Longitudinal Follow-Up of Children With Autism Receiving Targeted Interventions on Joint Attention and Play

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Objective: This study examines the cognitive and language outcomes of children with an autism spectrum disorder (ASD) over a 5-year period after receiving targeted early interventions that focused on joint attention and play skills. **Method:** Forty children from the original study (n = 58) had complete data at the 5-year follow-up. **Results:** In all, 80% of children had achieved functional use of spoken language with baseline play level predicting spoken language at the 5-year follow-up. Of children who were using spoken language at age 8 years, several baseline behaviors predicted their later ability, including earlier age of entry into the study, initiating joint attention skill, play level, and assignment to either the joint attention or symbolic play intervention group. Only baseline play diversity predicted cognitive scores at age 8 years. **Conclusions:** This study is one of the only long-term follow-up studies of children who participated in preschool early interventions aimed at targeting core developmental difficulties. The study findings suggest that focusing on joint attention and play skills in comprehensive treatment models is important for long-term spoken language outcomes. J. Am. Acad. Child Adolesc. Psychiatry, 2012;51(5):487–495. **Key Words:** autism, intervention, joint attention, symbolic play, language

Young children with autism spectrum disorders (ASD) are noted for a constellation of developmental difficulties that differentiate them from other children.[1,2] These early difficulties center primarily on social and communication skills, such as joint attention, imitation, affective sharing, and object play skills. Longitudinal studies document the importance of these early skills to later developmental outcomes and particularly spoken language, a core developmental problem of autism.[1,3] Several examples include the following: motor imitation skills at age 2 years led to greater language at age 4 years, initiating joint attention at age 2 was associated with better language outcomes at age 5 years[4,5]; and responding to joint attention at age 3 to 5 years predicted better language outcomes 1 year later[3] and 8 years later.[6] Theoretically, these early skills may affect language outcome because they require a shared focus of attention that enables the child to acquire the types of skills that are socially learned, such as language.[7,8]

Perhaps the greatest goal of early intervention for children with autism is to gain functional spoken language by entry into school at age 5 years. Indeed, acquiring spoken language before age 5 has been heralded as the single most important achievement leading to the best social outcomes of children with autism.[9-12] Thus one approach to improving spoken language outcomes is to target the prelinguistic skills that develop before the onset of spoken words (e.g., gestures used for sharing attention with another about an event or common interest) and that are impaired in children with autism.[13,14] These gestures include pointing to share, showing an ob-

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ject, and coordinating looks between people and objects.

There is ample evidence that these early skills are important to later spoken language outcomes in children with autism and that they should be teaching targets for early intervention programs.[1,15] Over the past 10 years, comprehensive early intervention programs have focused greater effort on improving joint attention, imitation, and play skills in young children.[16,17] We also have amassed a great deal of evidence of the effectiveness of comprehensive early interventions on the developmental outcomes of children with ASD when interventions are delivered with intensity, at least 20 hours per week for several years.[18] However, because early skills in joint attention and play are rarely assessed before and after intervention, we have little information on how they might change with specific interventions, and whether changes in these skills account for improvements in developmental outcomes. In general, greater change is identified in cognitive developmental domains compared to spoken language, with language outcomes requiring longer durations of intervention.[18] For example, in two randomized controlled experiments examining outcomes of comprehensive intervention, spoken language standard scores significantly improved only after 2 years of intensive treatment in one study[19] and were nonsignificant in the other.[20]

An issue is whether interventions that directly target joint attention might yield better language outcomes.[21] Recent studies that have directly taught these early skills have had mixed results. The reasons for these inconsistent findings may relate to the intensity in which the intervention was delivered and/or the method of delivery. For example, two studies implemented a parent education model in which there was only a small amount of direct intervention with children. One study found significant change in children's social communication skills when the intervention was delivered over 12 months,[22] but neither study found significant main effects on language outcomes for the experimental intervention compared to a no-treatment control group.[22,23] Thus, whether the intervention comprised 11 sessions of intervention over 3.5 months[23] or 18 sessions over 1 year,[22] findings were similar and may relate to the minimal direct intervention with children (as opposed to parents), or to the low intensity of the intervention in general. Most children participated in additional community interventions, with nonsignificant differences across groups. Similarly, in a toddler classroom study, overall improvements in cognition and language were noted for children in two classrooms, one in which joint attention and imitation were infused into the curriculum, and one in which this focus was not included.[24] Compared to children in the control classroom, the children in the experimental classroom showed significantly better imitation skills at the end of treatment. No other group main effects were noted at the end of treatment or in cognitive and language outcomes 6 months later.

Changes in language development may come about with a certain level of intensity of intervention, as well as targeted focus on the content of the interventions. For example, significant effects on joint attention skills were found in a study in which focused content on joint attention was delivered by skilled interventionists for 30 minutes daily over an average of 6 weeks and layered into an intensive early intervention program of 30 hours per week.[25] This randomized controlled study also included a targeted play intervention and a control group receiving only the standard preschool program. Not only did joint attention skills improve relative to the control group, but children also demonstrated significantly greater spoken language scores 1 year after the end of intervention.[26] In this study, children receiving the play intervention also demonstrated significantly improved language scores 1 year later, suggesting that the joint attention and play interventions had a common mechanism of joint engagement between adult and child affecting language. Theoretically, joint engagement serves as a platform for the continued development of social, communication, and language skills over time.

These data suggest there are benefits to focused content on joint attention and play skills in early intervention programs of sufficient intensity. Furthermore, language outcomes improved at least 1 year post intervention. However, to date we have limited data on the long-term effects of children's early intervention experiences. Indeed, most rigorously tested (randomized controlled) early intervention studies report limited or no follow-up data.[19,20] One example of a long-term follow-up of early intervention was reported recently. This 7-year follow-up study was noncontrolled/nonexperimental; children

TABLE 1 Comparison of Returners Versus Discontinuers

	Returners n = 40, n (%)	Discontinuers n = 18, n (%)	*p* Value
Gender			
Male	33 (82)	13 (72)	$p = .38$
Female	7 (18)	5 (28)	
CA at baseline	42 (6)	43 (5)	$p = .57$
IJA	4.1 (2.8)	3.5 (2.5)	$p = .46$
SYMPLAY	2.9 (3.2)	3.0 (3.6)	$p = .91$
PLEVEL	6.0 (2.3)	5.9 (2.3)	$p = .81$
FUNPLAY	12.3 (5.0)	12.8 (5.3)	$p = .72$
RJA	9.1 (5.4)	8.9 (4.0)	$p = .87$
Treatment group			$p = .76$
Joint Attn	15 (37)	5 (28)	
Sym Play	14 (35)	7 (39)	
Control	11 (27)	6 (33)	

Note: CA = Chronological Age; FUNPLAY = Functional Play Types; IJA = Initiate Joint Attention; PLEVEL = Play Level; RJA = Responds Joint Attention; SYMPLAY = Symbolic Play Types.

received 2 years of intensive community based early intervention services and assessments before enrollment and again at 7 years post intervention.[27] Assessments were standardized measures of cognition, language, adaptive behavior, and severity of diagnosis. Results indicated great variability in this sample, but time 1 scores on assessments tended to predict scores on the 7 year follow-up; thus early cognitive abilities predicted later cognitive abilities. This study did not examine early core social communication skills as predictors of later language and cognition.

The current study reports on 5-year follow-up data for the original targeted intervention study in which 3- to 4-year-old children were randomized to a joint attention, symbolic play or control group within the same intensive early intervention program.[25] We were particularly interested in the long-term effect on expressive language outcomes of early interventions that targeted core deficits of joint attention and play skills. Our first aim was to determine the spoken language outcomes of this group of children 5 years post treatment, at age 8 to 9 years. Second, we examined predictors of language and cognitive development at age 8 to 9 from early assessments of joint attention and play at ages 3 to 4 years. We hypothesized that both joint attention and play abilities would predict more positive developmental outcomes in children with autism spectrum disorder.

METHOD

Participants

The original randomized controlled trial (RCT) consisted of 58 participants who met the following inclusion criteria: a diagnosis of ASD on the Autism Diagnostic Interview—Revised[28] and the Autism Diagnostic Observation Schedule[29]; no seizures or medical co-occurring conditions; and age less than 5 years. The sample consisted of 20 children in the joint attention (JA) group, 21 children in the symbolic play (SP) group, and 17 children in the control (CO) group. Of the 58 children in the original study, 40 children returned for the 5-year follow-up assessments. Of the 18 children who did not return, 5 (28%) were assigned to the JA treatment, 7 (39%) to the SP treatment and 6 (33%) to the control group. These ratios are not different from the ratios in the returning children (15 [37%], 14 [35%], and 11 [27%] respectively, χ^2 (2) = 0.55, p = .76) (Table 1).

The present sample of 40 children consists of mostly males (82%) with an average age of 8 years, 8 months. The mothers of these children were highly educated, with a mean of 16.9 years of education (Table 2).

The ADOS was re-administered to all 40 children at the follow-up. Because of the different developmental and language abilities of the children, 8 children were administered Module 1 of the ADOS, 5 children were administered Module 2, and the remaining 27 were administered the Module 3. Of the children, 26 met criteria for Autism, 8 met criteria for Autism Spectrum Disorder (ASD), and 6 children did not meet criteria for autism or ASD, but displayed elevated scores on the ADOS indicative of the broader autism phenotype. Of the 40 children, 32 met the basal criteria (2 years, 6 months) of functional usage of language on the Expressive Vocabulary Test,[30] and were tested

TABLE 2 Demographic Characteristics of Study Patients

	Mean n = 40	SD
CA at return visit	106	7
CA at baseline	42	6
Gender, n (%)		
Male	33 (82)	
Female	7 (18)	
Ethnicity, n (%)		
African American	1 (3)	
White	27 (69)	
Hispanic	1 (3)	
Asian	5 (13)	
Other	6 (15)	
Mother's age (y)	36	4.9
Mother's education (y)	16.9	2.5

Note: CA = chronological age.

TABLE 3 Developmental Characteristics

	JA n = 15 Mean (SD)	SP n = 14 Mean (SD)	Control n = 11 Mean (SD)	Total n = 40 Mean (SD)	*p* Value
Baseline					
IJA	3.95 (2.32)	4.31 (3.07)	3.29 (2.74)	3.89 (2.72)	.52
RJA	8.92 (4.49)	9.47 (5.27)	8.67 (5.36)	9.05 (4.96)	.88
PLEVEL	6.44 (2.03)	5.37 (2.43)	6.17 (2.24)	5.98 (2.54)	.29
FUNPLAY	12.15 (6.34)	12.14 (5.23)	13.23 (3.09)	12.46 (5.09)	.77
SYMPLAY	3.82 (3.84)	2.09 (2.54)	2.91 (3.23)	2.93 (3.26)	.24
Follow-up					
Cognitive and language ability					.67
>30 Months	13 (87%)	11 (79%)	8 (73%)	32 (80%)	
<30 Months	2 (13%)	3 (21%)	3 (27%)	8 (20%)	
Diagnostic group					.39
Nonspectrum	5 (33%)	1 (7%)	2 (18%)	8 (20%)	
Autism	9 (60%)	11 (79%)	7 (64%)	27 (67%)	
ASD	1 (7%)	2 (14%)	2 (18%)	5 (13%)	
DAS (standard score)	93.5 (22.32)	87.73 (17.96)	89.23 (13.13)	90.44 (18.51)	.75
EVT (standard score)	86.5 (18.9)	86.4 (19.3)	80.5 (22.3)	85.0 (19.4)	.77
School assignment (n = 40)					.14
Reg. Ed. Classroom	3 (20%)	0	2 (18.2%)	5 (12.5%)	
Reg. Ed. + Special Ed.	8 (53.3%)	7 (50%)	2 (18.2%)	17 (42.5%)	
Special Ed. Classroom	4 (26.7%)	7 (50%)	7 (63.6%)	18 (45%)	

Note: ASD = autism spectrum disorder; DAS = Differential Abilities Scale; EVT = Expressive Vocabulary Test; FUNPLAY = Functional Play Types; IJA = Initiates Joint Attention; PLEVEL = Play Level; RJA = Responds Joint Attention; SYMPLAY = Symbolic Play Types.

with this measure and the Differential Abilities Scale (DAS)[31] (Table 3).

Procedures

All children in the original RCT attended the same hospital-based early intervention program (EIP) consisting of 30 hours of behavioral treatment per week. At the time of their admission to EIP, children were randomized to one of three experimental treatment conditions: JA intervention, SP intervention, or the control condition. Families were re-contacted five years post entry into the study, and returning families visited UCLA for two separate visits, each lasting roughly 2 hours.

Assessments

Testers who were blinded to group status and who were not part of the original RCT study administered all assessments.

Language Assessment at 5-Year Follow-up. The Expressive Vocabulary Test[30] is a standardized assessment of expressive vocabulary for children and adults aged 2 years, 6 months to 90 years. This test is a quick measure of expressive vocabulary. The measure was administered at the follow-up, and although it was expected that all 40 children would be able to complete the measure, only 32 children received valid scores.

Cognitive Assessment at 5-Year Follow-up. The Differential Abilities Scale[31] measures cognitive abilities in children from 2 years, 6 months through 17 years, 11 months across a broad range of developmental levels. The Global Intelligence composite (GCA) is derived from the six core subtests: Recall of Designs, Word Definitions, Pattern Construction, Matrices, Similarities, and Sequential and Quantitative Reasoning. The measure was administered at the follow-up assessment. Although it was expected that all children would be able to score above the basal of 2 years, 6 months, a subgroup of 8 of the 40 participants did not receive valid scores.

Assessments from the Baseline Visit (age 3-4 years). Early Social Communication Scales (ESCS). The ESCS is a semi-structured behavioral assessment during which the child and tester sit facing each other at a table with a set of toys in view but out of reach of the child.[32] Toys include several small wind-ups and hand-operated mechanical toys, a hat, comb, glasses, ball, car, balloon, and book. The child is presented with three trials each of the wind-up and hand-operated toys, and two trials of a social song/game. The procedure is videotaped and later scored by raters blind to treatment status.

The major variables of interest for this study are the same variables reported in earlier papers and include the frequency on both initiations and responses to joint attention (JA) behaviors.[25,26] Initiations included coordinated looking, distal pointing, proximal pointing, and showing. Responses included responding to experimenter points and gaze. Inter-rater reliability was high between blinded coders (ICC = 0.79 for initiations and 0.82 for responses).

Structured Play Assessment (SPA). The SPA is a semi-structured play assessment during which the child is presented with toys at a table.[33] Toys consist of 4 different sets. Set 1 has a tea set and two dolls. Set 2 has a telephone, brush, mirror and two dolls. Set 3 is a set of furniture with several small dolls, and set 4 is a garage with blocks, a truck and a small figure. The child's play behaviors are taped and later coded.

The variables used in this study include (a) functional play types, (b) symbolic play types, and (c) play level. Functional play type refers to the number of different novel child-initiated functional play acts. An example would be a child who puts a spoon to his mouth (Type 1) or puts a comb to his hair (Type 2). The number of types is two; the frequency of acts is not factored into the type variable. Symbolic play type refers to the number of different novel child-initiated play acts. Play level refers to the highest, most frequent and flexible level at which the child played with mastery. Mastery was defined as the highest spontaneous play level attained with at least three different types of that level. Play level ranged from 1 (single acts with objects) to 14 (socio-dramatic).[33,34] Inter-rater reliability of blinded coders (ICC) was 0.97 for functional play types, 0.99 for symbolic play types and 1.0 for play level.

Parent-Child Interaction (PCX). The PCX is a 15-minute naturalistic play interaction between the parent and child. The dyad is asked to play as they normally would with a standard set of toys consisting of several doll figures, furniture, a tea set, pretend food, a ball, building blocks, and a truck.

The PCX was coded for joint attention and play behaviors using the same codes as those from the ESCS and the SPA. The variables of interest include the frequency of joint attention initiations and responses, the highest level of mastered play, and the number of functional and symbolic play types. Blinded coders rated tapes with ICC values ranging from 0.78 to 1.0.

Data Analysis Plan

The main goals of this study were to first identify predictors of both cognitive and spoken vocabulary ability and then to evaluate the relative contributions of the different predictors to the outcome based on a conceptual framework.

The approach to identifying predictors was forward stepwise regression. This approach allowed us to determine which of a large set of predictors had the greatest predictive value. For the primary outcome of DAS ability level >30 months, we used a logistic link function to account for the dichotomous nature of the variable; for the continuous outcomes DAS and EVT, we used the canonical link function. We specifically chose the forward approach to address the relatively small sample size in relation to the number of potential predictors. The set of potential baseline predictors included gender of the child (GENDER), chronological age at assessment (CA), mothers education (MED), average of PCX and ESCS joint attention initiations (IJA), average of PCX and ESCS joint attention responses (RJA), average of PCX and SPA functional play types (FUNPLAY), average of PCX and SPA symbolic play types (SYMPLAY), average PCX and SPA play level (PLEVEL), and the treatment group (TX) the participants were assigned to at baseline.

When multiple predictors were identified, we used a hierarchical regression approach to establish the relative contributions of this set of predictors to the outcome variable. To maximize the interpretability of the results, we grouped the potential predictors into demographics, core deficits, and treatment characteristics, and entered them in that order. This approach ensures that the relative contributions associated with each variable are estimated controlling for the contributions of lower level variables. This ensures that though many of the predictors are correlated with each other, we are able to determine unique contributions of specific variables beyond what has been explained by the lower level variables. In doing so, we avoid the problem of when predictor variables are correlated; some of the explained variance is associated with variability that is shared between the predictors.

RESULTS

Descriptive Data at Follow-up

Of the 40 participants with complete follow-up data, five were enrolled in a regular education settings with no special education services (Reg. Ed. Classroom); 17 were enrolled in a regular education classroom with some special education support (Reg. Ed. + Spec. Ed.), mostly in the form of a few hours of additional pull out services for speech therapy or social skills; and 18 were in special education classroom (Special Ed. Classroom). There was no difference in the number of children who were assigned to each placement by treatment group (χ^2 (4) = 6.87, p = .14) (Table 2).

Prediction of Spoken Vocabulary

A forward hierarchical regression with a logistic link function was used to characterize the best

TABLE 4 Expressive Vocabulary Test (EVT) Hierarchical Regression

	β	SE(β)	R^2	F	p	Δ^2	F	*p*
CA	−1.07	.47	.14	5.05	.03	.14	5.05	.03
CA	−1.06	.42	.36	8.33	<.01	.22	10.09	<.01
IJA	3.45	1.08						
CA	−1.05	.35	.57	12.47	<.01	.21	13.53	<.01
IJA	2.29	.96						
PLevel	4.78	1.30						
CA	−1.11	.33	.64	11.89	<.01	.07	4.91	.03
IJA	2.04	.91						
PLevel	5.42	1.25						
Tx	11.7	5.29						

Note: *CA = Chronological Age; IJA = Initiate Joint Attention; PLevel = Play Level; Tx = Treatment group.*

predictors of those children who achieved the basal EVT score of 2 years, 6 months (n = 32) from those who did not (n = 8). The only predictive variable was the initial play level (PLEVEL) ($\chi^2 = 18.15$, $p < .01$, $R^2 = 0.58$). At baseline, the average play level of the 8 children who were unable to achieve scores on the EVT at the 5-year point was 3.3 (SD = 1.1) (essentially single acts), whereas the average play level of the other 32 children at baseline was 6.7 (SD = 2.0) (early combination play).

Prediction to Cognition at Age 8 Years

For the subgroup of children (n = 32) who were able to complete both the DAS and EVT measures, a forward hierarchical regression was used to identify the best predictors of cognition and language ability. For overall cognitive ability, measured by the DAS, the only predictor selected from the candidate set was functional play types ($F_{1,30} = 14.62$, $p < .01$). For a 1-unit increase in functional play types, there was a 2.12 (SE = 0.55) standard score increase on the DAS.

Prediction to Spoken Vocabulary at Age 8 Years

For the EVT, the predictor set identified by the forward hierarchical regression included age at the first assessment, joint attention initiations, play level, and treatment assignment ($F_{5,26} = 9.22$, $p < .01$, $R^2 = 0.57$). On average, the children gained a standard score of 1.1 (SE = 0.3) in spoken vocabulary ability per month that they enter the treatment earlier and they gain a standard score of 2.1 (SE = 0.9) in spoken vocabulary ability per one frequency increase in joint attention initiations. Similarly, spoken vocabulary ability increased by 5.8 (SD = 1.3) per increase in play level at baseline. The JA treatment group scores on average 12.5 (SE = 5.8) points higher than controls on the language measure, and the SP treatment group scores an average of 10.6 (SE = 6.2) points higher on the language measure than the control group. The difference between the treatment groups was nonsignificant ($p = .61$).

To further elaborate on the relative impact of the variables identified above, we conducted hierarchical regressions with three groups of outcome predictors (demographics, core deficits, treatment characteristics) entered sequentially to identify their relative contributions to the overall prediction of spoken vocabulary ability (Table 4).

The only demographic variable defined above, chronological age at the beginning of the study predicts by itself 14% of the variability of spoken vocabulary ability at age 8. This contribution is significant ($p = .03$). Initiation of joint attention adds an additional 22% of explained variance, for a total of 36% of the explained variance ($p < .01$). The unique contribution of play level beyond this is another 21% ($p = .03$), and even after controlling for these variables treatment assignment adds another 7% ($p = .03$). The model including all these predictors explains about two-thirds (64%) of the variability of spoken vocabulary ability at the 5-year follow-up point, and all these variables show unique, specific contributions

that cannot be explained by conceptual or methodological overlap, or general impairment.

DISCUSSION

This study examined the longitudinal outcomes of children who participated in a randomized controlled early intervention study at 3 to 4 years of age. There were three main findings. First, we were interested in functional spoken language as a main outcome of this social communication early intervention program. The majority of children (80%) whom we tested at the follow-up had useful, functional spoken language by age 8 to 9 years consistent with other longitudinal studies of children with autism.[27,35] In this study, only one predictor was significant in identifying children who were able to use functional spoken vocabulary. Children with higher play levels when they were 3 to 4 years of age were categorized in this group at the 5-year follow-up. Children who could demonstrate simple combination play at age 3 to 4 years were able to use functional spoken language versus children who played with objects indiscriminately, such as mouthing or banging, or with simple discriminations of pushing a pop-up toy. These data lend converging support to other studies that have suggested an important moderator of language outcomes is the child's ability to demonstrate object "interest," most likely reflecting an exploratory and functional level of play.[4,23]

Second, among the children who completed the assessments at the 5-year follow-up, only one predictor was associated with later cognitive skills as measured on the DAS. Children who showed more functional play types at baseline obtained better cognitive scores. Thus, these data underscore the importance of object play skills for children's cognitive development. It may be that diversity (which reflects flexibility in play) shown at a young age propels children toward greater exploration of objects and events in their environment that, in turn, allows for greater conceptual development. Play diversity along with a minimum level of play level ability (beyond indiscriminate and discriminate skills in which children are mouthing or banging toys) may be critical in pushing along cognitive skills in young children.

Third, spoken vocabulary was predicted by a wider set of factors than cognitive outcomes. Thus, beginning intervention at an earlier age, initiating more joint attention, demonstrating higher play levels and receiving the experimental interventions yielded greater spoken vocabulary scores at the 5-year follow-up. These findings are novel since other studies have not followed children long term after a randomized controlled intervention study, and have rarely tested early social communication skills as predictors of any measure of language outcome.

There is a general belief that beginning treatment as early as possible is associated with better outcomes. To date, our data have been fairly gross, with some data suggesting better outcomes for children who begin treatment before the age of 5 years.[36] With increasingly earlier identification of children with ASD, the age of beginning treatment has dropped to younger ages, with 2-year-olds routinely enrolled in early intervention. A recent nonexperimental follow-up study of 36 children who received intensive early interventions did not find a younger age advantage on later cognitive and language outcomes.[27] Characteristics of the sample of children in this study and the current study were comparable in average chronological, mental, and language ages, and likely in timeframe of data collection.[27] Thus, our data are inconsistent with the foregoing study but may be explained by several factors, including fewer hours of intervention per week in the nonexperimental study, and the recruitment of all children from the same early intervention program in the current study. Intensity of treatment hours very early may affect the trajectory of outcomes, although much more data are needed on this issue. As we gather more data on very early interventions (between 12 and 36 months), we will be in a better position to understand how important timing is in children's ultimate outcomes.

The finding that initiating joint attention and play level are both associated with better language outcomes is consistent with longitudinal data.[3] These data lend further support to focusing on these early developmental skills as a means of improving language outcomes. Importantly, treatment effects were long lasting in this study, with the joint attention intervention group gaining 12.5 expressive language standard score points and the play group 10.6 points above the control group. Thus these data are some of the first to demonstrate the long-term effectiveness of an intervention focused on early core deficits in autism.

These data are particularly important given the difficulty improving language outcomes in children with autism. Finding active ingredients of early interventions that may affect language long term is critical, and these data provide information on potentially important active ingredients. Implicated are the timing and the content (joint attention, play) of early interventions. Dose is also likely important.All of the children who participated in the original randomized study received 30 hours of intervention per week. The experimental interventions were short term (average of 6 weeks) but delivered every day. After the experimental intervention program, children continued to receive a minimum of 20 hours per week of community interventions. Thus, the difference in findings between the current study and other studies targeting social communication skills could be attributed to differences in the density of the experimental treatments and the additional background of significant hours of early intervention.

There are a number of advantages of the current study. One is that the original study was a randomized controlled trial that systematically tested whether the content of early interventions led to improved outcomes. Assessments were extensive during baseline, post intervention, and at follow-up, and were conducted by assessors who were blinded to child assignment and independent of the interventionists. However, there are also limitations to the study. The sample is relatively small, and follow-up assessments were obtained on approximately 70% of the original participants 5 years later. Although the children who did not come back for assessments were distributed across all three groups, we do not know if there was selective failure to return. Future research needs to follow children longitudinally, with particular efforts made to maintain the original sample. Another issue concerns the children who remained nonverbal at age 8. We need further description of these children, and likely more intensity and/or different combinations of novel methods to move these children to become verbal. Assistive technology is one approach that holds promise, particularly given the rapid growth in new technologies with application to autism. Future studies should focus on these children. Finally, we need better outcome measures of language ability. The EVT used in the current study does not capture more complex language use including pragmatics of language. Future studies will likely need multiple measures of language, including natural language samples, to capture meaningful changes in language ability.

In summary, this study provides evidence that targeted interventions on core deficits are important to later developmental outcomes. Early intervention programs should incorporate these targets into the curriculum in order to better affect long term meaningful outcomes. &

Accepted February 27, 2012.

Drs. Kasari and Gulsrud are with the Center for Autism Research and Treatment. Drs. Kasari, Gulsrud, Freeman, Paparella, and Hellemann are with the University of California at Los Angeles Semel Institute for Neuroscience and Human Behavior.

This research was supported by grants from the Collaborative Program of Excellence in Autism (P01-35470), Autism Centers of Excellence (P50-HD-55784), and Health Resources and Services Administration (UA3MC11055).

We appreciate the families and children who participated and assessors and coders: Susan Kwon, PhD, Eric Ishijima, M.A., Jason Lee, B.A. and Lizzy Karp, B.A. of the University of California at Los Angeles; Tracy Guiou, PhD, of Ohio State University; and Erin Rotheram- Fuller, PhD, of Temple University.

Disclosure: Dr. Kasari has received salary support from grants from Autism Speaks, the National Institutes of Health (NIH), and the Health Resources and Services Administration (HRSA). Dr. Gulsrud has received salary support from Autism Speaks, NIH, and HRSA. Dr. Hellemann has received salary support from grants from NIH, Division of Health and Human Services/Centers for Disease Control, and the Veterans Administration. Dr. Freeman has received salary support from NIH. Dr. Paparella has received salary support from NIH.

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0890-8567/$36.00/©2012 American Academy of Child and Adolescent Psychiatry

DOI: 10.1016/j.jaac.2012.02.019

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