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Improvement in Cognitive and Language Skills from Preschool to Adolescence in Autism

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This paper reports on the developmental progression of a sample of 48 adolescents and young adults with autism who were previously assessed at preschool age and again in the mid-school period. In contrast to the earlier period when about one-third of the children made dramatic gains, cognitive and language skills tended to remain stable or decline over this time span. The gain in mental and language age of the non-retarded adolescents with autism was less than half the change in their chronological age. The mentally retarded adolescents with autism showed some gain in mental age over time but this was far less than their change in chronological age, and they showed almost no gain in language age. Early childhood predictors of language skills in adolescence were functional play skills, responsiveness to others' bids for joint attention, and the frequency of requesting behaviors.

KEY WORDS: Developmental change; communication; pretend play; language.

INTRODUCTION

There is great variation in the cognitive and language skills of individuals with autism. Although the percentages differ from one study to another, the fact remains that a sizeable number of individuals with autism are quite capable in terms of language and cognitive skills while a considerable number of individuals have more limited abilities.

Many of the adults with autism who have good cognitive and language abilities did not show these in early life. Thus, one question that arises is when during childhood and adolescence this improvement in skills is manifested. Little is known about continuity and discontinuity in the development of children with autism. Most longitudinal studies of children with autism have either been short-term or have used only descriptive terms to describe the quality of social adjustment at outcome (Chung, Luk, & Lee, 1990; Gillberg & Steffenburg, 1987; Kobayashi, Murata, & Yoshinaga, 1992; Lotter, 1974). The results from a few studies suggest that cognitive abilities are variable from early childhood to middle childhood (Eaves & Ho, 1996; Lord & Schopler, 1989a, 1989b; Lord & Venter, 1992; Venter, Lord, & Schopler, 1992) but remain relatively stable from middle childhood to adolescence (Mesibov & Handlan, 1997). Gillberg & Steffenburg (1987) reported some deterioration of cognitive abilities during adolescence in a subset of individuals with autism. This deterioration in adolescence was associated with the pubertal onset of seizures.

The current study investigates the extent of improvement in a sample of about 50 children with autism followed from the preschool years to adolescence/early adulthood. Recruitment of the sample began in 1978 before specialized intervention programs were available to most families. Therefore, this study traces the cognitive and language development of children with autism who attended school and

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whose other intervention experiences were mostly restricted to speech therapy.

In a previous publication (Sigman & Ruskin, 1999), we documented the progress of this sample from 3 to 5 years of age into middle childhood. Forty-three children were administered developmental assessments or intelligence tests at recruitment and 39 of these children had scores in the mentally retarded range. At the follow-up, half the children with autism (22 of the 43) showed increases in IQs with the mean increase for this group equaling 22.38 points. About 28% of the mentally retarded children with autism (11 of the 39) showed sufficient intellectual development to move out of the mentally retarded range, although they continued to meet the criteria for the diagnosis of autism. Thus, a proportion of the sample of children with autism showed remarkable intellectual growth.

The issue investigated in the current study is whether this growth continued from the mid-school period to the adolescent/adulthood period. Based on the literature reviewed in the previous paragraph, we hypothesized that there would be much less dramatic change in intelligence over the period from middle childhood to adolescence.

We also expected little improvement in language skills over this later period based on our findings in the previous period. Over the period of 8–9 years, the 41 children with autism who were administered language tests at both ages made an average gain of only 28 months. The mean language age at recruitment was 18 months, which increased to 46 months during the mid-school period. Using a receptive language age of 24 months as a criterion for understanding of language, 9 of the 41 children with autism demonstrated some understanding of language at recruitment and follow-up, 23 children did not understand language at recruitment but did so at follow-up, and 9 children never demonstrated understanding of language. Mawhood, Howlin, and Rutter (2000) reported modest increases in language ability in a group of high functioning males seen originally at 7–8 years of age and again at 23–24 years of age with a gain of roughly 5–6 years in language age over the 15–16-year period.

In the present study, the initial intelligence levels of the children with autism who gained an understanding of language did not differ from the initial intelligence levels of those who did not gain such an understanding (although both groups were initially less intelligent than children who started the study with an understanding of language). These findings are very similar to those from a study by Lord and Schopler (1989a, 1989b). Thus, many children with autism made important gains in language skills over the 8–9-year period, but these improvements were still somewhat limited. We expected that language acquisition would level off at the mid-school period and less change would be seen by late adolescence.

Besides aiming to identify the extent of change in children with autism over the first two decades of life, the second aim of this study was to determine if the variables that predicted language gains in the previous follow-up in the middle school period continued to predict in the subsequent follow-up. Understanding the factors involved in the developmental course of language in autism remains a central question. Our variables of interest are early language, non-verbal social communication, and play skills, areas in which groups of individuals with autism tend to have deficits yet show a great deal of individual variability.

Research and theory suggests that non-verbal social communication, specifically joint attention, is predictive of later language abilities for both typically developing children and children with autism (Baldwin, 1991; Mundy & Crowson, 1997; Mundy & Sigman, 1989; Mundy, Sigman, & Kasari, 1990). Baldwin (1991) argues that learning words and object labels depends critically on the achievement of joint attention. In order to learn a new word, a learner must link the object with that word as referenced by another person. Infants must be able to use non-verbal joint attention such as following a speaker's line of regard in order to correctly interpret the labels of reference.

Language has also been linked to play behaviors in both typically developing children (Lewis, Boucher, Lupton, & Watson, 2000; McCune-Nicholich, 1981) and children with autism (Mundy, Sigman, Ungerer, & Sherman, 1987). The nature of the relationship between language and play remains unclear. It has been argued that both language and pretend play require the ability to symbolize, that is the knowledge that one thing can stand for another (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). At a more fundamental level, play and language require conceptual skills. For example, a child who brushes a doll's hair will usually have some concept of dolls, hair, brushes and brushing. Play also requires representational thinking skills such as the knowledge of how people and objects interact and the ability to represent this information during play.

Play behavior is thought to both require language and facilitate language acquisition, suggesting an interaction between play and language. Within a play context, children can practice language, interpret the verbal and non-verbal social communicative bids of others, and ultimately gain language skills (Schuler & Wolfberg, 2000).

In the previous study, three preschool measures—the children's expressive language age, frequency of functional play acts, and responsiveness to others' bids for joint attention-accounted for 43% of the variance in expressive language age in middle childhood in a hierarchical linear regression with all the variables contributing significantly to the regression. We expected that these variables would continue to predict gains in language skills from both early childhood and middle childhood to late adolescence.

METHODS

Participants

The original sample seen in early childhood consisted of 70 children with autism. Fifty-one children of the original sample of 70 children (73%) participated in the mid-school follow-up (Sigman & Ruskin, 1999). Forty-eight adolescents and adults (68% of the original 70 subjects) were seen in the current follow-up. Forty-five of the 48 participants in the current follow-up were also seen during the mid-school follow-up. Six subjects from the mid-school follow-up did not participate in the most recent follow-up for the following reasons: one individual had died; one was living in a group home and had no contact with her parents who were required to give consent for her participation; one could not be located by his original foster mother; and three families declined to participate. Three families participated in the current follow-up whom we were unable to locate when their children were in the mid-school period.

The current sample of 48 was composed of 6 females and 42 males. The ethnic composition of the group was as follows: 31 Caucasian, 7 African-American, 7 Asian, 2 Hispanic, and 1 other. The majority of participants (42 of 48) continued to live at home with their families and the other six lived in residential facilities. For the 48 participants in the most recent follow-up, their mean ages at recruitment, middle childhood/early adolescence, and later adolescence/young adulthood, respectively, was as follows: 3 years, 11 months of age (SD = 1 year), 12 years, 8 months of age (SD = 3 years, 9 months), and 19 years of age (SD = 3 years, 10 months). The degree to which the groups seen in middle childhood/early adolescence and later adolescence/young adulthood were representative of the original sample was analyzed. ANOVA revealed that the mid-school group (sample 2) and the current participant group (sample 3) did not differ significantly from the original sample (sample 1) in terms of chronological age (sample 1: $n = 70$, $M = 47.24$, SD = 12.14; sample 2: $n = 51$, $M = 46.53$, SD = 11.27; sample 3: $n = 48$, $M = 47.27$, SD = 12.12), mental age (sample 1: $n = 70$, $M = 23.71$, SD = 9.81; sample 2: $n = 51$, $M = 24.49$, SD = 10.76; sample 3: $n = 48$, $M = 25.04$, SD = 11.00), developmental or intelligence quotient (sample 1: $n = 70$, $M = 49.31$, SD = 13.27; sample 2: $n = 51$, $M = 50.82$, SD = 12.81; sample 3: $n = 48$, $M = 51.13$, SD = 12.77), or language age (sample 1: $n = 69$, $M = 16.48$, SD = 7.62; sample 2: $n = 50$, $M = 16.87$, SD = 8.22; sample 3: $n = 47$, $M = 17.42$, SD = 8.62) at intake.

Procedures

During the current follow-up, participants' cognitive abilities were evaluated using standardized assessments. Approximately half the families came to UCLA for testing and the other half of the sample was assessed in their residence depending on parental request and/or distance from UCLA. Testing did not begin until parents signed a consent form and participants who had sufficient capacity signed an assent form. Families were paid for their participation. Testing of all participants was conducted by experimenters who were naive as to the scores of any participant on previous testing.

Parents were not questioned about the intervention experiences of their children at recruitment because, as mentioned above, few specialized intervention programs existed at the time. Assessments at the mid-school and adolescent follow-ups would have had to depend on parental recollection of their children's earlier intervention experiences over a considerable gap in time. Because of our concern with the possible unreliability of parental reports in these circumstances, the issue of intervention effects is not addressed in this study.

Cognitive Assessments Administered at All Ages

At recruitment, the majority of children with autism were administered the Cattell Scales of Development, the measure that was used in the

Clinical Services in the Department of Psychiatry at that time. Five children whose abilities were sufficient for them to receive basal scores on the Stanford-Binet, 3rd edition (Terman & Merrill, 1973), were administered this scale instead of the Cattell Scale. At both the middle childhood and adolescent/young adult follow-up, the Stanford-Binet, 4th edition (Thorndike, Hagen, & Sattler, 1986) was administered to all participants who received basal scores on the vocabulary subtest. At the middle childhood follow-up, the Bayley Scales of Infant Development (BSID; Bayley, 1969) was administered to those who were unable to be tested using the Stanford-Binet. At the adolescent/young adult follow-up, the Mullen Scales of Early Learning (Mullen, 1995) was administered to all those who could not be tested with the Standford-Binet. All of the sub-tests of the Mullen were used except the gross motor scale.

The Stanford-Binet yields mental age equivalent scores and a generalized intelligence quotient (IQ). As suggested by the Guide for Administering and Scoring the Fourth Edition of the Stanford-Binet, mental age equivalent scores were derived by calculating the median of the age equivalent scores of the four subtests administered to the subjects: vocabulary, bead memory, pattern analysis, and quantitative. Three participants had total scores on one or more subtests used in the computation of mental age that reached the maximal mental age equivalent provided in the manual. For these three participants the maximal age equivalent scores were used. For this reason the mental ages of these three participants may have been underestimated.

All the developmental scales, the Cattell Scale, the BSID, and the Mullen Scales of Early Learning, yield age equivalent scores. One potential problem was translation of scores on the developmental scales into IQ scores given that our participant sample exceeded the established age range for translation of raw scores into standard IQ scores. To handle this problem, ratio developmental quotients (DQs) were calculated by dividing average mental age by chronological age and multiplying by 100.

Among the 47 participants who received cognitive assessments at the adolescent/young adult follow-up, 27 received the Stanford-Binet and 20 the Mullen Scales of Early Learning. Of the 47 tested at the adolescent/young adult follow-up, 38 had also received cognitive assessments at the middle childhood follow-up with 16 assessed using the BSID and 22 assessed with the Stanford-Binet. Of those 22 who had been tested with Stanford-Binet during middle childhood/early adolescence, 20 were tested with the Stanford-Binet again in adolescence/young adulthood and two were tested with the Mullen Scales. Of the 16 who had been tested with the BSID during middle childhood/early adolescence, 15 were tested with the Mullen Scales in adolescence/young adulthood and one was tested with the Stanford-Binet.

Language Assessments Administered at All Ages

Language during early childhood was measured with a standardized language assessment, the Reynell Scales of Language Ability (Reynell, 1977), once it became available (Sigman & Ruskin, 1999). The Reynell is a broad test of language skills from 12 months to 5 years of age and consists of two subscales, one for receptive language and one for expressive language. Standardized scores for both the receptive and expressive language scales translate into age equivalents. Averaging the expressive and receptive language age equivalent scores calculated an overall language age equivalent.

At the middle school follow-up and the adolescent and young adult follow-up, the Reynell Scales continued to be used for those with phrase speech, single word speech or no expressive language, and the Clinical Evaluation of Language Fundaments-Revised (CELF-R; Semel, Wiig, & Secord, 1987) was used for those with more fluent language. The CELF-R is designed for language skills from 5 to 18 years of age and assesses both comprehension and use of language. The CELF-R yields receptive and expressive language standardized scores and an overall language age equivalent. For participants who were older than the standardized sample norms, scores were calculated using the oldest norms given, 17 to 17 years, 11 months. None of the participants scored at or above ceiling on the CELF-R.

Of the 48 participants in the current follow-up (time 3), 17 participants were administered the CELF-R and 28 the Reynell Scales of Language Ability. One participant was untestable due to noncompliance and aggression so no language scores were generated. One participant received the preschool version of the CELF (Wiig, Secord, & Semel, 1992) designed for language ages from 3 to 5 years because he spoke in full sentences but was unable to achieve basal scores on the CELF-R. The CELF-P is scored in the same manner as the CELF-R, yielding standardized scores of receptive and expressive language and an overall age equivalent score. One participant's language age equivalent was derived from the receptive and expressive sub-tests of the Mullen Scales of Early Learning (Mullen, 1995) since he was assessed in his home out of state and the Reynell Scales of Language Ability were unavailable. The Mullen Scales of Early Learning yield separate language age equivalent scores for receptive and expressive language. Averaging receptive and expressive language age equivalent scores computed an overall language age.

Of the 47 individuals with language assessments at this most recent follow-up, 37 participants received language assessment in the mid-school follow-up; 25 received the Reynell Scales of Language Ability and 12 received the CELF-R. Those who received the CELF-R at the mid-school follow-up also received the CELF-R at the adolescent/young adult follow-up. Of the 25 who received the Reynell Scales of Language Ability at the mid-school follow-up, 22 received the Reynell again in the adolescent/young adult follow-up and 3 whose language skills had improved sufficiently received the CELF-R in the adolescent/young adult follow-up.

Measures of Non-Verbal Communication Administered at All Ages

The Early Social Communication Scale (ESCS; Seibert, Hogan, & Mundy, 1982) was used as the measure of non-verbal communication in early childhood and a modified version was used in the mid-school and the adolescent/young adult follow-ups. The ESCS and the modified version have been used effectively and reliably in research to show deficits in joint attention and non-verbal communication among autistic samples (Mundy, Sigman, & Kasari, 1994; Sigman, Mundy, Sherman, & Ungerer, 1986).

The ESCS is an instrument of pre-linguistic communication acts that usually develop between 8 and 24 months of age. In this procedure, the examiner sits across from the child at a small table and presents the child with a variety of toys that are in view but out of the child's reach. A series of structured situations are presented that are designed to assess how the child uses gestures and eye contact for requesting behavior, joint attention, and social interaction. In addition, on several trials, the experimenter points to the left, right, and behind the child while emphatically saying the child's name. The ESCS was modified at follow-up using more developmentally appropriate objects and certain social interaction tasks such as a tickle game were excluded.

The following behaviors were coded for both their verbal and non-verbal presentation: (a) initiates joint attention—directs the examiner's attention to objects or events with the goal of sharing attention; (b) initiates requesting behavior—requests objects that are out of reach or asks for aid in activating mechanical devices; (c) responds to bids for joint attention—responds to the examiner's attempt to direct the participant's visual attention. Non-verbal initiation of joint attention and requesting behavior were coded as frequency counts and responses to bids for joint attention as a percentage score.

Non-verbal communication behaviors were coded and computed in accordance with the guidelines specified for the ESCS, with one exception: The act of giving an object to the experimenter to get rid of it (a form of requesting behavior) occurred so infrequently at the middle school follow-up that it had not been coded and hence was not included in the analysis of the mid-school follow-up or this most recent follow-up. The coding was done by an observer who had been trained to reliably code the ESCS by one of the designers of the scales and coding system. Across various studies, mean generalized coefficients for interrater reliability were .80 (Sigman & Ruskin, 1999). More recent checks of the reliability of the coder continued to be good; mean coefficients were .95 (range = .88 to .98) between the major coder and another coder and .96 (range = .89 to .98) with a third coder.

Pretend Play Skills Assessed at Recruitment

Play skills during early childhood were assessed in a structured setting using a well-established play paradigm (Mundy *et al.*, 1987; Ungerer & Sigman, 1981, 1984). Each child was presented with a variety of toys in sets of related toys (e.g. a doll, a doll's brush and doll's mirror). An observer recorded each child's spontaneous play behavior on a checklist, grouping play as either functional or symbolic. Mean generalized reliability coefficients for coding these behaviors tends to be around .85 (Mundy *et al.*, 1987; Sigman & Ruskin, 1999).

RESULTS

Change in Cognitive Scores

Hypotheses: The children will show moderate improvements in cognitive functioning as measured by mental age over the course of the period from middle childhood to adolescence/young adulthood. There will be less change in overall intelligence from the previous testing to the current testing than was true for the period from preschool to middle childhood. Very few children will move from the retarded to the non-retarded range. Intelligence level in the middle school years will predict intelligence level in late adolescence.

Paired samples *t*-tests revealed that mental age equivalent scores continued to improve for the sample as a whole over the approximately 6-year-period from the mid-school years to the adolescent/young adult years, $t(37) = -3.47$, $p < .01$. As was expected, the non-retarded children made larger gains in mental age than the retarded children, $F(1, 36) = 6.70$, $p < .05$ (see Table I). For individuals with IQs above 70 at the mid-school follow-up ($n = 14$), average gains in mental age ($M = 26.07$ months, SD = 29.03) were less than half of the change in chronological maturation (+71 months chronological age). For those individuals with IQs below 70 at the mid-school follow-up ($n = 24$), mental age continued to improve ($M = 6.04$ months, SD = 17.96) but more disproportionately to chronological maturation (+73 months chronological age).

Mean IQ/DQ scores did not change from early childhood ($M = 52.2$, SD = 13.3) to middle childhood (M = 50.8, SD = 32.5), but declined significantly from middle childhood to adolescence/young adulthood ($M = 46.1$, SD = 33.6), $t(37) = -2.89$, $p > .01$. Despite this decline in IQ/DQ scores for the group as a whole, we did not see the dramatic individual changes in intelligence scores from middle childhood to adolescence/young adulthood that were seen from early childhood to middle childhood when half the participants gained 22 points and half lost 23 points on average.

Table I. Mean Mental and Language Age Equivalents (in months) by Mid-School IQ level

	Mid-school			Adolescence		
	M	SD	*n*	*M*	SD	*n*
Mental age						
Low IQ < 70	33.77	15.69	24	40.17	21.58	24
High IQ ≥ 70	117.32	27.56	14	143.39	33.37	14
Language age						
Low IQ < 70	26.30	9.12	23	27.65	17.33	23
High IQ ≥ 70	87.04	18.75	14	116.64	30.94	14

Assuming some margin of error in measuring IQ/DQ, change in intelligence was operationalized as ± 10 or more IQ/DQ points (Eaves & Ho, 1996). Of the 38 participants who had cognitive assessments in middle childhood and adolescence/young adulthood, 21% ($n = 8$) showed a decline of 10 or more IQ/DQ points, whereas only 2 participants (5%) showed a gain of 10 or more IQ/DQ points (13 and 25 points). The majority of participants, 74% ($n = 28$), showed relative stability in IQ/DQ scores from middle childhood to adolescence/young adulthood. Partial correlation analysis controlling for initial IQ/DQ scores and chronological age revealed that IQ/DQ scores from middle childhood strongly predicted scores in adolescence and young adulthood, $r\ (34) = .95$, $p < .001$.

We were particularly interested in the 11 participants who had moved from the retarded to the non-retarded range from initial testing to the middle childhood follow-up. Of those 11 individuals, 9 continued to have IQ scores above 70 at this most recent follow-up. The intelligence quotients of two individuals dropped down below 70 (IQ scores of 72 and 80 during middle childhood; IQs of 64 and 62, respectively, during adolescence). No individuals advanced to the non-retarded range from the mid-school follow-up to the adolescent and young adult follow-up.

Change in Language Abilities

Hypotheses: Mean language ages will increase from the last testing to the current testing but the size of the increase will be less than from the preschool years to the mid-school follow-up. Gains in language from the mid-school years to late adolescence will be predicted from language skills in the preschool and mid-school years.

Over the course of the 6–7 years from middle childhood to adolescence and young adulthood, the 37 participants with language assessments at both time points showed an increase of only 12 months in language age on average with a range from a loss of 10.5 months to a gain of 83 months (SD = 22 months). Mean language age had increased an average of 28 months over the approximately 8 years from early childhood to middle childhood. Pearson product moment correlation analysis (two-tailed test) demonstrated that early childhood language ability continued to predict language ability into adolescence and early adulthood, $r(45) = .51$, $p < .01$. Similarly, language in middle childhood was a robust predictor of language in adolescence and young adulthood, *r*

(36) = .94, $p < .001$, even after controlling for early childhood language score, $r(33) = .92$, $p < .001$.

Analyses were conducted to determine whether there were relationships between IQ/DQ scores and language gains. A one way ANOVA revealed that individuals whose IQ scores were 70 or above during the mid-school years gained significantly more months of language ability than individuals whose IQ/DQ scores were below 70, $F(1, 36) = 23.45$, $p < .0001$. Those whose IQ was above 70 ($n = 14$) during the mid-school years gained an average of 29.61 months (SD = 23.79) in language ability over the approximately 6-year-period from the mid-school to adolescent/young adult follow-up, whereas those whose IQ/DQ was below 70 ($n = 23$) gained an average of only 1.34 months in language ability (SD = 11.71).

By adolescence and young adulthood, 49% (23 individuals) had little to no functional language (language age equivalents below 30 months), 15% (7 individuals) had moderate understanding and use of language (language age equivalents between 30 and 47 months), and 36% (17 individuals) had fluent or near fluent language (language age equivalents of 48 months or greater). Among those with fluent or near fluent language, 13% (6 individuals) had language age equivalents between 48 and 95 months and the remaining 23% (11 individuals) had language age equivalents of 96 months or above.

Change in Nonverbal Communication Behaviors

Hypotheses: Autistic adolescents will show more non-verbal communicative behavior than they did during the mid-school years. There will be continuity in individual differences in these behaviors and skills from the mid-school period to adolescence/young adulthood.

Contrary to the hypotheses, participants did not differ in their percent of responding to bids for joint attention during the mid-school years ($M = 88$, SD = 26) and the adolescent and young adult years ($M = 81$, SD = 27). At both the mid-school period and adolescence/young adulthood, participants were responding to more than 80% of bids for joint attention on average. Responding to bids for joint attention during the middle school years predicted scores in the adolescent/young adult years, $r = .65$, $p < .01$.

Initiation of joint attention declined from middle childhood ($M = 6.4$, SD = 5.6) to adolescence/young adulthood ($M = 2.6$, $SD = 3.0$), $t(21) = -3.36$, $p < .01$. Requesting behavior also declined in adolescence/young adulthood ($M = 3.8$, SD = 3.9) compared to middle childhood ($M = 9.7$, SD = 6.2), $t(23) = -3.9$, $p < .01$. Frequency of initiating joint attention and requesting during middle childhood were not predictive of scores in adolescence/young adulthood, $r(21) = .35$ and $r(23) = .012$, respectively. The same pattern of results was observed for high and low IQ/DQ participants: no change in responding to joint attention, but significant declines in initiation of joint attention and requesting behavior from the mid-school assessment to the adolescent/young adult assessment.

Predictors of Gains in Language Abilities

Hypotheses: Gains in language abilities from the preschool years to late adolescence will be predicted from nonverbal communication and play skill in the preschool years and from nonverbal communication skills in the mid-school years.

Controlling for initial language level in preschool and using one-tailed tests, gains in language from preschool to adolescence/young adulthood were predicted by preschool measures of functional play, $r(43) = .36$, $p < .01$, responsiveness to joint attention, $r(35) = .28$, $p < .05$, and initiation of requesting behavior, $r(35) = .30$ $p < .05$. In contrast to these findings, non-verbal communication skills in the mid-school years did not predict language gains over the subsequent years of these adolescents' lives.

DISCUSSION

In line with some previous research and clinical impressions, the results of this longitudinal study supported the hypothesis that most of the improvements in cognitive and language skills that occurred in children with autism would be evident by the mid-school years. In contrast to the earlier period of life, only a few children showed increases greater than 10 points in IQ, and none moved from the mentally retarded to the non-mentally retarded range of function. Similarly, the mean change in language age was only half as large from middle childhood to adolescence/adulthood as from the preschool to the mid-school period.

As would be expected, the rate of gain was greater for the high-functioning children than for the low-functioning children. The low-functioning children continued to make gains in mental age but more disproportionately to chronological maturation. The language skills of the low-functioning children did not seem to improve at all after the mid-school period.

The limited amount of improvement in cognitive and language skills over the course of the school years in contrast to the preschool and early school years is quite striking. One possible explanation is that there is a sensitive period for children with autism to gain elementary cognitive and language skills. Secondly, it is possible that the types of skills expected to develop in the adolescent period are more difficult for individuals with autism and, therefore, set a ceiling on the MA equivalents that the individuals can reach. Finally, a third interpretation is that preschool experiences, even as limited as they were, were more effective in bringing about change than the experiences that were provided for the children during the second decade of life. Without systematic information about the experiences of children with autism at home, at school, and in other programs, there is no way to choose between these explanations.

We have already mentioned that specialized intervention programs were scarce when this longitudinal study was begun so that children's remediation experiences were limited to preschool and elementary school attendance. Therefore, the improvements that occurred between preschool and mid-school ages were likely to have taken place with less intensive interventions than children currently experience. If there was little intervention in the early years, this was even truer as the children progressed through elementary school. Therefore, the decline in the rate of improvement after the mid-school period may be attributable to the dearth of interventions as the children matured. The lack of information about intervention in this study creates a major limitation to interpretation of the findings.

Besides attempting to chart the progress made by children with autism over the first two decades of life, the second aim of this study was to determine whether the preschool child characteristics that predicted language gain by the mid-school period continued to predict language gain in the adolescent/young adult period. The results showed that, as in the previous period, the number of functional play acts and the percentage of responses to bids for joint attention in the preschool years continued to predict language gains in adolescence and young adulthood. The lack of correlation between either symbolic play acts or initiation of joint attention and language outcome may be due to the restricted range of these behaviors.

The fact that these child characteristics predict gains in language skills at two different time points supports the hypothesis that joint attention and play skills are important precursors of language acquisition in children with autism. Studies are needed that attempt to improve the joint attention and play skills of young children with autism in order to encourage their language gains.

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