Spring 5-10-2009

Joint Attention in Young Children with Autism

Sabrina Jara
University of Connecticut - Storrs, SABRINA.JARA@uconn.edu

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University of Connecticut

Abstract

Autism spectrum disorders (ASDs) are classified as pervasive developmental disorders characterized by social, communicative, and behavioral impairments. According to formal and informal reports, children with ASD present with receptive and expressive language delay. Joint attention (JA: the behavior that occurs when two individuals focus on the same object or event) has been identified as a possible marker of delayed language development in children with ASD. In this study, the JA behaviors in children with ASD were contrasted with initially language-matched typically developing (TYP) children across three visits. Measures of language, the frequency, duration, and source of initiation of JA episodes, and the choice of toy during those episodes, were coded. Across visits and groups, mothers initiated more JA episodes than children; however, typical children also initiated more JA episodes than ASD children at visits 1 and 2. Also, the total duration of typically developing children's JA episodes was generally longer than that of the ASD children's, significantly so at Visit 2. Significant associations emerged between children's vocabulary and two measures of JA: frequency and number of maternal initiations. Teaching parents to incorporate JA training in their interactions with their children may likely help children with ASD acquire language.

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Joint Attention in Young Children with Autism

Autism spectrum disorders (ASD) are pervasive developmental disorders estimated to affect as many as one in every 150 children (CDC, 2007). In order to be diagnosed with autism, children 36 months old and younger must present with pronounced deficits in the social (lack of reciprocity in relationships), communicative (impaired comprehension and expression), and behavioral (restrictive and repetitive actions) domains (APA, 2000). Diagnosis of other ASDs such as pervasive developmental disorder, not otherwise specified (PDD-NOS) and Asperger syndrome, occurs when children show impairments in these domains but do not meet the exact criteria for autism (Chakrabarti and Fombonne, 2001).

Communication is intrinsically linked to the development of language. Due to the varying degree of severity within the diagnosis of ASD, mildly affected children may have intact language skills while others remain completely nonverbal (Lord, Risi, and Pickles, 2004, as cited by Luyster, Kadlec, Carter, and Tager-Flusberg, 2008). In fact, parents and clinicians often view the absence of language milestones as the most salient risk factor leading to the screening of children for ASD (Thurm, Lord, and Lee, 2007).

Determining the nature of the language deviation from the norm has implications for narrowing the focus of language therapy for children with ASD. Swensen, Kelley, Fein and Naigles (2007) investigated language development in their Intermodal Preferential Looking (IPL) study, tracking eye movement during language comprehension in children with ASD and typically developing (TYP) children. Participants in the ASD group were language-matched with their typical counterparts; however, they were on average one year older and used fewer multiword utterances than the typical group. This conclusion provides evidence for the presence of a delay in some children with ASD.

If children with ASD learn language more slowly than TYP children, isolating other factors in which they differ could shed light on the reasons for the language delay. One observable component of typical development that has been identified as a risk factor for language delay in children with autism is engagement in joint attention. Joint attention (JA) encompasses a number of behaviors, including gaze monitoring, point following, pointing, and showing. One aspect of joint attention that has particular relevance for autism concerns who begins it; therefore, joint attention episodes are usually coded for who initiates the episodes (IJA) versus who responds to them (RJA) (Bruinsma, Koegel, and Koegel, 2004; Jones & Carr, 2004; Mundy and Gomes, 1998). From the perspective of the child as the principal agent, an RJA occurs when a child looks towards the direction of a parent's point or gaze. An IJA occurs when the child seeks someone else's attention. RJA and IJA could also occur from the parent's point of view.

Several studies have demonstrated difficulty in children with ASD's engagement in joint attention. Osterling and Dawson (1994) analyzed the videotapes of children's first birthday parties; eleven children later diagnosed with ASD were compared with eleven TYP children. Osterling and Dawson (1994) discovered a significant difference in the groups' frequency of usage of joint attention behaviors (point, vague point, and show). None of the children with ASD pointed, vague-pointed, or showed an object to another whereas TYP children engaged in, on average, one episode of each behavior. Though autism is not diagnosed during the first year of life, this study reflected the possibility that children with ASD behave differently from TYP children in infancy.

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The study of the interaction of joint attention and language development is critical to the argument that one behavior may enhance the other. Baron-Cohen, Baldwin, and Crowson (1998)

presented nonsense words (i.e. *toma, peri*) in reference to objects children had never seen before. They tested 17 children with autism and 17 children with mental handicap, matched for gender, chronological age, and expressive language capability. In the first condition, the child was handed an object (A) while the experimenter held another object (B). The experimenter waited for the child to look at A, then the experimenter looked at and labeled B. In the second condition, the experimenter again waited for the child to focus on A, then the experimenter looked at A as well, and labeled it. Afterwards, the toys were placed in a bag and the experimenter asked the child to give him the novel object he had previously named. In order to correctly label the object in the first condition, the child needed to understand that the experimenter referred to an object s/he had not been looking at. The second and easier condition required the child to find the object s/he had looked at and map the label onto it. Baron-Cohen et al. (1998) found that children with mental handicap (12 of 17) outperformed children with ASD (5 of 17) in the first condition. In a second experiment, TYP children around 24 months of age were also tested and 19 of 24 passed the first condition. This finding provides at least a partial explanation for why children with autism acquire vocabulary more slowly than their peers; namely, providing a label helps children associate the name of the object with the object itself and children with ASD were less likely to benefit from this labeling because they did not generally venture outside their frame of reference to consider the examiner's point of view.

Siller and Sigman (2008) conducted a longitudinal study over three and a half years designed to evaluate how children with ASD acquire language. They studied 22 boys and 6 girls (MA=45.2 months) diagnosed with ASD. They measured joint attention with the Early Social Communication Scale (ESCS) at Visit 1, an approximately 20 minute play task designed to measure a child's ability to perform nonverbal communication. As part of the paradigm, the

child saw several toys in the room but could not reach them. The examiner set one toy on the table at a time and the child was observed for his/her initiation of joint attention and response to joint attention. IJA was coded when the child looked at the toy and then at the examiner, and when the child showed a toy to the tester. RJA occurred when the child turned his head and eyes towards the direction the examiner pointed to. Joint attention was also coded during mother-child interactions for frequency, or number of times the child was seen engaging in IJA or RJA. Siller and Sigman (2008) found a positive correlation between the frequency with which children respond to joint attention in both contexts and a higher language gain over a period of 3 to 4 years as measured by the Reynell Developmental Language Scales.

Bruinsma et al. (2004), in their review of the literature, assumed only IJA was critical to language acquisition. In one study, the ESCS was used again to correlate joint attention with language development (Koegel, Koegel, and Shoshan, 1999, as cited by Bruinsma et al., 2004). In a longitudinal study, children with ASD (3-4 years of age) who initiated more episodes of joint attention at their earliest visit had more language gains at their last visit, which took place when they were 10 to 15 years old.

Luyster et al. (2008) studied 164 toddlers with autism using the ESCS and compared their findings with various measures of the children's receptive and expressive language, including the Mullen Scales of Early Learning, Vineland Adaptive Behavior Scales, and the Bates-MacArthur Child Development Inventory. In contrast to Bruinsma et al. (2004), Luyster et al. (2008) found that RJAs were more critical to language acquisition in toddlers. RJAs correlated with measures of receptive and expressive language; additionally, RJA predicted concurrent receptive language ability in a regression analysis when other factors (chronological age, non-verbal cognitive ability, IJA, imitation, gestures, play and motor skills) were partialled out.

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Prospectus

In sum, studies of joint attention have revealed that children with ASD are less likely to initiate and respond to bids for joint attention; possibly as a result, language skills are often delayed. However, these studies are not conclusive on several grounds. That is, previous studies have only investigated joint attention in children over four years of age (Baron-Cohen et al., 1998; Leekam, Hunnisett, and Moore, 1998), in dyads where experimenters engaged with the children (Leekam and Ramsden, 2006; Koegel et al., 1999), and only coded the number of joint attention episodes (Siller and Sigman, 2008). These factors limit the conclusions one can draw concerning the role of joint attention in language development in children with ASD.

First, it is not clear whether joint attention difficulties are an early or late marker of ASD. Now that early intervention for children with ASD is becoming more widespread, this can be investigated. The Modified Autism Checklist for Toddlers (M-CHAT) is a popular parent questionnaire designed to identify children with autism at around 24 months of age (Robins, Fein, Barton, and Green, 2001). Detection of ASD at an early age is highly desired because of the numerous studies citing the importance of treatments, such as Applied Behavior Analysis, beginning early in life (Dawson, 2008; Foxx, 2008; Reed, Osborne, and Corness, 2007). For these reasons, joint attention must be studied within younger children with ASD.

It is also possible that the duration of the joint attention episodes is a more important factor than the overall number of episodes. Research of duration of attention span has been mostly dedicated to the difficulty children with ASD may have in shifting attention from one object to another (Landry and Bryson, 2004). There however remains the possibility that children with ASD are looking at objects for longer periods of time because processing characteristics of an object, including its label, takes them more time. In this situation, they

would be using a compensatory strategy to increase their vocabulary. Thus, while children with ASD might lag behind typical children in their number of JA episodes, they might be comparable in terms of the duration of these episodes.

Finally, it is possible that investigating joint attention only in experimenter-child dyads underestimates the ASD children's abilities. As Adamson, McArthur, Markov, Dunbar, and Bakeman (2001) note, mothers have a distinct advantage over experimenters in eliciting joint attention because of their thorough knowledge of the child's clinical background and their previous experience engaging children over the course of their development. However, mothers might also create more joint attention episodes because of familiarity. Naber, Swinkels, Buitelaar, Dietz, Van Daalen, Bakermans-Kranenburg, Van Ijzendoorn, and Van Engeland (2007) studied the presence of attachment to caregivers in groups of children with ASD children, and children with mental retardation. The Strange Situation task (Ainsworth, Blehar, Waters, and Wall, 1978) distinguished the children into secure attachment and disorganized attachment groups. Children from all groups who exhibited secure attachment also exhibited a greater number of joint attention episodes than children who exhibited disorganized attachment did.

In this study, we will also examine the toys that children in both groups select during free play, with the expectation that children who play with a wider variety of toys may learn more words as a result (Vig, 2007).

The research questions in this study are as follows: (1) How do children diagnosed with ASD compare with typically developing (TYP) children in the types and amount of joint attention they engage in? (2) How is joint attention related to the language development of both populations? (3) How do the groups of children differ in their usage of toys? We hypothesize that children with ASD will have longer total duration of joint attention. We also think that the

ASD group will initiate fewer episodes than the TYP group. Mothers will also likely succeed in eliciting joint attention in TYP children more than in children with ASD. Duration of joint attention and choice of toy category will possibly lead to language gain.

Method

Participants

Ten TYP children (MA=20.33 months, SD=2.09) and ten children with ASD (MA=32.67 months, SD=3.87) from English-only homes formed the participant pool, selected from a larger study of language in children with ASD (Naigles, 2005; Tek et al., 2008). The ASD group was recruited through treatment facilities and schools in Connecticut, Massachusetts, Rhode Island, New York, and New Jersey. All children in the ASD group (10 males) were diagnosed by professionals prior to beginning the study. Their diagnosis was confirmed with the Autism Diagnostic Observation Schedule (Lord, Rutter, Goode, Heemsbergen, and Jordan, 1989) and the Childhood Autism Rating Scale (Schopler, Reichler, and Renner, 1988) before the start of the study. These children were visited for the first time within 6 months of their diagnosis and one month of starting ABA treatment.

The other ten children (MA=17-19 months at visit 1, 6 males) were found to have Mullen scores in the normal range (within 1.5 SD of the mean), scores outside the autism spectrum on the ADOS, and could produce 50 words or more according to the Bates-MacArthur Child Development Inventory (CDI; Fenson, Dale, Reznick, Thal, Bates, et al., 1991). Based on these scores, they did not fit any developmental diagnosis and are considered TYP children. Their test scores further ensured that the children were comparable with their peers with ASD with regards to language production and comprehension (see Table 1).

Materials

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The standardized tests used to measure the children's language ability are the Bates-MacArthur Child Development Inventory (Fenson et al., 1991) and the Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, and Balla, 2005). The CDI is a standardized parent report designed for monolingual children. The infant version was administered at Visit 1 and the toddler version was used for Visits 2 and 3. The infant version assesses vocabulary development and nonverbal communication. The toddler version is focused on word production and mastery of language domains such as morphology and syntax.

The Vineland is also a parent report consisting of four categories of adaptive functioning (communication, daily living skills, socialization, and motor skills). The beginning questions of the scale have been identified as critical to future development similar to a developmental scale. The Vineland is used to identify strengths and weaknesses in children with ASD as well as other developmental disorders.

Procedure

A research assistant visited all twenty participants at their homes every four months for a total of three visits. Additional visits were conducted but not included in this study. During the first session, the child was administered the ADOS (Lord, Rutter, and Le Couteur, 1989) and the Mullen Scales of Early Learning (Mullen, 1995); the caregiver was also interviewed using the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, and Le Couteur, 1994); and the Vineland Adaptive Behavioral Scales (Sparrow et al., 2005).

As part of the first visit, the child and the mother next participated in the Screening Tool for Autism in Two Year Olds (STAT; Stone, Coonrod, Turner, and Pozdol, 2004). The STAT is a 15-20-minute procedure that attempts to elicit "children's symbolic play, joint attention, imitation, communication, and reciprocal social behavior" (Mash and Barkley, 2007). There are

twelve activities involved, including turn-taking (in which the adult rolls the ball or toy car to a child), inflating a balloon and letting it go to elicit requesting, and presenting a bag of toys for the child to explore (Stone et al., 2004). The first fifteen minutes of the thirty-minute play session within this study were dedicated to these activities; this first half can be referred to as structured play. In the second half of the session, the mother was instructed to let the child engage in free play.

Coding

The videos were displayed in Quicktime and analyzed with ELAN (Brugman and Russel, 2004), a computer program capable of measuring milliseconds of streamed data specifically designed for studying language and communication. All visits were coded for number of joint attention episodes, duration of the episodes (total seconds and average seconds per episode), source of the episodes (i.e., who initiated, who responded), number of toys used during the episodes, and the different toys used (see Table 2 for a list of the toys and their categories).

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The joint attention episodes were assigned to one of four categories. The two main categories were coded in the following manner: a notation was made when the mother or child started the process. A mother initiating a joint attention episode would point or gaze in a direction to call the child's attention to an object, often including vocalization. If the child then turned from what he or she was looking at towards the object intended by the mother (a response), the joint attention episode would begin. The episode would continue as they looked at the object or one another. It ended when they stopped looking at each other or the object. Initiation of the joint episode by the child (and response by the mother) could also unfold with the child as the propagator of the action.

Alternatively, a child may already be involved with an object when his mother joins in and tries to manipulate the object. If the child did not leave the episode, it was counted as an example of initiation of joint attention. This likely led to an inflation of child initiations that were counted in the final tally. Children rarely followed their mothers' lead when they were both concentrated on different objects, but if they did, response to joint attention was coded.

Ten percent of the videos (6 of 60) were coded for reliability by an advanced undergraduate student. The coders agreed on joint attention boundaries, initiations, and responses 88% of the time.

Results

Table 1 shows the children's CDI scores by group over the course of three visits. Children with ASD were reported to have smaller vocabularies than TYP children at Visits 2 ($t(18) = 5.04$, $p<.001$) and 3 ($t(18) = 7.11$, $p<.001$), but not at Visit 1 (recall the groups were selected to be matched at Visit 1).

Table 3 presents the number of joint attention episodes that took place between mothers and children. No significant difference between the groups in frequency of episodes was found at any visit.

Table 4 shows the total amount of time the children spent in joint attention. That is, out of the 30-minute play sessions, children spent approximately half of the time engaged in joint attention. The difference between groups was significant at Visit 2 ($t(18) = 4.09$, $p = .001$), when TYP children spent about 5 more minutes engaged in joint attention than children with ASD. At Visit 3, the amount of time approached significance ($t(18) = 1.86$, $p = .079$); the TYP children still led in duration of the episode, but the children with ASD's duration had increased three minutes.

Table 5 displays the average duration of episodes the children and their mothers were involved in. Episodes of joint attention tended to last about 30 seconds. There were no significant differences in episode duration between the groups.

Table 6 shows that mothers in both groups initiated joint attention episodes more than twice as frequently as did their children at all three visits. Two-way ANOVAs revealed these differences were significant at Visit 1 ($F(1, 18) = 106.93$, $p<.001$), Visit 2 ($F(1,18) = 68.07$, $p<.001$), and Visit 3 ($F(1,18) = 57.82$, $p<.001$). At Visit 1, a marginally significant interaction of source of initiation of joint attention episodes between the TYP and ASD groups was found ($F(1,18) = 3.88$, $p = 0.064$). Post-hoc t-tests revealed that TYP children initiated joint attention more frequently than the children with ASD ($t(18) = 3.52$, $p=.002$). At Visit 2, a similar interaction between the TYP and ASD groups was obtained ($F(1, 18) = 5.60$, $p=.029$); again, the TYP children initiated more joint attention episodes than the children with ASD ($t(18) = 3.68$, $p = .002$). At Visit 3, no significant interaction emerged, nor did any pairwise differences between the groups. One-way ANOVAs performed across visits found no significant difference in RJAs or IJAs for either group.

Table 7 shows the percentage of time children spent with each category of toy. There was a significant difference across categories: the children consistently preferred to play with inanimate objects rather than toy animals and humans and everyday items at Visit 1 ($F(2,36)=75.29$, $p<.001$), Visit 2 ($F(2,36)=75.3$, $p<.001$), and Visit 3 ($F(2,36) =75.67$, $p<.001$). Eleven inanimate toys were presented during the free play, while 7 of each of the other categories were available.

Correlations were next performed to find how the children's behavior might be associated with other measures at the same visit. No significant correlations were found in the TYP

children at any visit. However, within the ASD group at Visit 1, the number of times the mothers engaged in joint attention was correlated with the number of episodes (r = .64, p = .04). Also at Visit 1, the children's ADOS scores significantly correlated with the number of JA episodes (r = .81, p = .004). This finding would imply that children with more severe ASD engaged in more episodes at Visit 1. The ADOS further correlated with the frequency of initiation of JA by the mothers (r = .75, p = .01). The mothers of children with autism initiated more episodes if their child was more severely autistic.

At Visit 2, the number of episodes again correlated with the number of times mothers initiated joint attention (r = .86, p = .001). Mother initiation of JA also correlated with the children's CDI scores (r = .72, p = .001). Mothers who directed their children more frequently towards objects in the STAT had children with higher vocabulary scores. The CDI also correlated with the number of JA episodes (r = .79, p = .006). That is, children who engaged in more JA episodes had higher vocabulary scores. Also, the Vineland communication scores were significantly related to the number of mother-initiated joint attention episodes (r = .73, p = .01). Mothers who initiated more JA episodes were reported to have children with higher Vineland communication scores. Similarly, mothers who initiated more JA episodes had children with higher Vineland receptive language scores (r = .68, p = .02). The Vineland motor scores correlated with the duration of JA episodes (r = .65, p = .04). That is, children who were reported to have better fine motor skills also sustained JA for a greater proportion of the session. At Visit 3, the only correlation that existed was between the child's initiation of JA episodes and the number of JA episodes (r=.64, p=.04). Thus, children who initiated more JA episodes also engaged in more JA episodes.

Discussion

Children with autism spectrum disorders (ASDs) often develop language delay, a communication-based discrepancy that sets them apart from the typical population. Joint attention is a nonverbal communicative behavior that has been reported to be impaired in children with ASD. The present study was designed to compare how ASD and TYP children's joint attention skills changed improved over the course of 12 months, and to examine whether their language changed as well. Overall, the children with ASD demonstrated joint attention skills to a lesser degree than TYP children and also a smaller vocabulary by Visit 3.

The hypotheses of the study were that that language measures would show different vocabulary gains across groups, that differences in joint attention could be seen in age-matched children of TYP and ASD group, that language measures would show different vocabulary gains in both groups, that mothers could elicit joint attention from children in both groups, and that duration of joint attention and choice of toy category would lead to gains in vocabulary.

The CDI language scores increased steadily in both groups, though at Visits 2 and 3 the TYP children had more robust vocabularies than the children with ASD as hypothesized. This does not reflect individual differences however; several children in the ASD group showed tremendous gains (e.g. At Visit 3, Alfie was reported to produce 566 words and Jerry 580 words) while a few showed imperceptible increases (e.g., At Visit 3 Ryder was reported to produce 7 words and Omar none). The TYP group developed more uniformly as a whole.

Mothers of children in either group successfully initiated similar numbers of joint attention episodes. Correlations at Visit 1 and 2 included a positive relationship between the frequency of joint attention episodes and the number of times mothers engaged in joint attention. Also at Visit 1, the ADOS further correlated with the frequency of initiation of JA by the mothers. At Visit 2, maternal initiation of JA correlated with the children's CDI scores. All of

these findings indicate the importance of maternal input in their childrens' vocabulary and that younger children with ASD were directed more often towards objects. Mothers of children with ASD were equally or more involved than mothers of TYP children in the STAT sessions.

The analysis of total duration of joint attention revealed that the TYP children spent about 5 more minutes in JA than the ASD group at Visit 2. Therefore, TYP children engaged in JA for a greater proportion of the second visit than ASD children. This finding was marginally significant at Visit 3.

However, the frequency of initiation of joint attention was also an important factor contrary to the hypothesis. At visits 1 and 2, TYP children initiated significantly more joint attention episodes than children with ASD. This finding replicates several joint attention studies mentioned thus far (Luyster et al., 2008; Siller and Sigman, 2008; Bruinsma et al., 2004; Osterling and Dawson, 1994). At Visit 3 in the present study, however, the children with ASD appeared to catch up. That is, there was no significant difference between the children's IJA at Visit 3.

Also, at Visit 2, children who engaged in more total JA episodes (IJA or RJA) had higher vocabulary scores. This finding is critical to the hypothesis that joint attention skills influence language development. If children are directed or direct others towards objects more often, their vocabulary skills may increase as a result. The only correlation at Visit 3 was between the child's initiation of JA and the number of JA episodes. This finding could also imply that children with ASD appear more like TYP children by Visit 3, which may be representative of the language delay.

One strange finding was that the ADOS scores rose as frequency of episodes increased at Visit 1. This could mean that children with more severe ASD divert their attention more often

than typically developing children at a young age, in contrast to the study conducted by Landry and Bryson (2004). This correlation decreased over time, which could be due to maturity or possibly the concurrent intervention.

At Visit 2, the duration of JA was correlated with the Vineland motor skills scores, meaning that the more coordination children had, the more likely they were able to engage in joint attention for longer periods of time. This finding could mean that by working on motor control and refinement, children may be able to focus on objects for longer periods of time and thus learn more about their unique and universal qualities.

ASD children did not differ significantly from the TYP group in their choice of toys. Both groups of children preferred to play with inanimate objects than the other two categories across visits. This may also be a result of the STAT structural play procedure. An explanation for the children with autism could be that imaginative play is lacking in this population. Both groups of children may have been more inclined to play with other toys had they been available at the time as well. Toy choice is seemingly not a critical factor to language development though this could change in a context where very few novel objects are introduced to a child.

Limitations of this study include the small sample size of ten children in each group. However, analysis of three visits assisted with increasing the validity of the study. More visits could be conducted to provide more evidence for these results. Also, females and males were not equally represented (10 males with ASD, 7 TYP males). ASD is most often diagnosed in males (CDC, 2007), which may partially account for the development of the participant pool. Future studies will strive to maintain a 4:1 ratio of male to females to better represent the population. Furthermore, cross-lagged correlations between joint attention skills and language measures should be performed to determine how JA might predict language development

longitudinally. By partialing out other factors such as non-verbal IQ and chronological age, we might be able to see a more direct relationship between the two factors of interest.

Joint attention in children is a collection of nonverbal behaviors that often correlates with or predicts the ability to acquire language. Studies exploring the nature of joint attention have helped discern its specific importance in children with autism. It seems that response to joint attention may play a strong role in the development of language based on maternal guidance. The lack of initiation of joint attention can also be concurrent with smaller language gain seen in young children with autism. The implications of this finding can be further studied as training is developed to help children become more comfortable with nonverbal communication and subsequently expressive language skills. By focusing joint attention training on the interaction between children and their parents, these skills will likely generalize to communication in other critical relationships the child will make.

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Table 1

CDI and Vineland Scores (Mean and Standard Deviation)

	CDI (out of 396 at Visit 1, out of 680 at Visits 2 and 3)			Vineland (standard score)		
Group	Visit 1	Visit 2	Visit 3	Visit 1	Visit 2	Visit 3
TYP	108.9	364.9	498.9	105	113	110.2
	(97.34)	(147.41)	(172.64)	(7.59)	(11.16)	(8.02)
ASD	100.6	228.5	304.6	77.4	79.7	81.6
	(111.90)	(228.32)	(250.90)	(20.55)	(21.43)	(23)

Table 2

Specific Toys Used Across Categories

Inanimate Objects	Toy Animals and Humans	Everyday Objects
Bag (with toys inside)	Baby doll	Bathtub
Ball	Bear	Blanket
Balloon	Elephant	Bottle
Blocks	Fish	Brush
Book	Frog	Cup
Jack-in-the-box	Rabbit	Snack Container
Pop-up game	Snake	Sponge
Puzzle		
Remote Control Car		
Schoolbus		

Table 3

Frequency of JA Episodes (Mean and Standard Deviation)

Group	Visit 1	Visit 2	Visit 3
TYP	35.10	33.8	34.9
	(8.05)	(7.50)	(9.84)
ASD	29.90	28.8	34.4
	(7.85)	(8)	(8.48)

Table 4

Total Duration of JA Episodes in Minutes (Mean and Standard Deviation)

Group	Visit 1	Visit 2	Visit 3
TYP	17.46	18.97	19.83
	(4.76)	(2.57)	(2.26)
ASD	16.05	13.45	16.29
	(4.17)	(3.39)	(5.56)

Table 5

Average Duration of Joint Attention Episodes in Seconds (Mean and Standard Deviation)

Group	Visit 1	Visit 2	Visit 3
TYP	30.48	36.13	36.16
	(6.92)	(11.99)	(9.66)
ASD	30.37	29.23	30.16
	(10.73)	(8.58)	(13.45)

Table 6

JA Initiations by Participant (Mean and Standard Deviation)

	Child Initiation			Mother Initiation		
Group	Visit 1	Visit 2	Visit 3	Visit 1	Visit 2	Visit 3
TYP	9.7	11.3	11.1	25.0	23.6	27.0
	(4.66)	(5.40)	(4.01)	(6.25)	(4.60)	(6.74)
ASD	3.7	3.8	7.40	26.2	26.0	23.9
	(2.66)	(3.45)	(7.41)	(7.87)	(9.30)	(7.56)

Table 7

Average Percent of Time of Entire Interaction Spent Playing with Toys of Different Categories (Mean and Standard Deviation)

	Inanimate Objects			Toy Animals and Humans			Everyday Items		
Group	Visit 1	Visit 2	Visit 3	Visit 1	Visit 2	Visit 3	Visit 1	Visit 2	Visit 3
TYP	57	58.61	57.46	20.8	22.3	23.77	20.90	19.09	18.77
	(8.24)	(5.86)	(7.58)	(5)	(8.89)	(8.82)	(7.78)	(6.02)	(7.20)
ASD	60.50	59.6	62.74	15.5	29.95	17.88	23.2	18.45	19.39
	(12.26)	(8.04)	(10.75)	(12.58)	(7.57)	(9.91)	(8.53)	(6.13)	(12.9)