Subgroups of Children With Autism by Cluster Analysis: A Longitudinal Examination

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ABSTRACT

Objectives: A hierarchical cluster analysis was conducted using a sample of 138 school-age children with autism. The objective was to examine (1) the characteristics of resulting subgroups, (2) the relationship of these subgroups to subgroups of the same children determined at preschool age, and (3) preschool variables that best predicted school-age functioning. **Method:** Ninety-five cases were analyzed. **Results:** Findings support the presence of 2 subgroups marked by different levels of social, language, and nonverbal ability, with the higher group showing essentially normal cognitive and behavioral scores. The relationship of high- and low-functioning subgroup membership to levels of functioning at preschool age was highly significant. **Conclusions:** School-age functioning was strongly predicted by preschool cognitive functioning but was not strongly predicted by preschool social abnormality or severity of autistic symptoms. The differential outcome of the 2 groups shows that high IQ is necessary but not sufficient for optimal outcome in the presence of severe language impairment. *J. Am. Acad. Child Adolesc. Psychiatry,* 2000, 39(3):346–352. **Key Words:** autism, subtype, subgroup, cluster, IQ.

Many recent studies have attempted to describe subtypes within the spectrum of pervasive developmental disorders (PDD). The identification of subtypes within the spectrum is needed to clarify the etiology, pathophysiology, course, treatment, and outcomes for children with PDD (Roux et al., 1994). As cognitive ability in this population is shown to be stable throughout childhood and adolescence (Lord and Schopler, 1989a,b; Venter et al., 1992), most researchers agree on the importance of including IQ when defining subtypes (Rutter and Garmezy, 1983). Studies have found similar differences with family histories of high- and low-functioning PDD (Gillberg, 1989; Piven et al., 1990). However, the best support for this approach to subtyping is the differential outcome of high- versus low-functioning children with PDD. Some (DeMyer et al., 1973) describe behavioral and cognitive improvement over time in high-functioning individuals, as opposed to a relative decline in lower IQ children. Cohen et al. (1987), Lord and Venter (1992), and Tsai (1992) agree in designating an a priori IQ cutoff score of 70 to differentiate high- and low-functioning PDD.

Our earlier research (Fein et al., 1999) provides strong evidence for high- and low-functioning subgroups of autism at preschool age, using social, language, cognitive, and behavioral data with a variety of rigorously pursued empirical analyses. Specifically, this study empirically identified 2 subgroups of preschool-age children with PDD, differentiated primarily by intellectual level of functioning. All cognitive measures differentiated the 2 groups, with a nonverbal IQ of 65 providing the best single differentiator. While children in both groups showed behaviors within each of the major symptom areas of autism, the groups differed on specific items. Children in the lower-functioning group showed developmentally lower or more severe manifestations of the symptoms (e.g., no peer relationships, no spontaneous waving, mutism). Children in the higher-functioning group

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showed developmentally higher or less severe manifestations (e.g., naive attempts at peer relationships, greetings with stereotyped phrases, one-sided conversations).

In studies of autistic disorder (AD), some investigators have approached subtyping by putative etiology or by behaviors and symptoms (Allen, 1988; Allen and Rapin, 1992; Overall and Campbell, 1988; Simmons and Baltaxe, 1975; Wing and Gould, 1979). Other investigators have attempted classification using cognitive profile (Eaves et al., 1994; Ehlers et al., 1997; Fein et al., 1985) or by the combination of social, language, and cognitive variables (Fein et al., 1999). Level of intellectual function has been found to correlate significantly with degree of symptomatology in all 3 domains of autistic impairment (Volkmar et al., 1992). Cohen et al. (1987) demonstrated differences in language and neurological signs in children with autism based on this distinction. DeLong (1994) found more neurological signs in low-functioning autism and a higher prevalence of family psychiatric history in high-functioning autism. The Wing and Gould subtypes are strongly related to IQ (Castelloe and Dawson, 1993; Volkmar et al., 1989).

As with PDD research, perhaps the most usefulness of subtyping studies comes from the predictive power shown by differential outcome of empirically defined groups. Poorer outcome in autistic children (Bartak and Rutter, 1976) and adolescents (Waterhouse and Fein, 1984) was found with greater degrees of mental retardation. A recent study (Carpentieri and Morgan, 1996) shows greater adaptive behavior impairment in low-functioning autism than in mental retardation without autism, a finding that supports the notion that the impairments of low-functioning autistic children may be developmentally more limiting than in other low IQ children. These findings suggest that level of functioning plays a unique role in predicting the developmental course of children with autism and sets the stage for further longitudinal study of autism subgroups.

The purpose of this study was to explore empirical subtypes in a sample of preschool children with AD when they reached school age. The following specific questions were explored: (1) What are the characteristics of empirically defined school-age clusters? (2) What is the degree of overlap between preschool and school-age group membership? (3) Starting with the school-age subgroups and looking retrospectively at their preschool functioning, which preschool behavioral and cognitive variables would have best predicted school-age outcome?

METHOD

Selection and Assessment of Autistic Subjects at Preschool Age

The sample was studied in the Autism and Language Disorders Nosology Project, a longitudinal study of autism, language disorder, and mental retardation funded by the National Institute for Neurological Disorders and Stroke. Data collection began in 1983 and lasted 8 years. Details on subject selection procedures and descriptive data on all groups are found in Rapin (1996). In brief, children were recruited by clinical referral for communication disorders in several cities. These included Cleveland, Ohio; Bronx, New York; Boston, Massachusetts; Long Island, New York; and Trenton, New Jersey. Because of the low base rate of autism, no effort was made to randomly select subjects for the study. All subjects had English as their primary language.

At preschool age, all children were screened using the Wing Autistic Disorder Interview Checklist (WADIC) (Wing, 1985) to confirm the presence of social impairment. Child psychiatrists then performed a comprehensive clinical evaluation of the children with social impairment, using clinical interviews of the child, the parent, and a 21-item Social Abnormalities Scale to arrive at *DSM-III* and *DSM-III-R* (American Psychiatric Association, 1980, 1987) diagnoses of AD for each child (Rapin, 1996). Every child underwent a standard neurological examination (Rapin, 1996). In addition, parents and teachers were asked to complete questionnaires about each child's behavior and skills at home and in school (reprinted in Rapin, 1996). These extra clinical data provided information necessary for *DSM-IV* (American Psychiatric Association, 1994) and *ICD-10* (World Health Organization, 1990) diagnoses of AD. The sample used in this analysis is based on the more inclusive *DSM-III-R* criteria, since these diagnoses were judged to be most sound as they came from board-certified psychiatrists' clinical experience using a standardized symptom checklist. Correspondence between *DSM-III-R* and *DSM-IV* diagnoses in the present sample is addressed in an article by Waterhouse et al., 1996).

Children were excluded from the sample at the time of preschool diagnosis if they had conditions known to result in autistic symptoms. Children were excluded for known brain lesions, tuberous sclerosis or neurofibromatosis, hemiparesis, ataxia, or any "hard" neurological sign. Therefore, only children with no known cause of AD were included in the preschool sample. The children were also screened out of the sample at diagnosis for major dysmorphism such as cleft lip or palate or diagnosable malformation syndrome. After the preschool phase of the study was completed, a specific diagnosis was made for 4 children. This included 2 unrelated boys with fragile X syndrome and Cornelia de Lange syndrome in a monozygotic twin pair. However these children did not display overt dysmorphism at diagnosis. Neurologists were also instructed to reject children who had frequent seizures (>1 per month), but in actuality most of the children were seizure-free or had seizures controlled by reasonable doses of medications (2.1% of high-functioning and 4.6% of low-functioning AD children were receiving anticonvulsants at preschool age). Children were also excluded if neurologists judged that their medications contributed to drowsiness or hyperactivity (e.g., phenobarbital). Subjects had no hearing deficits and no gross sensorimotor deficits. The resulting sample in the preschool database had 194 subjects with a mean age of 4.7 years and was 83.0% male.

Measures Used

The study provided detailed data on every subject, including family, medical, and developmental history, neurological examination, psychiatric evaluation, adaptive functioning, cognitive functioning, language development, play development, and socioeconomic status of the family. See Rapin (1996) for a complete description of all measures.

For preschool children, nonverbal IQ was measured by the Abstract/Visual Reasoning scale of the Stanford-Binet Intelligence Scale, 4th edition (SB) (Thorndike et al., 1986). Because many preschool subjects were untestable using the SB, it was necessary to assess some low-functioning children with the Mental scale of the Bayley Scales of Infant Development (Bayley, 1969), which also provided an estimate of nonverbal intelligence. Based on the assumption that both tests used visual/spatial items assessing similar constructs, both sets of scores were converted into comparable nonverbal ratio mental age scores (Rapin, 1996). This ratio is the nonverbal IQ mental age score divided by the child's chronological age.

Other variables included ratings of impairment in interaction (WADIC-A), communication (WADIC-B), and presence of restricted/repetitive behaviors (WADIC-C), using the WADIC (Wing, 1985). Social behavior was also assessed using the Vineland Adaptive Behavior Scales-Revised (Sparrow et al., 1984). Language was evaluated using the Vineland and Peabody Picture Vocabulary Test (PPVT) (Dunn and Dunn, 1981).

Some subjects were unable to complete the PPVT and SB tests at preschool. These data points were recoded from "missing" to raw scores of 0 for those tests that were administered, but they did not yield valid scores. The inclusion of these data points normalized the distribution of scores. This correction provides data that more accurately fit assumptions of normality for parametric analyses. Only those subjects who had all essential preschool variables were included in the final school-age database. This ensured that all school-age subjects in the current analysis were validly screened, diagnosed, and assessed at preschool age.

Reassessment of Autistic Subjects at School Age

Children were retested either at age 7, 9, or both time points with a full assessment battery. Cognitive measures at school age included the SB and the PPVT. Behavioral data in this battery were obtained through interview and both parent and teacher behavioral ratings, including the WADIC and the Vineland.

School-age children seen at both ages 7 and 9 had 2 data sets. The majority of school-age subjects had data from age 9 testing. When a subject had duplicate data of this sort, we retained data from age 9 testing unless data from age 7 were significantly more complete. The resulting sample in the school-age database had 138 subjects. Sample characteristics included mean age of 8.6 years, 81.9% male; 94 (68.1%) of 138 subjects used data from age 9 testing.

Classification Analyses

A hierarchical cluster analysis was performed on the school-age data to corroborate the validity of a 2-group solution, while identifying those variables that best predicted group membership. The variables chosen to be included in the initial hierarchical model had commonly accepted theoretical relationships to the core impairments in autism. They included expressive and receptive measures of language, nonverbal intelligence, and both normal and abnormal social behavior. All variables entered into the model were determined by t test and χ^2 analysis to have empirical association to a priori defined levels of functioning. Where possible, these measures were age-standardized (PPVT, nonverbal IQ ratio, and Vineland standard scores).

Forty-three records in the school-age database were missing various test scores for the measures included in the analyses. Scores were missing for a variety of reasons, including that some children were untestable with certain instruments, and from attrition before full batteries could be completed. Of all the school-age data, 95 cases had complete data and could be used in the hierarchical cluster analysis. A total of 72 children (75.8%) in the final sample had data from age 9 testing. The ranges, means, and standard deviations of variables entered into the analysis for the resulting sample are displayed in Table 1.

Clustering was determined by the unweighted pair-group method using arithmetic averages. The dissimilarity measure selected for the interval data was squared Euclidean distance. To control for the unequal scaling of the variables, which can affect hierarchical cluster results, all data were transformed to z scores before entering the analysis. Once cluster membership was obtained, a discriminant function analysis was performed to determine the degree of association of the variables to the predictive equation that determined cluster membership. The membership information provided by this new discriminant function was saved and compared to the results of the hierarchical cluster analysis by Pearson correlation. School-age subgroup membership was examined for correspondence with subgroup membership derived from the preschool database analyses (Fein et al., 1999) and for correspondence with preschool subgroups split at nonverbal IQ of 80. Children within each school-age subgroup were then examined for their preschool characteristics by repeated-measures analysis of variance (ANOVA). Repeated-measures ANOVAs were also performed on the longitudinal data, examining whether children in each subgroup showed improvement, decline, or no change in scores from preschool to school age.

RESULTS

The agglomeration schedule suggests the data are indeed best divided into 2 clusters. The ranges, means, and standard deviations for children in each group are shown in Table 2. The higher-functioning group ($n = 24$) is smaller than the lower-functioning group ($n = 71$).

A discriminant function analysis was then performed to determine the degree of association of the variables to the predictive equation that determined cluster membership. The significant Box M test ($p < .001$) and the small Wilks λ value (0.246) indicate that there is small within-

TABLE 1
Sample Characteristics for Hierarchical Cluster Analysis

Variable Name	n	Range	Mean	SD
WADIC-A	120	0–9	6.08	3.04
WADIC-B	120	0–5	2.52	1.62
WADIC-C	120	0–7	2.56	1.96
PPVT	119	40–140	61.07	24.73
Nonverbal IQ ratio	118	22–156	74.35	31.16
Vine Comm	125	23–116	57.98	24.96
Vine Social	125	35–118	61.09	17.73

Note: WADIC = Wing Autistic Disorder Interview Checklist, areas A, B, and C; PPVT = Peabody Picture Vocabulary Test standard score; Vine Comm = Vineland Adaptive Behavior Scales Communication Domain standard age score; Vine Social = Vineland Adaptive Behavior Scales Socialization Domain standard age score.

TABLE 2
Characteristics of Subgroups Compared by *t* Test

School Age Variable	Low Cluster (n = 71) Mean	SD	Range	High Cluster (n = 24) Mean	SD	Range	p
WADIC-A	7.20	1.99	0–9	1.83	2.39	0–9	<.001
WADIC-B	3.15	1.40	0–5	0.79	1.25	0–5	<.001
WADIC-C	3.03	1.90	0–7	0.54	0.78	0–3	<.001
PPVT	51.96	16.70	40–102	95.08	16.51	68–140	<.001
Nonverbal IQ ratio	65.92	27.77	22–133	106.00	17.70	83–156	<.001
Vine Comm	52.73	16.36	26–92	93.58	14.83	64–116	<.001
Vine Social	56.49	9.78	40–86	86.29	15.86	63–118	<.001

Note: WADIC = Wing Autistic Disorder Interview Checklist, areas A, B, and C; PPVT = Peabody Picture Vocabulary Test standard score; Vine Comm = Vineland Adaptive Behavior Scales Communication Domain standard age score; Vine Social = Vineland Adaptive Behavior Scales Socialization Domain standard age score.

group variation but that there is great difference in the mean scores between the 2 clusters, confirming the satisfactory nature of the cluster solution. The Box M test is a good multivariate test of equality of variable covariance between the 2 clusters.

Several variables in the solution had much larger standardized discriminant function coefficients (0.498, 0.553, and −0.601) than most, suggesting that some variables were more important in determining cluster membership. The discriminant function analysis was redone using a stepwise selection method that picked variables that maximized the difference between the clusters and minimized within-group variance. This selection method was based on the overall decrease of Wilks λ using F test criteria for variable entry and removal from the model. This procedure excluded 4 statistically redundant variables (i.e., WADIC-B, WADIC-C, Vineland Communication, and nonverbal IQ ratio) that did not significantly improve prediction. Three variables were found to relate most strongly to the predictive equation as follows: the WADIC-A score (measuring social abnormalities), the PPVT standard score (measuring receptive vocabulary), and the Vineland Socialization Domain score (measuring social skills).

The membership information provided by this new discriminant function was saved and compared with the results of the hierarchical cluster analysis by Pearson correlation. The linear association of the memberships was r = 0.918 ($p < .001$), indicating that the agreement between the larger clustering classification and the smaller, 3-variable solution is nearly identical. This 3-variable, 2-cluster solution is therefore the best reduction of the data used to cluster the subjects.

Comparison of School-Age Clusters to Preschool-Age Classifications

School-age subgroup membership was examined for correspondence with subgroup membership derived from the preschool database analyses (Fein et al., 1999). The Pearson χ^2 = 16.189 ($p < .001$) for this cross-tabulation; the Fisher exact test was significant at $p < .001$. These results are displayed in tabular form for clarity in Table 3.

School-age subgroup membership was also examined for correspondence with preschool a priori clinical assessment as high- versus low-functioning (nonverbal IQ greater than or less than 80). The Pearson χ^2 = 19.928 ($p < .001$) for this cross-tabulation; the Fisher exact test showed significance at $p < .001$. The pattern is similar to that of the subgroups reported in Table 3. A total of 42 subjects had nonverbal IQ ≥80, whereas 53 had IQ <80. Of the 42 high-functioning children, 20 were in the high cluster, while 4 had nonverbal IQ ratio <80 at preschool. Of the 53 low-functioning children (IQ < 80), 49 of them were in the low cluster. The cluster membership therefore shows a significant association with original level of functioning as well as with preschool subgroup membership. Almost all of the lower-functioning group at preschool stayed in the

TABLE 3
Comparison of School-Age and Preschool Group Membership

Subgroup in School-Age Cluster Analysis	Subgroup at Preschool: High-Functioning	Low-Functioning
Low Cluster	28	40
High Cluster	17	1
Total	45	41

TABLE 4
Characteristics of Subgroups at Preschool Compared by Repeated-Measures Analysis of Variance

	Cluster 1		Cluster 2		
Preschool Age Variable	Mean	SD	Mean	SD	*p*
WADIC-A	7.65	1.74	6.54	2.25	<.05
WADIC-B	3.76	3.83	1.26	1.34	NS
WADIC-C	2.77	2.54	1.61	1.44	NS
PPVT	66.94	15.39	79.10	16.97	<.01
Nonverbal IQ ratio	65.72	29.15	94.13	26.83	<.001
Vine Comm	58.46	15.33	81.42	15.37	<.001
Vine Social	58.59	9.40	74.75	10.78	<.001

Note: WADIC = Wing Autistic Disorder Interview Checklist, areas A, B, and C; PPVT = Peabody Picture Vocabulary Test standard score; Vine Comm = Vineland Adaptive Behavior Scales Communication Domain standard age score; Vine Social = Vineland Adaptive Behavior Scales Socialization Domain standard age score; NS = not significant.

lower-functioning school-age group, whereas the higher-functioning preschool group had divergent outcomes.

Retrospective Analysis of Preschool Characteristics of School-Age Subgroups

Children within each school-age subgroup were then examined for their preschool characteristics. This analysis provides a profile of how the subjects within each hierarchical school-age cluster presented upon original assessment. These results and the significance levels of the repeated-measures ANOVA are presented in Table 4.

Cognitive and developmental variables (PPVT standard scores, nonverbal IQ ratio, Vineland Socialization and Communication) strongly differentiate the groups. Although the WADIC-A difference reaches significance, the mean difference between the 2 groups is very small, and the WADIC-B and WADIC-C fail to show group differences.

Repeated-measures ANOVAs were also performed on the longitudinal data, examining whether children in each subgroup showed improvement, decline, or no change in scores from preschool to school age (Table 5).

In general, language and social scores remained stable or dropped significantly from preschool to school age for the lower-functioning group. For the higher-functioning group, all measures improved. Most of these measures show highly significant gains in ability or reductions in abnormal behaviors.

DISCUSSION

The current analyses provide evidence for the validity of 2 subgroups of autism, differentiated at school age by behavioral measures of social abnormality, by language ability, and by cognitive level. Both development of normal social skills and the presence of deviant social behaviors contribute independently to subgroup membership, as has been previously suggested (Barth et al., 1995; Fein et al., 1999). This highlights the importance of looking at both types of social information independently when evaluating subgroup membership.

When we examined longitudinal trends for the high-functioning subgroup, the following patterns appeared: the high group showed social behavioral abnormalities at preschool that are equal or almost equal to those of the lower-functioning group; these subsided by school age, leaving only mild residual social symptoms. Nonverbal IQ was within the average range at preschool and remained there. PPVT receptive vocabulary score was mildly depressed at preschool but normalized, as did Vineland Communication. The development of adaptive social skills (as measured by the Vineland) was mildly delayed at preschool and recovered into the low normal range, suggesting mild social

TABLE 5
Comparison of School-Age and Preschool Data for Children in the Two Subgroups by Repeated-Measures Analysis of Variance

	Cluster 1				
	Preschool Data		School-Age Data		
	Mean	SD	Mean	SD	*p*
WADIC-A	7.64	1.74	7.20	1.99	NS
WADIC-B	3.76	1.26	3.15	1.40	<.01
WADIC-C	2.77	1.61	3.03	1.40	NS
PPVT	66.94	15.39	51.96	16.70	<.001
Nonverbal IQ ratio	65.72	29.15	65.92	27.77	NS
Vine Comm	58.47	15.33	52.73	16.36	<.01
Vine Social	58.59	9.40	56.49	9.78	NS
	Cluster 2				
	Preschool Data		School-Age Data		
	Mean	SD	Mean	SD	*p*
WADIC-A	6.54	2.25	1.83	2.39	<.001
WADIC-B	3.83	1.34	0.79	1.25	<.001
WADIC-C	2.54	1.44	0.54	0.78	<.001
PPVT	79.10	16.97	95.08	16.51	<.001
Nonverbal IQ ratio	94.13	26.83	106.0	17.70	NS
Vine Comm	81.41	15.37	93.58	14.83	<.01
Vine Social	74.75	10.78	86.29	15.86	<.05

Note: WADIC = Wing Autistic Disorder Interview Checklist, areas A, B, and C; PPVT = Peabody Picture Vocabulary Test standard score; Vine Comm = Vineland Adaptive Behavior Scales Communication Domain standard age score; Vine Social = Vineland Adaptive Behavior Scales Socialization Domain standard age score; NS = not significant.

delays, consistent with the residual mild social abnormalities indicated in this group.

At preschool age, the lower-functioning group showed significant abnormalities in all 3 associated behavioral areas (social, communicative, restricted/repetitive behaviors), as well as cognitive measures. In general, behavior abnormalities indicative of autism continued to be quite pronounced at school age. Nonverbal IQ and the development of social skills were moderately impaired and remained unchanged relative to peers. However, school-age nonverbal IQ was very heterogeneous, with IQ ratios ranging from 22 to 133 (Table 2). The development of language skills appears arrested, actually declining relative to same-age normal peers over time.

These subgroup characteristics suggest that normal or near normal nonverbal IQ is the most potent predictor of school-age subgroup membership. Normal IQ is necessary for an optimal outcome, but it is not sufficient in the presence of significant language and social delays and abnormalities. Lower-functioning preschool subgroup children overwhelmingly remained in the lower-functioning school-age group, while the higher-functioning preschool group split into a good outcome and a less good outcome group. Approximately 38% of the subjects classified in the high-functioning subgroup at preschool not only improved, but showed relatively normal scores at school-age follow-up. If an a priori cutoff of at least 80 nonverbal IQ is used, nearly half of the high-functioning subjects at preschool had generally normal scores upon follow-up several years later.

Limitations

There are a few noteworthy limitations to the current study. The foremost is that no intervention data were collected for the period between evaluations. Therefore, it is not possible to determine whether specific factors (besides IQ) were responsible for the gains that occurred. Another limitation is that more inclusive *DSM-III-R* diagnostic criteria were used. If more stringent modern diagnostic methods using structured interview techniques like the Autism Diagnostic Interview-Revised (Lord et al., 1994) had been used, the sample might be different. Cross-validation with such a sample would highly support the current findings. A further limitation is the sizable degree of attrition through the loss of subjects from preschool to school-age follow-up (only 71%, or 138 of 194, returned for the study). The slight demographic differences in gender and recruitment site between those subjects who remained in the study and those who were lost may reduce confidence in the generalizability of the follow-up sample. Despite the differences, however, no systematic reasons for the attrition were ascertained, and the large size of the follow-up sample lends to the validity of the current findings. The final limitation is that there was no follow-through to older age groups. While clinical status is expected to remain stable after late childhood, maturational processes in early adolescence may cause interesting changes in the variables measured to provide insight into these youths' capacities for cognitive development at later ages.

Clinical Implications

The current results are further support for the validity and usefulness of subgrouping AD children by level of functioning. Consistent with previous research (Fein et al., 1999), nonverbal IQ, receptive language, and adaptive functioning (as measured by Vineland Socialization) are the most predictive variables. This is the most significant finding, as much previous work has suggested the primary dominance of social and language symptoms in AD.

The implications of the importance of cognitive status are far-reaching, as outcome appears to depend significantly on cognitive ability. Although it has been shown that aggressive early intervention can circumvent some of the abnormalities in autistic children, it is not currently known whether IQ itself can be influenced by therapies that capitalize on existing cognitive strengths for treatment. This should be an intensive focus of future treatment research. This research is especially important for the low-functioning group, which this study suggests does not show widespread cognitive or behavioral improvements over time. In this group, there is great variability in the low-functioning group's language, cognitive, and behavioral scores, suggesting the presence of potential strengths that might be exploited in treatment.

Although the 3 measures isolated in the current study (i.e., PPVT standard score, Vineland Socialization standard score, and WADIC-A social abnormalities rating) lend themselves to a quick screening of autistic children to determine level of functioning, it is demonstrated that nonverbal IQ is the crucial factor underlying cluster membership. These 3 predictive variables' association with cluster membership suggests that they are ideal to be included as outcome measures in future treatment research.

Results are encouraging for developmental outcome, in that a significant minority of the children followed at school age have not just improved, but achieve scores that fall at the low end of the normal range of adaptive skill development. Mild residual deficits in social behavior and delays in social functioning suggest that symptoms in the social domain may be most resistant to maturation or treatment. Factors that limit the development of the lower-functioning group of children remain to be elucidated.

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