD-specific interventions were initiated. Furthermore, it allowed age-matched comparisons (as opposed to language-matched comparisons of older children with ASD and older children with DD to younger TD children) so that we could discern how variations in joint attention late in the

2nd year are related both to language use and language outcome in the middle of the 3rd year.

Joint Attention Skills and Joint Engagement

Our first aim was to broaden the view of joint attention from one that focuses primarily on toddlers' discrete joint attention skills and joint engagement states during interactions. First, we broadened the description of joint engagement in parent–toddler interactions so that we could document not only children's joint engagement states but also parents' support for shared activities and the overall dynamics of their exchange (Aim 1a). This expansion helps capture a fuller picture of what transpires during joint activities, which by definition entail a triadic arrangement between a person, his or her social partner, and a shared topic (Adamson & Bakeman, 1991; Werner & Kaplan, 1963). To document the parents' contribution to joint engagement, we characterized the quality of the parents' scaffolding of shared activities (e.g., Bruner, 1983) and the parents' following-in on the child's attention (e.g., Tomasello & Farrar, 1986) to probe how the partner is guiding the child toward crucial developmental accomplishments, including language. Additionally, to document the dynamics of the dyadic interaction, we characterized the flow of the shared activity in terms of its fluency and connectedness (Adamson et al., 2012). Of central interest was how well a parent and child used both nonverbal and verbal acts to stay on topic and to orchestrate the balanced turn-taking structure of a dialog, aspects of early exchanges that are a prelude to later sustained conversations about a shared topic (Nelson, 2008).

We expected to replicate not just the well-documented negative effect of ASD on joint engagement, primarily a toddler contribution, but also to show that ASD impairs the interaction's fluency and connectedness relative both to TD peers and to toddlers in the DD group who screened positive for ASD risk but were subsequently not diagnosed with ASD. However, we were less certain how ASD would affect the parent's contributions. To date, most studies indicate that parents of young children diagnosed with ASD and parents of language-comparable TD children provide their children with remarkably similar linguistic and communicative environments (Arunachalam & Luyster, 2016; Bang & Nadig, 2015). However, because we were comparing groups comparable in age and because we timed our initial observation before diagnosis, we hypothesized that parents in our ASD group would have more difficulty scaffolding the interaction and following-in on their child's focus than parents in either the TD group or the DD group.

The second issue related to the description of joint attention we addressed was the link between discrete joint attention skills and joint engagement during interactions (Aim 1b). The skill and engagement approaches to joint attention are often considered complementary views of shared attention (Adamson & Dimitrova, 2014; Bottema-Beutel, 2016; Mundy, 2016). The skills approach seeks to determine whether a child can use communicative acts such as points and gaze to accomplish declarative communicative functions related to sharing interest in objects and events, often using standardized assessments of RJA and IJA. In contrast, the engagement approach seeks to document the child's joint engagement experiences, often using systematic observational methods to document how states such as supported and coordinated joint engagement that capture the interactive contributions of both the child and the caregiver are sustained. But surprisingly few studies have explored the relation between children's performance during assessments of joint attention skill and observations of joint engagement during interactions. The literature is so thin that in Bottema-Beutel's (2016) meta-analysis of 71 reports on joint attention and language in ASD and TD groups there was only one published study (Markus, Mundy, Morales, Delgado, & Yale, 2000) that assessed both joint attention skills and joint engagement during parent–child interactions. Although this study was limited to TD infants, to one joint attention skill (RJA) and to only one aspect of joint engagement (the duration and frequency of episodes of coordinated joint engagement), its intriguing findings suggest that skills and interactions may make unique contributions to language development. Thus, as Markus et al. concluded, their results "demonstrate the need to look at antecedent processes, either within the context of infant–parent interaction or within infants themselves, in order to better understand the relation between episodes of joint attention and language development" (p. 313).

To fill this empirical gap, we compared RJA and IJA scores on the ESCS with ratings of various aspects of joint engagement during interactions. We hypothesized that, regardless of diagnostic group, RJA and ratings of supported joint engagement would be positively correlated because both depend heavily on the child's active apprehension of another person's actions. Moreover, we expected that

IJA would correlate positively with ratings of coordinated joint engagement because both capture the child's overt attention to a social partner as well as attention to shared objects. Moreover, because joint attention skills as well as coordinated and supported joint engagement are consolidated by age 2 in TD toddlers but may not be in toddlers who screen positive for ASD risk, we anticipated that joint attention skills and ratings of joint engagement at 24 months would be more strongly correlated for children with ASD and DD than for TD children. Finally, as an exploratory matter, given our expectation that RJA but not IJA would be linked to joint engagement during interaction generally, we examined associations of RJA and IJA with symbol-infused joint engagement (whether coordinated or supported), parent scaffolding, parent following-in, and the fluency and connectedness of the interaction.

Skills, Engagement, and Language

By design, our participants were selected based on their risk for ASD. We expected that toddlers at risk for ASD, especially those who were subsequently diagnosed with ASD, would have joint attention difficulties that would affect the use of language during interactions as well as language outcome. We examined the relation between joint attention difficulties and language in two complementary ways. First (Aim 2a), we asked how variations in joint attention skills and shared experiences during parent–toddler interactions predict expressive vocabulary outcome. To date, there is convincing evidence that early RJA skills predict vocabulary quite well but that IJA skills often do not, and so we anticipated that we too would find similar relations between skills at age 2 and vocabulary a half year later. Likewise based on previous studies, we anticipated that joint engagement observed during parent–toddler interaction would also be related to later expressive vocabulary. Here we also asked the new question of how skills and engagement might work together to predict language outcome. Our primary expectation was that information about joint engagement would add significantly to the prediction of language outcome over and above information about joint attention skills, more so for at-risk toddlers who presumably will have poorer joint attention skills than for TD toddlers. This pattern of findings would support intriguing claims that joint attention skills and experiences may be more crucial for first word learning than for later vocabulary development (Bottema-Beutel, 2016; Toth, Munson, Meltzoff, & Dawson, 2006).

Our second approach to the relation between joint attention and language (Aim 2b) was to ask whether and how joint engagement experiences might vary as a function of a child's use of language during interactions. A previous study (Adamson et al., 2012) found that joint engagement changed quite dramatically after TD toddlers and young children with ASD acquired a 50-word expressive vocabulary, a milestone that is often used as an indicator that a 2-year-old is not experiencing late language emergence (Zubrick, Taylor, Rice, & Slegers, 2007) and as a sign that word learning is accelerating (e.g., Goldfield & Reznick, 1990). After passing this milestone, toddlers were more likely to sustain periods of symbol-infused joint engagement, parents' scaffolding was stronger, and the overall fluency and connectedness of the dyad's exchange was higher. In the current study, we examined what occurred when a toddler passed the even earlier milestone of beginning to talk during interaction. We anticipated that not talking during an interaction would have a profound impact on joint engagement such that all aspects of joint engagement would be lower when toddlers were not yet talking than when they were producing even a relatively few words. Moreover, we expected that moving from not talking at the initial visit to using even a limited expressive vocabulary a half year later would have an impact on joint engagement such that it would be more similar to the joint engagement of toddlers who were already talking at the initial visit than toddlers who remained nonspeaking. Furthermore, we expected that if toddlers were still not talking during interactions by the middle of the 3rd year, joint engagement would remain or even become more compromised.

Method

Participants

Participants in the current study were recruited from an early ASD detection project (Robins et al., 2014) that screened for ASD risk in private pediatric practices and public primary care clinics in the metropolitan Atlanta area. Potential participants for the at-risk group were identified based on the caregiver's responses to the Modified Checklist for Autism in Toddlers–Revised, with Follow-Up (M-CHAT–R/F; Robins, Fein, & Barton, 2009). Families of children whose M-CHAT-R/F scores indicated risk for ASD were invited for a free clinical evaluation and, if the child was < 32.5 months old, the parent was also invited to participate in the research project reported here. A comparison TD group was recruited by contacting parents of children who screened negative on the M-CHAT–R/F at the same sites as participants in the at-risk group, attempting to balance between groups for child age, gender, minority status, and level of the mother's education. Included in the current study were 144 children: 104 who screened positive for ASD risk (68% boys) and 40 who screened negative (70% boys). An additional 6 children were recruited but then excluded, 5 because they screened positive but were subsequently diagnosed as TD and one who withdrew before the clinical evaluation was completed. Demographic details for the participants are given in Table 1.

Initial Visit, Evaluation, and Follow-Up Visits

Participant visits took place between January 2007 and October 2013. After screening (but before evaluation for the at-risk sample) parents and their children visited our laboratory for an initial visit. After this initial visit children who screened positive for ASD risk received a free diagnostic evaluation that was conducted by research-reliable licensed psychologists and other clinical personnel in a university clinic. The evaluation included standardized assessments for developmental disorders and gold standard ASD-specific assessments; final diagnosis was made by clinical best estimate using all available information from the evaluation session. Of the 104 at-risk toddlers, 58 received a diagnosis of ASD and 46 of DD. Specific DD diagnoses included global DD (n = 23, 14 boys), developmental language disorder (n = 9, 6 boys), epilepsy (n = 1, a boy), developmental coordination disorder (n = 1, a boy), and visual impairment (n = 1, a girl); an additional 11 children (6 boys) had notable developmental concerns that did not lead to a specific clinical diagnosis using *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV) criteria.

For participants in the at-risk sample, a follow-up visit was scheduled approximately a half year after the diagnosis (mean time between visits = 7.5 months, SD = 2.9, n = 78). In addition, participants who were < 36 months old at the first follow-up visit were invited for a second one,

Table 1
Child's Age, Gender, Language, and Ethnicity and Mother's Education

	Initial visit			First follow-up visit		
Statistic	ASD (n = 58)	DD (n = 46)	TD (n = 40)	ASD (n = 46)	DD (n = 32)	TD (n = 31)
Returned for first follow-up (%)	—	—	—	79	70	78
Mean child age (months)[a]	24.5	24.5	24.1	31.6	31.6	30.3
SD for mean child age	3.4	3.5	2.0	2.2	2.4	0.6
Range for child age	16–32	19–33	19–28	30–36	29–37	29–31
Male (%)	76	59	70	70	56	71
Not talking initially[b]						
Total sample (%)	88	54	15	—	—	—
Sample with follow-up visit (%)	87	56	13	—	—	—
Not talking at follow-up (%)[b]	—	—	—	43	25	0
Ethnicity						
Non-Hispanic White	40	52	50	41	63	48
Non-Hispanic Black	33	33	20	33	28	13
Asian	5	4	3	4	3	3
Mixed race	12	7	13	11	3	16
Hispanic	10	4	15	11	3	19
Mother education						
Less than high school (%)	10	9	0	2	6	0
Completed high school (%)	33	33	28	41	38	23
Bachelor's degree (%)	24	35	45	24	31	45
Graduate degree (%)	33	24	28	33	25	32

Note. Statistics are shown for the 144 dyads at the initial visit and for the 109 dyads who returned for the first follow-up visit. ASD = autism spectrum disorder; DD = developmental delay; TD = typically developing.
[a]The mean ages for the ASD and DD groups were the same for both the initial and the first follow-up visits when rounded to a 10th of a month. [b]See text for definition of *not talking*.

providing an additional opportunity to obtain scores for the analysis of language outcome (mean time between follow-up visits = 5.9 months, *SD* = 0.7, *n* = 50). For children in the TD sample, the study design included two laboratory visits, an initial one soon after screening and one follow-up visit (mean time between visits = 6.1 months, *SD* = 1.9, *n* = 31).

Observing Parent–Child Interactions

All children were observed at the initial and follow-up visits with the same partner using the Communication Play Protocol (CPP; Adamson, Bakeman, & Deckner, 2004; Adamson et al., 2009). The child's mother was almost always the partner (47, 44, and 39 in the ASD, DD, and TD groups, respectively), but there were also fathers (9, 2, and 1 in the ASD, DD, and TD groups, respectively) as well as 1 grandmother and 1 partner in the ASD group. This protocol produces seminaturalistic observations of parent–child interaction in a laboratory playroom during which the parent (as supporting actor) plays with the child (the star) so that we can observe how the child currently communicates. The play consisted of six 5-min scenes that probed three communicative contexts (social interacting, requesting, and commenting). Before each scene, the parent was given a cue card with the scene's plot (e.g., visiting an art gallery) and a few directorial suggestions (e.g., looking at pictures together) and relevant props (e.g., eight pictures). The CPP was video recorded using two cameras situated behind one-way mirrors.

The CPP interactions were systematically described using the Joint Engagement Rating Inventory (JERI; manual available upon request) that contains eighteen 7-point Likert scale items that characterized various aspects of joint engagement. The items were designed to span the range of possibilities likely to be observed during interactions with 18- to 30-month-old TD children as well as similarly aged and older children with developmental difficulties, including ASD (Adamson et al., 2012). As in previous studies (e.g., Hirsh-Pasek et al., 2015; Suma et al., 2016), a subset of JERI items was selected that are germane to our research questions. The definition and scale points for these seven items are presented in Table 2.

Ratings were made by trained research staff who were blind to the child's diagnosis, the child's scores on joint attention skills and language outcome, and the study's hypotheses. The CPP was divided into two 3-scene segments; segments were assigned to an observer who applied the JERI to each 5-min scene, completing one before proceeding to the next. To check agreement, at least 15% of each observer's corpus was independently rated by a second observer (stratified by diagnostic group; observers did not know which of their sessions were double coded). Agreement was assessed with weighted kappas (Cohen, 1968). The range of weighted kappas for ratings within 1 point on the 7-point rating scale was .78–.95, suggesting that observers were about 90% accurate and often much better (see Bakeman & Quera, 2011).

Measuring Joint Attention Skills

Joint attention skills were measured using the ESCS (Mundy et al., 2003), which assesses nonverbal communication skills and is normed for TD children between 18 and 30 months old and children with delay whose estimated language measure is in the same range. Scores are based on the child's behavior during a series of tasks presented by a trained examiner who, in our case, was blind to the child's diagnosis and to the study's hypotheses. The IJA score was the total number of initiating bids made by the child, combining the counts for bids that occurred during tasks with four interesting spectacles and spontaneous bids during the entire session. RJA was assessed by observing the child's performance on distal, or line of regard items, during which the examiner got the child's attention and then pointed to one of four posters that were located to the right, back-right, back-left, and left of the child. The RJA score—considered valid if at least four RJA items were administered—was the percent of times the child followed the examiner's point. An agreement sample (*n* = 40; 17% of the corpus) was scored independently by two teams of observers. Reliability was estimated with intraclass correlation coefficients and equaled .92 (95% CI [.86, .96], $p < .001$) for RJA and .91 (95% CI [.84, .95], $p < .001$) for IJA.

Language Outcome

Parents were asked to complete the MacArthur Communicative Development Inventory: Words and Sentences (CDI; Fenson et al., 1993) prior to each visit. The CDI is an expressive vocabulary measure that includes a checklist of 680 words. It is appropriate for TD children over 16 months of age and provides a stable estimate of total number of words for young children with DD (Yoder, Warren, & Biggar, 1997).

Table 2
Interaction Rating Items

		Anchors		
Rating item	Definition	1=	4=	7=
1. Child's supported joint engagement	The child and caregiver are actively involved with the same object or event, but the child is not actively acknowledging the caregiver's participation.	No episodes of the supported joint engagement state	Spends about a third of the scene in supported joint engagement that is of moderate quality, or briefly in supported joint engagement is of notably high quality.	Frequently in rich and varied episodes of supported joint engagement
2. Child's coordinated joint engagement	The child and caregiver are actively involved with the same object or event and the child is actively and repeatedly acknowledging the caregiver's participation.	No episodes of the coordinated joint engagement state	Spends about a third of the scene in coordinated joint engagement that is of moderate quality, or briefly in coordinated joint engagement is of notably high quality	Frequently in rich and varied episodes of coordinated joint engagement
3. Child's symbol-infused joint engagement	The child is both in a state of supported or coordinated joint engagement and actively using symbols (words, iconic gestures, signs), producing symbols and/or demonstrating receptive symbol use.	No episodes of the symbol-infused joint engagement state	Spends about a third of the scene in symbol-infused joint engagement that is of moderate quality, briefly in symbol-infused joint engagement is of notably high quality	Frequently in rich and varied episodes of symbol-infused joint engagement
4. Caregiver's scaffolding	The caregiver's support of the child's activities and provision of opportunities for learning about shared objects and events and about communicating, including language.	Provides minimal support for the child's communication and/or actions on objects	Provides moderate levels of support	Continually supports and extends the child's actions
5. Caregiver's following-in on child's focus	The caregiver's placement of his or her actions relative to the child's ongoing interest.	Rarely follows in on the child's current focus	Builds on the child's focus on a regular, but not continual basis	Almost continually joins and acts to sustain the child's interest
6. Fluency and connectedness	The overarching flow and cohesion of the interaction including the balance between partners' contributions, the negotiation of turn taking, and the fluidity of the interaction.	No interaction is established	Interaction lacks smoothness, appears to be largely dominated by one partner	Fluid and balanced interaction that is often sustained
7. Child's expressive language use	The child's use of expressive language, including spoken words and manual signs	No expressive language	Produces many different single words; few or no word combination	Fluent and frequent use of sentences

Note. The first six items are the joint engagement rating items used as outcomes; the seventh was used to categorize children as talking or not talking during the interaction.

Language Groups

Children were categorized as *not talking* or as *talking* during the parent–child interaction using the expressive language rating item. If all six CPP scenes were rated 1 (=child uses no words) or 2 (=child uses 1 or 2 different words) or only one scene was rated 3 (=about 5 words) the child was categorized as *not talking*, but if two or more scenes were rated 3 or higher the child was categorized as *talking* during the interaction.

Data Analysis

Outcome variables (ratings of joint engagement and CDI scores) were analyzed with hierarchic multiple regression (Bakeman & Robinson, 2005; Cohen & Cohen, 1983). Two predictor variables were used when analyzing for diagnostic group (ASD, DD, TD): the first contrasted the at-risk sample with the TD sample and the second contrasted the two at-risk groups (ASD vs. DD). A three-group analysis of variance (ANOVA) gives identical results, but contrast codes give greater conceptual precision than the usual two-degree of freedom omnibus ANOVA test, and the effect size provided by hierarchic multiple regression, proportion of variance accounted for or R^2, has intuitive appeal; still, given group differences, we provide Tukey's post hoc results for their descriptive value. One predictor variable was used when analyzing only for diagnosis: the ASD versus DD contrast. Predictors representing other variables were added in subsequent steps, thereby controlling for diagnostic group differences.

Many ratings for joint engagement intercorrelated strongly (> .50) or moderately (> .30 absolute; see Table 3), especially in the at-risk sample. Nonetheless, to maintain their conceptual distinctiveness we analyzed the six rating items separately. Given this level of intercorrelation, we would expect some redundancy, which we take into account when interpreting these results.

Table 3
Correlations Between Interaction Rating Items

Sample and variable	1.	2.	3.	4.	5.
At-risk sample (*n* = 104)					
1. Supported joint engagement	—				
2. Coordinated joint engagement	**.47**	—			
3. Symbol-infused joint engagement	.54	**.54**	—		
4. Parent scaffolding	.70	**.62**	.62	—	
5. Parent following-in on child's focus	.58	**.54**	.54	.72	—
6. Fluency and connectedness	**.71**	**.62**	.84	.77	.63
TD sample (*n* = 40)					
1. Supported joint engagement	—				
2. Coordinated joint engagement	−**.37**	—			
3. Symbol-infused joint engagement	.38	**.14**	—		
4. Parent scaffolding	.72	**.09**	.59	—	
5. Parent following-in on child's focus	.59	**.15**	.42	.76	—
6. Fluency and connectedness	**.44**	**.29**	.86	.66	.62

Note. None of the 15 correlations for the ASD and DD groups differed ($p < .05$ per Fisher's r to z test) and so the two groups were not tabled separately. The six bolded correlations in the at-risk and TD groups differed ($p < .05$ per Fisher r to z test). All at-risk correlations were significant, $p < .01$ or better, and all TD correlations except the four between *coordinated joint engagement* and the last four variables in the table were significant, $p < .05$ or better. ASD = autism spectrum disorder; DD = developmental delay; TD = typically developing.

Results

Joint Engagement During Interactions

To examine joint engagement at the first visit and replicate negative effects of ASD (Aim 1a), we analyzed interaction rating items, specifically ratings of toddlers' joint engagement and their partners' scaffolding and following-in (to characterize toddler and partner contributions) and the rating of the fluency and connectedness of the interaction (to characterize the overall dynamics of their exchange). For all items, means for the ASD group were lower than means for the DD group, which were lower than means for the TD group (see Figure 1). The first predictor entered in hierarchic multiple regressions contrasted the at-risk (ASD + DD) group with the TD group; it accounted for 15%–32% of the variance in the rating items ($p < .001$ for all). The second predictor contrasted the ASD with the DD group; it accounted for an additional 6%–14% of the variance in the rating items ($p < .001$ for all). Additionally, Tukey's post hoc tests showed that diagnostic group means for all items differed significantly ($p < .05$).

Joint Attention Skills and Joint Engagement During Interactions

To assess associations between toddler joint attention skills and various aspects of toddler–parent interaction (Aim 1b), we selected for analysis

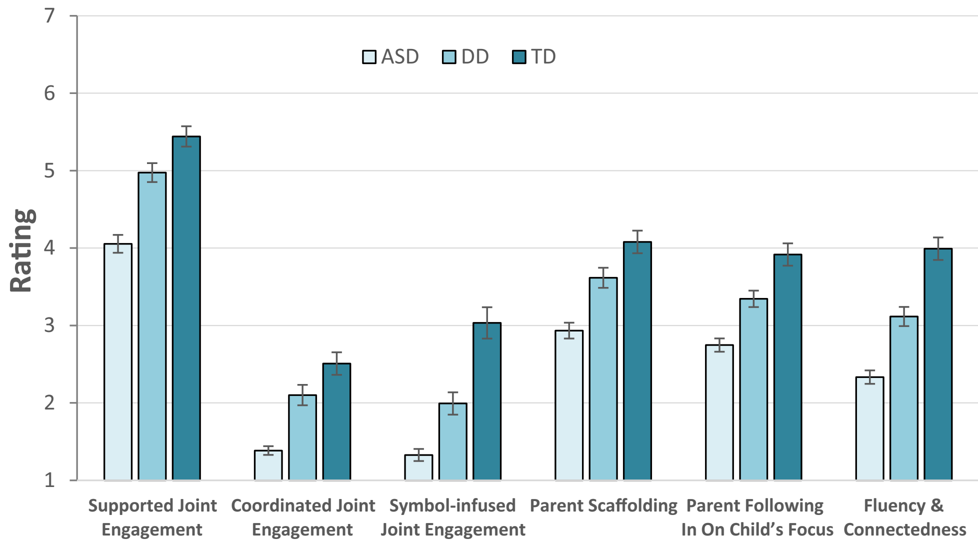

Figure 1. Diagnostic group means for the initial visit rating items. Error bars represent standard errors of the mean. $N = 144$ (58, 46, and 40 for autism spectrum disorder [ASD], developmental delay [DD], and typically developing [TD] groups, respectively).

the first visit for which both RJA and IJA scores were valid ($n = 45$, 46, and 39 for the ASD, DD, and TD groups, respectively). Many RJA scores were zero, whereas IJA scores were more evenly distributed; consequently their analyses are not parallel. With respect to RJA, in the TD sample, $M = 69$ ($SD = 28$) and only one score was zero, but in the at-risk sample, 36 were zero (40%, 26 ASD and 12 DD). Consequently, we analyzed RJA as a binary variable in the at-risk sample and as a continuous variable in the TD sample. For the nonzero cases, *M*s in the ASD and DD samples = 41 and 44 ($SD = 23$ and 24), respectively; these means did not differ from each other, but did differ from the TD mean ($p < .05$ per Tukey's post hoc test). When zero scores were included, *M*s in the ASD and DD samples = 19 and 33 ($SD = 26$ and 28), respectively.

RJA correlated significantly with some rating items in the at-risk sample, but none in the TD sample. For all rating items in the at-risk sample, means for the RJA = 0 group were lower than means for RJA > 0 group (see Table 4), three significantly so. The first predictor entered in hierarchic multiple regressions contrasted the ASD with the DD group, thereby controlling for group differences in diagnosis. The second—of primary conceptual interest here—contrasted the RJA = 0 versus > 0 groups; it accounted for significant additional variance in *supported joint engagement*, *symbol-infused joint engagement*, and *fluency and connectedness* (marginal for *following-in*). Diagnosis did not further qualify these effects: Proportions of variance accounted for by the third predictor, which coded for the ASD versus TD by RJA = 0 versus > 0 interaction, accounted for little additional variance (ΔR^2 = 0.1%–1.9%, p = .18–.78). By contrast, in the TD sample no rating item correlated significantly with RJA scores. When rating item scores were regressed on RJA, ΔR^2 = ~0% to 3.1%, p = .28–.92.

IJA had little effect on the rating items except for coordinated joint engagement. The mean IJA score for the ASD group ($M = 9.8$, $SD = 8.5$) was significantly lower than either the DD mean ($M = 19.6$, $SD = 12.0$) or the TD mean ($M = 23.0$, $SD = 11.6$); the latter two did not differ significantly ($p < .05$ per Tukey's post hoc test). These mean differences led to spuriously high correlations with the rating items when diagnostic groups were combined; consequently, we analyzed association between IJA and the rating items separately for the diagnostic groups. Of the 18 possible correlations (six rating items, three diagnostic groups), only four were moderate or strong (i.e., > .3, $p < .01$ for all). In the TD group, higher IJA scores tended to be associated with lower *supported joint engagement* ($r = -.45$, $p = .004$), and in all groups, higher IJA scores tended to be associated with higher *coordinated joint engagement* (r = .59, .39, and .47, p < .001, = .007, and .003 for ASD, DD, and TD groups, respectively).

Predicting Expressive Language Outcome

To assess associations between toddlers' joint attention skills, toddler–parent interaction, and later expressive vocabulary (Aim 2a), we selected the first visit that had valid RJA and IJA scores and a CDI score for the next visit. For the ASD, DD, and TD groups, $n = 33$, 29, and 29 and $M_{age} = 32$, 32, and 30 months ($SD = 2.8$, 2.5, 0.5), respectively; ASD and TD mean ages differed from each other but not from the DD mean ($p < .05$ per Tukey's post hoc test). The ASD and DD mean CDI scores (Ms = 168 and 212, SDs = 157 and 171) differed from the TD mean ($M = 470$, $SD = 133$), but not from each other ($p < .05$ per Tukey's post hoc test). In the at-risk sample, 27 of the RJA scores were zero (44%, 21 ASD and 6 DD); in the TD group only 1 was. Consequently, we analyzed RJA as a binary variable in the at-risk sample and as a continuous variable in the TD group.

Employing hierarchic multiple regression, for the at-risk group we regressed the CDI first on the predictor that contrasted the ASD with the DD group and then on binary RJA, whereas for the TD group, we regressed the CDI first on the continuous RJA. For both groups this was followed by IJA and then by *fluency and connectedness*, which—given the intercorrelations among the joint engagement ratings—we selected to serve as a marker for joint engagement. In all three diagnostic groups, *fluency and connectedness* was the item that most consistently correlated strongly with the other items; indeed, with the exception of a correlation with *coordinated joint engagement* of .09 in the TD group, all correlations ≥ .48.

In the at-risk sample, diagnosis accounted for 1.8% of the variance in the CDI scores. RJA accounted for an additional 6.7% of the variance, IJA for 3.9% more (albeit $p = .11$ and the association with CDI was negative, $r = -.094$, $p = .47$), and *fluency and connectedness* for an additional 33% (see Table 5). Diagnosis did not further qualify these effects in the at-risk sample. Proportions of variance accounted for by predictors that coded for the ASD versus TD by RJA, IJA, and *fluency and connectedness* interactions accounted for little additional variance (ΔR^2 = ~0% to 1.8%, p = .21–.90). In the TD sample, RJA and IJA accounted for small amounts of variance, and *fluency and connectedness* for just an additional 9.8% ($p = .11$; see Table 5).

Effects of Children Not Talking During Interaction

To consider the impact of talking during interactions on joint engagement (Aim 2b), we focused our analyses on the 104 participants who screened at-risk for ASD; since almost all of the TD children were talking at the initial visit, we did not include the TD group.

First, we compared ratings at the initial visit for the 76 toddlers who were not talking (51 of whom were subsequently diagnosed ASD and 25 DD) with the 28 toddlers who were talking (7 of whom

Table 4
Rating Item Means by RJA Group for the At-Risk Sample and R^2 *Accounted for by RJA for the At-Risk and TD Samples*

	At-risk sample				TD sample	
	M					
Rating item	RJA = 0	RJA > 0	RJA_B R^2	*p*	RJA R^2	*p*
Supported joint engagement	4.3	4.9	3.8	.044	0.0	.92
Coordinated joint engagement	1.6	2.0	1.5	.20	3.1	.28
Symbol-infused joint engagement	1.5	2.1	5.1	.029	2.0	.38
Parent scaffolding	3.2	3.6	2.4	.13	1.5	.45
Parent following-in on child's focus	2.9	3.3	3.3	.065	0.1	.86
Fluency and connectedness	2.5	3.2	6.9	.009	1.2	.50

Note. $N = 91$ for the at-risk sample ($n = 36$ for RJA = 0 and 55 for RJA > 0) and 39 for the TD sample (selecting the first visit for which both RJA and IJA scores were valid). RJA_B (a binary variable) is 0 if RJA = 0 and is 1 otherwise. The 12 R^2s resulted from separate regressions, one for each rating item in the at-risk and in the TD samples. IJA = initiating joint attention; RJA = responding to joint attention; TD = typically developing.

Table 5
Changes in R^2 *Regressing Expressive Language on Joint Attention Skill and Engagement*

	At-risk sample		TD sample	
Variable added	ΔR^2	*p*	ΔR^2	*p*
ASD versus DD	1.8	.30	—	—
RJA[a]	6.7	.041	0.5	.72
IJA	3.9	.11	2.8	.40
Fluency and connectedness	32.7	< .001	9.8	.11

Note. $N = 62$ for the at-risk sample and 29 for the TD sample (selecting the first visit for which both RJA and IJA scores were valid and that had a CDI score for the next visit). Statistics are increases in R^2 when variables are added to a regression equation predicting expressive language (CDI scores a half year later). The ΔR^2s resulted from two regressions, one each for the at-risk and TD samples. ASD = autism spectrum disorder; CDI = MacArthur Communicative Development Inventory; DD = developmental delay; IJA = initiating joint attention; RJA = responding to joint attention; TD = typically developing.
[a]RJA is a binary variable for the at-risk sample and a continuous one for the TD sample.

were subsequently diagnosed ASD and 21 DD). For all items, means for the not talking group were lower than means for the talking group (see Figure 2). The first predictor entered in hierarchic multiple regressions contrasted the ASD with the DD group. The second predictor—of primary conceptual interest here—contrasted the not talking with the talking group; it accounted for 4.3%, 8.5%, 8.7%, 13%, 28%, and 45% additional variance in *coordinated joint engagement*, *parent scaffolding*, *supported joint engagement*, *parent following-in*, *fluency and connectedness*, and *symbol-infused joint engagement*, respectively ($p < .001$ to = .018). Diagnosis did not further qualify these effects. The third predictor, which coded for the ASD versus DD by not talking versus talking interaction accounted for little additional variance (ΔR^2 = ~0% to 2.4%, p = .078–.98).

Second, we focused on the 78 at-risk children who returned for their first follow-up visit (46 diagnosed ASD and 32 DD). We categorized the children into three groups: those who were not talking at both the initial and follow-up visits (N-N, n = 28, 20 of whom were diagnosed ASD), those who changed from not talking at the initial visit to talking at the follow-up visit (N-T, n = 30, 20 of whom were diagnosed ASD), and those who were talking at both visits (T-T, n = 20, 6 of whom were diagnosed ASD). In all three groups, means increased from the initial to the follow-up visit for all items (see Figure 3), significantly so for *coordinated* and *symbol-infused joint engagement* and for *following-in* in the N-N group, for all items in the N-T group, and for *supported*, *coordinated*, and *symbol-infused joint engagement* and *fluency and connectedness* in the T-T group (per repeated measures t tests, $p < .05$).

For *supported joint engagement*, *parent scaffolding*, *parent following-in*, and *fluency and connectedness*, the amount of change was greatest for the N-T group; for *coordinated joint engagement*, change was greatest for the T-T group; and for *symbol-infused joint engagement* change was essentially the same for the N-T and T-T groups (see Table 6). The first predictor entered in hierarchic multiple regressions contrasted the ASD with the DD group. The second and third predictors are of primary conceptual interest here: The second contrasted the initially not talking groups (N-N + N-T) with the always talking group (T-T); it accounted for statistically significant variance only for *symbol-infused joint engagement*, whereas the third predictor, which contrasted the N-N with the N-T group, accounted for statistically significant additional variance for four of the six rating items. Additionally, Tukey's post hoc tests ($p < .05$) showed that for these four items—*supported joint engagement*, *symbol-infused joint engagement*, *parent scaffolding*, and *fluency and connectedness*—change was significantly higher for the N-T than the N-N group. Only for *parent scaffolding* was

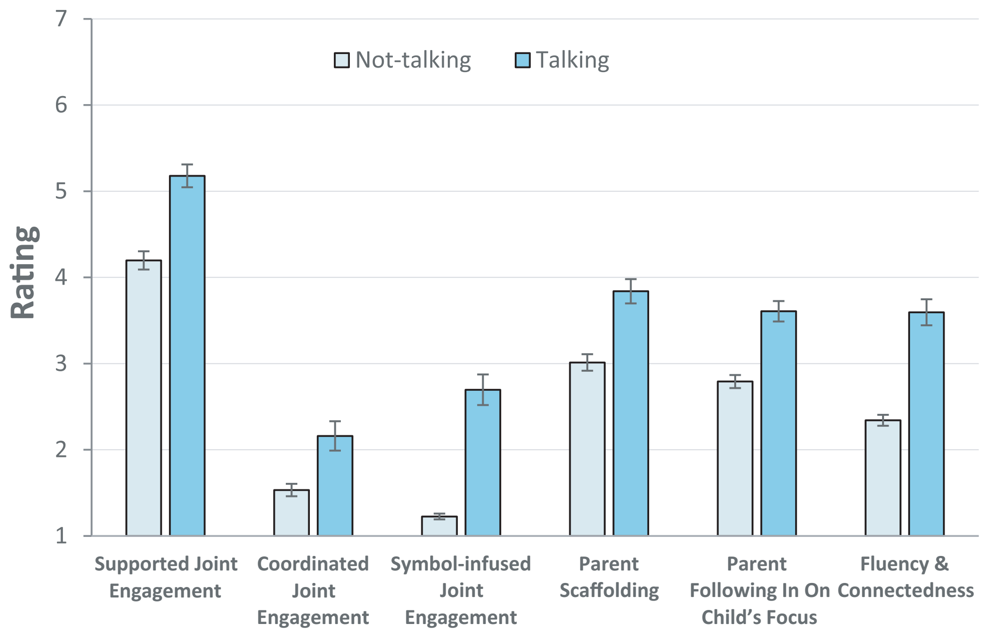

Figure 2. Language group means for the initial visit rating items. Error bars represent standard errors of the mean. N = 104 (76 and 28 for not talking and talking groups, respectively; excludes typically developing children).

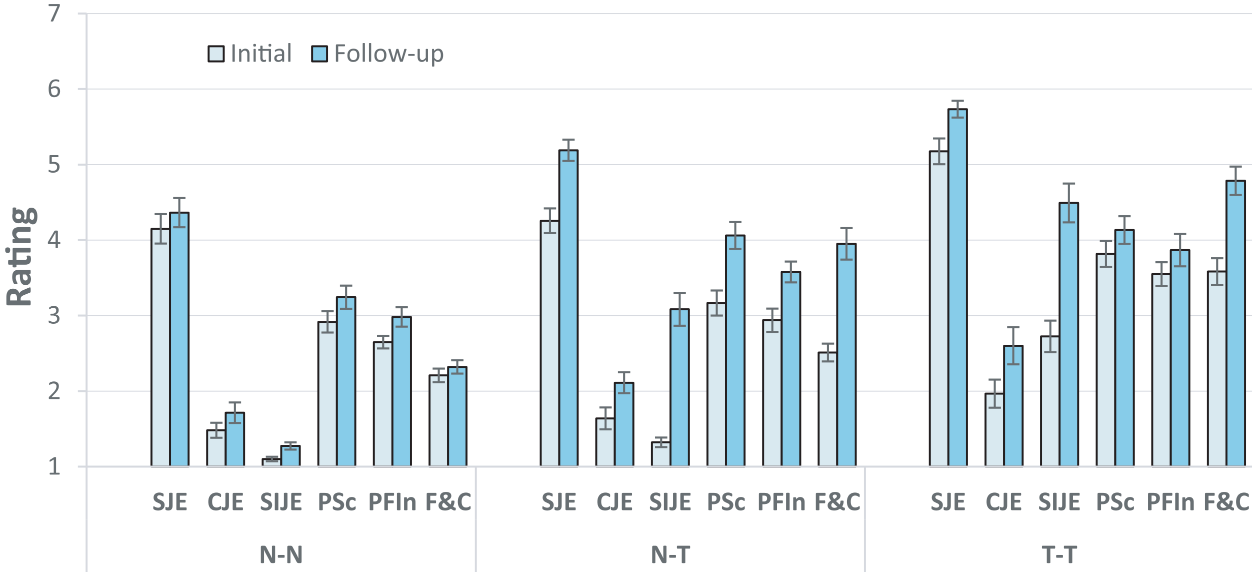

Figure 3. Language change group means for the initial visit and follow-up visit rating items. Error bars represent standard errors of the mean. N = 78 (28, 30, and 20 for the N-N, N-T, and T-T groups, respectively; excludes typically developing children).

change significantly greater for the N-T than the T-T group.

With one marginal exception, diagnosis did not further qualify these effects. Proportions of variance accounted for by the fourth and fifth predictors, which coded for the ASD versus DD by talking change status interaction, accounted for little additional variance (ΔR^2 = ~0% to 3.5%, p = .23–.98)—excluding *supported joint engagement*. For this code, ΔR^2 = 7.0%, p = .052; follow-up tests showed that the pattern of language change group differences shown in Table 6 for *supported joint engagement* characterized only the ASD group and not the DD group.

At the follow-up visit, the N-T group had partly caught up to the T-T group. Although follow-up visit means for *symbol-infused joint engagement* and *fluency and connectedness* were higher for the T-T than the N-T group, means for the other four rating items did not differ significantly. By contrast, N-N means were significantly lower than N-T means for all items except *coordinated joint engagement* ($p < .05$ per Tukey's post hoc test).

Discussion

This study provides an expanded view of joint attention—one that includes both joint attention skills and multiple facets of joint engagement during parent–toddler interactions—during the first half of the 3rd year, an especially auspicious time for language development when toddlers typically make major strides acquiring vocabulary and toddlers with ASD and toddlers with other developmental concerns may falter. Our findings indicate that toddlers who screen positive for ASD risk, especially those who are subsequently diagnosed with ASD, have pervasive joint attention problems. Moreover, our results reveal that joint engagement during parent–child interactions is a potent predictor of expressive vocabulary in toddlers with ASD and DD, adding considerably to predictions based only on joint attention skills, and how, in contrast, the association between joint attention at 24 months and later expressive vocabulary was relatively weak in TD toddlers. Furthermore, they illuminate a dynamic relation between joint engagement and language use; joint engagement is most severely impacted when toddlers do not talk during interactions and, most notably, it improves markedly when they begin to speak.

Recruiting our sample through a large, community-based early ASD detection project let us gain exceptionally early access to toddlers with joint attention deficits and to TD toddlers of comparable age and background. This procedure opened up a new window on joint attention and language that was not filtered by information about diagnosis or language proficiency, allowing us to compare groups of toddlers months if not years before ASD

Table 6
Change in Rating Item Means by Language Change Group

	Mean increase			Contrasts			
	Language change group			[N-N + N-T] versus T-T		N-N versus N-T	
Rating item	N-N	N-T	T-T	ΔR^2	p	ΔR^2	p
Supported joint engagement	0.21_a	0.93_b	0.56_{ab}	0.0	.89	10.9	.003
Coordinated joint engagement	0.23	0.47	0.63	1.4	.30	1.7	.26
Symbol-infused joint engagement	0.17_a	1.76_b	1.77_b	4.8	.049	32.9	< .001
Parent scaffolding	0.33_a	0.89_b	0.32_a	2.6	.16	7.8	.013
Parent following-in on child's focus	0.33	0.64	0.32	0.7	.45	2.5	.17
Fluency and connectedness	0.11_a	1.44_b	1.20_b	1.5	.29	30.2	< .001

Note. $N = 78$ dyads from the ASD and DD groups who completed the follow-up visit: N-N ($n = 28$), N-T ($n = 30$), and T-T ($n = 20$) are the continue not talking, change from not talking to talking, and continue talking groups, respectively. Mean increases in rating are from the initial to the follow-up visit. Group means that do not differ ($p < .05$ per Tukey's post hoc test) share a common subscript. The 12 ΔR^2s resulted from separate regressions, one for each rating item for each of the two contrasts. ASD = autism spectrum disorder; DD = developmental delay.

is usually diagnosed (Robins et al., 2014, 2016). Thus, our study complements previous studies of joint attention difficulties that focused on older toddlers and preschool-aged children already diagnosed with ASD that either did not have a TD comparison group (e.g., Bottema-Beutel et al., 2014; Mundy et al., 1990) or made comparisons to younger, language-comparable TD toddlers (e.g., Adamson et al., 2012).

Joint Engagement and Joint Attention Skills

As we anticipated, all aspects of joint engagement observed during parent–toddler interaction were compromised for toddlers who screened positive for ASD risk, most markedly so for those who were subsequently diagnosed with ASD. The impact of ASD was most apparent for coordinated and symbol-infused joint engagement whose mean ratings of 1.4 and 1.5 indicated that many of the toddlers never explicitly attended to the parent or to symbols during joint engagement. Moreover, the ratings of the parent's support and the exchange's dynamics all fell within the lower third of the scale, indicating that ASD also had a strong and widespread negative impact on aspects of joint engagement beyond the child focused ratings of joint engagement states. Interestingly, compared to other ratings, those for supported joint engagement were relatively high—the mean rating of 4.1 indicated that parents often influenced the child's experiences with objects for about a third of the 30-min observation—although ratings in the ASD group were still significantly lower than those in either the DD or TD groups. Moreover, once again, coordinated joint engagement was rated much lower than supported joint engagement in all three groups, providing an important reminder that even TD toddlers often focus intently on shared activities rather than explicitly on their social partner (Bakeman & Adamson, 1984; Yu & Smith, 2013).

One unusual aspect of our design is the presence of a group of toddlers who screened positive for ASD risk, but who were subsequently diagnosed with non-ASD DD. As we did not use a broader screening tool to detect all developmental disorders, this group provided a particularly interesting age-match comparison group that may contain children who display some symptoms in common with children who were diagnosed with ASD. Indeed we found that the DD sample was often situated between the ASD and TD samples on measures of joint attention. It is especially noteworthy that joint engagement was broadly affected in our DD group, especially in light of prior studies that indicate how specific developmental disorders such as Down syndrome (Adamson et al., 2012) and congenital deafness (Prezbindowski, Adamson, & Lederberg, 1998) may have selective impact on symbol-infused joint engagement rather than widespread impact.

Our findings that parent scaffolding and following-in were significantly impacted by ASD depart from previous reports that parents provide similar language and communicative input to TD children and those diagnosed with ASD (Arunachalam & Luyster, 2016; Bang & Nadig, 2015). This discrepancy may be explained in part by the fact that our observations occurred before diagnosis so that parents were not yet aware of the ASD diagnosis and most had not participated in interventions that might have altered their contributions (Suma et al., 2016). A second and perhaps more compelling possibility is that our ratings of scaffolding and following-in are inherently dyadic variables. Thus, unlike variables that quantify a parent's contribution in terms of number of communicative acts such as gestures and joint attention bids or the amount and complexity of speech, our ratings focused on the quality of a parent's actions to characterize how well they support the child's activities or, to use Vygotsky's (1978) heuristic phrase, the child's zone of proximal development.

We also were struck by how impaired RJA skills were in the toddlers who screened positive for ASD risk. In large measure, our sample's ESCS scores were consistent with previous reports. The joint attention skill scores for our 24-month-old TD toddlers were similar to those Mundy et al. (2007) reported for TD 18-month-olds (RJA means = 69% and 72%; IJA means = 24% and 19%, respectively). Moreover, the low mean IJA score (9.8) in our ASD group is comparable to those reported for groups of older children with ASD (e.g., Dawson et al., 2004; Toth et al., 2006, both report means of 7.9 for children whose mean age was 43.5 and 43.6 months, respectively). However, mean RJA scores in ASD and DD groups (19% and 33%, respectively) were markedly lower than those of older children with ASD (53% and 51%; Dawson et al., 2004; Toth et al., 2006). Thus, even though ASD-related RJA skill deficits, unlike IJA skill deficits, often remit (Mundy, 2016), during very early language development both skills may be severely impaired in toddlers with ASD.

Although both IJA and RJA skills were severely impaired in the at-risk sample, they were linked, as predicted, in conceptually reasonable ways for our systematic observations of joint engagement. These findings demonstrate that quite different measures of joint attention—one that requires the child to interact with a friendly stranger who is following a script and the other that asks the child's parent to play with the child in a series of unscripted scenes—can generate complementary information about variations in early joint attention.

Moreover, the difference in how IJA and RJA were associated with various aspects of joint engagement supports claims (Mundy, 2016) that they may be dissociated in ways that reflect different integrations of neurodevelopmental and social processes. Our finding that IJA and coordinated joint engagement were strongly correlated in all three groups—and that IJA is not significantly associated with any other aspect of joint engagement—is consistent with the notion that IJA and coordinated joint engagement both reflect a specific capacity for spontaneous social behavior that is a core aspect of social relatedness. Our findings for RJA skill and joint engagement present a more complex picture. First, as we anticipated, RJA was related to supported joint engagement as well as to symbol-infused joint engagement and fluency and connectedness. The breadth of its links to various aspects of interaction suggests that RJA relates more fully to the ability to perceive and be influenced by a partner's communicative actions than to impairments of the social engagement per se. Moreover, unlike the association between IJA and coordinated joint engagement, which was strong in all three groups, we did not find links between RJA and joint engagement in the TD group. These results suggest that an association between IJA and active attention to a partner is robust across groups. In contrast, by 2 years of age, TD toddlers may have more than sufficient RJA skills to sustain joint engagement so that variations in its structure and dynamics may well reflect variations in other processes such as interest in communicating with the partner.

Joint Attention and Language

We used two complementary approaches to probe the relation between joint attention and language: First, we examined whether joint engagement predicts expressive vocabulary outcome over and above any variance accounted for by children's joint attention skills, and second, we examined how beginning to talk after a delay in speech onset alters joint engagement. These two views converged to display a dynamic, transactional relation between joint engagement and first words, particularly for toddlers with ASD or other DD.

Our first approach to the relation between joint attention and language outcome assessed the relative contribution of earlier joint attention skills and joint engagement to subsequent expressive language outcome. We found that variations in joint engagement during interactions were a particularly potent predictor of emerging variability in expressive language. Replicating earlier findings (Bottema-Beutel, 2016), in the at-risk sample RJA scores significantly predicted expressive language outcome, but IJA scores did not. In addition, and most tellingly, we found that adding information about joint engagement significantly strengthened the prediction: Joint engagement accounted uniquely for three times as much of the variance in expressive language as RJA and IJA together (33% vs. 11%). However, in the TD group, neither joint attention skills nor joint engagement predicted expressive language outcome significantly.

Overall, these findings confirm and elaborate previous findings (Adamson et al., 2009; Bottema-Beutel et al., 2014; Hirsh-Pasek et al., 2015) that early vocabulary development is facilitated by experiences during periods of joint engagement. Moreover, they highlight how shared experiences can enhance early language outcome even when joint attention skills are markedly impaired. But why would joint attention predict expressive vocabulary size in the at-risk but not the TD sample? A compelling explanation for these differences is that joint attention may be more crucial for setting the stage for vocabulary acquisition than for continued language acquisition (Bottema-Beutel, 2016; Haebig, McDuffie, & Weismer, 2013; Toth et al., 2006). Unlike most toddlers with ASD and DD whose vocabulary development is delayed, by age 2 TD toddlers are likely using new strategies to expand their vocabulary (Nazzi & Bertoncini, 2003).

Our second question about the relation of joint attention and language focused on language use during joint engagement. First, by noting whether toddlers were producing no more than a few words during the CPP, we were able to document how a severe delay in functional speech impacts interactions. The transition to using words usually occurs by 24 months (Zubrick et al., 2007). But almost three fourths of the toddlers who screened positive for ASD risk in our sample—including almost 90% of the toddlers who were subsequently diagnosed with ASD—appeared minimally verbal at 24 months. Although our focus was on the use of words during interactions, and not on the child's vocabulary size, a strong relation between the two would support the validity of our categorization of children as not talking versus talking, which was based on the rating item for expressive language. Scores on this item correlated .74 with the CDI at the initial visit and .79 at the follow-up. Moreover, CDI scores were significantly different for the *not talking* and *talking* groups (M = 19 vs. 142 at the initial visit and 35 vs. 230 at the follow-up, $p < .001$ for both).

The joint engagement of children who were *not talking* during interactions was deeply impaired. Although a third of the toddlers in the *not talking* group were not subsequently diagnosed with ASD, ratings in this group were remarkably similar to the group composed of toddlers with ASD, indicating that a severe delay of speech onset with or without ASD symptoms compromises joint engagement. It is not surprising that symbol-infused joint engagement was most strongly affected by not talking; expressive language is usually the main indicator, albeit not the only indicator, that a child was attending to symbols during a shared activity. In contrast, it is less clear why fluency and connectedness was also strongly impacted given that balanced and flowing exchanges can be negotiated even before speech develops (e.g., Stern, 1977). One plausible explanation is that not talking during interactions reflects not only a severe delay in word learning, but also profound pragmatic difficulties.

Given the pervasive and often strong effects of a speech onset delay on joint engagement, it is especially striking that we found that these effects may rapidly ameliorate. More than half of the toddlers who were not talking at the initial visit—including 20 of the 30 with ASD who were initially not talking—spoke during the follow-up visit. Thus, by the middle of the 3rd year, the heterogeneity of language in ASD is becoming more evident than it was just a half year earlier. Moving from not talking to talking seemed to kindle a developmental transformation of joint engagement. While joint engagement for toddlers who were still not talking remained essentially unchanged, joint engagement of toddlers who started to speak was markedly improved. Change was most pronounced for symbol-infused joint engagement and fluency and connectedness, but ratings of supported joint engagement and parent scaffolding also rose markedly.

These results highlight how rapidly changes in the form and flow of joint engagement can occur in the first months following early diagnosis. Nevertheless, it is also important to recognize how difficult it is to catch up after an initial speech delay (Thal et al., 1997). The joint engagement of at-risk toddlers who were already talking at the initial visit also improved considerably for toddlers who had just begun to speak. Perhaps even more sobering, joint engagement development can continue at a rapid pace for TD toddlers during the 3rd year (Adamson et al., 2012) and well into the preschool years as interactions transform into conversations (Adamson, Bakeman, Deckner, & Nelson, 2014), often leaving even verbal children with ASD far behind in development.

Future Directions and Conclusions

Our findings have important implications for the conceptualization of the relation between joint attention and language in early development, one in which developing joint attention and acquiring expressive language mutually reinforce one another. By design, participants were selected based on a screener for ASD risk, not a screener for language delay. Thus, we gained a view that prioritized joint attention difficulties, not language delay. Yet, not surprisingly, many of the children who screened positive for ASD risk at age 2 were not yet talking during interactions and had vocabularies that were significantly smaller than TD toddlers' vocabularies, regardless of subsequent diagnosis. Future studies using a cross-lagged panel design as well as a sample that also included toddlers who screened positive for language delay but not for ASD might help further illuminate the complex relation between joint engagement and language by probing how changes in one might drive changes in the other. In addition, it would be illuminating to consider not only expressive language use and outcome but also receptive language, a crucial aspect of very early interactions and of language acquisition that remains hidden for want of valid receptive language measures for minimally verbal children with ASD (Skwerer, Jordan, Brukilacchio, & Tager-Flusberg, 2016).

Our findings also have implications for early intervention efforts. First, they underscore the value of ASD screening during well-baby pediatric check-ups for identifying toddlers who are experiencing joint attention and language delays even if they are not subsequently diagnosed with ASD (Robins et al., 2016). Moreover, our findings highlight the possibility of significant positive change in joint attention and language during the early months after a positive ASD screen (Suma et al., 2016). Indeed, they suggest that time is of the essence after screening and that, consistent with recent recommendations, children who screen positive should be referred simultaneously for early intervention and more extensive ASD evaluation, rather than waiting for a formal diagnosis before initiating treatment for specific concerns, such as language delay. Another approach is to use secondary screening to triage children in greatest need of ASD referrals (e.g., Khowaja, Robins, & Adamson, 2017). Furthermore, our findings lend support to early interventions that consider not only children's skills and joint engagement states but also how to help parents provide contextual supports that optimize word learning in toddlers with ASD (Adamson, Bakeman, & Brandon, 2015; Hurwitz & Watson, 2016; Luyster & Lord, 2009).

In conclusion, the findings of this study lend empirical support to a developmental transactional conceptualization of the relation between joint attention and language as toddlers begin to speak that highlights not only how joint attention facilitates word learning, but also how word use transforms joint engagement. Moreover, they emphasize the value of expanding views of joint attention to include both a toddler's joint attention skills and multiple facets of joint engagement during parent–child interactions, thereby gaining a broader sense of how dyads orchestrate shared activities both when toddlers are developing on pace and when they are experiencing developmental difficulties that can be detected during early ASD screening.

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