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High-functioning autism and schizophrenia A comparison of an early and late onset neurodevelopmental disorder

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Abstract

Autism and schizophrenia are separate neurodevelopmental disorders that share a number of interpersonal and cognitive deficits. The symptoms of autism first appear during early life while schizophrenic symptoms do not typically appear until adolescence at the earliest. Efforts have been made to characterize the pattern of cognitive function in both disorders, and certain resemblances have become apparent such as deficits in abstract reasoning and the more complex aspects of memory and language. The present study provided a comparison of cognitive function between the two disorders. The autistic sample consisted of well-diagnosed individuals with high-functioning autism ($IQ \geq 70$). The schizophrenic sample was divided into four subgroups using Ward's method of cluster analysis. Participants received the Wechsler Adult Intelligence Scale-Revised (WAIS-R), the Halstead Category Test, the Trail Making test, and the Wisconsin Card Sorting test (WCST). The profile of the autism sample was compared with the four schizophrenia cluster profiles. The autism group resembled only one of the schizophrenia clusters, with both showing elevations on the WAIS-R Information and Block Design subtests and depressions on Comprehension and Digit Symbol. It was concluded that individuals with high-functioning autism have a cognitive profile that resembles that of an empirically derived subgroup of schizophrenia patients but that does not resemble profiles found in other schizophrenia subgroups. The pattern itself, marked by a relatively

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depressed score on the Comprehension subtest among the Verbal subtests and a relatively elevated score on Block Design among the Performance subtests, has been characterized in the past as a prototypic profile for high-functioning autism. © 2002 National Academy of Neuropsychology. Published by Elsevier Science Ltd.

Keywords: Autism; Schizophrenia; Cognition

1. Introduction

Autism and schizophrenia are both neurodevelopmental disorders that share a number of features including marked impairment in interpersonal relations and cognitive dysfunction. However, they are considered distinct disorders, with the symptoms of autism first appearing during early life while schizophrenic positive symptoms do not typically appear until adolescence at the earliest (DeLisi, 1992; Minshew, 1996). Extensive efforts have been made to characterize the pattern of cognitive function in both disorders, and certain resemblances have become apparent such as deficits in abstract reasoning, problem solving, regulation of goal-directed behaviors, and the more complex aspects of memory and language. While individual characteristics of schizophrenia resemble those found in numerous neurological and neuropsychiatric disorders, the resemblance between autism and schizophrenia is sufficiently close that prior to DSM-III (American Psychiatric Association, 1980), the term childhood schizophrenia was often used in reference to autism, and there was some controversy concerning whether they were the same disorder (Eisenberg & Kanner, 1958). It was subsequently pointed out that individuals with autism share many of the negative features of schizophrenia, such as social withdrawal and communication deficiencies, but do not share the positive symptoms, mainly involving hallucinations and delusions (Rumsey, Andreasen, & Rapaport, 1986). Frith (1994) has provided a discussion of this matter pointing to similarities and differences in cognitive test performance between early and late acquired disorders. He also presents the idea that the same underlying cognitive disorder may be presented in different ways consistent with different etiologies and reviews literature suggesting that some individuals may meet diagnostic criteria for autism prior to a psychotic break and development of positive symptoms. However, this supposition has never been verified (Szatmari, Bartolucci, Bremner, Bond, & Rich, 1989). Rumsey et al. (1986) in a direct comparison of subjects with autism or schizophrenia, found that the autism subjects showed fewer features of “positive thought disorder” such as illogicality or derailment than did the patients with schizophrenia, but the two groups did not differ on measures of affective flattening, such as unchanging facial expression.

These considerations are not intended to question the widely accepted view that autism and schizophrenia are two different disorders (Minshew & Rattan, 1992). Rather, they are developed because the contrast among the characterizations of various disorders with

regard to both similarities and differences may be of heuristic value with regard to refinement of diagnosis and treatment planning. Since Kanner's (1943) original description of "early infantile autism" as a disorder is marked by extreme detachment, self-isolation, inability to form relationships, frequent failure to acquire communicative abilities, and preoccupation with sameness, there has been extensive discussion and controversy regarding the relationship between schizophrenia and autism, with many of the important issues discussed by Eisenberg and Kanner (1958) in 1956. Eisenberg and Kanner argued at that time for autism as a distinct syndrome but not without controversy. While their view ultimately prevailed, there remains the well-established observation that many of the cognitive deficits typically associated with schizophrenia, notably impairments in executive abilities, abstract reasoning, and goal-directed problem solving behaviors, are also common in autism (Ozonoff, 1995). Thus, while autism and schizophrenia are distinct disorders, there may be some degree of clinical and phenomenological overlap. In their defense of autism as a distinct disorder, even Eisenberg and Kanner said, "The history, early onset, and course distinguish it from older childhood schizophrenia, to which it is probably related generically" (p. 12).

In the case of schizophrenia, while the characteristic cognitive disturbances involving abstract reasoning, problem solving, and attention are commonly identified, it has been emphasized recently that schizophrenia is a cognitively heterogeneous disorder, with great diversity in level and pattern of cognitive function (Goldstein, 1994). Several groups of investigators have used empirical classification methods, notably cluster analysis, to establish cognitive subtypes of schizophrenia (Goldstein, 1990, 1994; Heinrichs & Awad, 1993; Liddle, 1996; Sautter et al., 1995; Seltzer, Conrad, & Cassens, 1997). Autism, on the other hand, is generally not viewed as a heterogeneous disorder in the sense of there being valid and stable subtypes but rather as an illness that can range extensively in severity (Rutter & Schopler, 1987). The commonly accepted distinction between high-functioning and low-functioning autism does not imply the existence of two subtypes but rather of the presence or absence of mental retardation, generally operationally defined by IQ level. Thus, some individuals with autism are profoundly retarded and mute, while others may have average or above intellectual levels and can speak fluently. The high-functioning group, estimated to represent about 20% of the population of individuals with autism, has received extensive study, with the general conclusion being that despite the presence of average or above intelligence and apparently normal speech, these individuals have significant cognitive dysfunction sufficient to have strong implications for adaptive behavior (Minshew & Goldstein, 1998; Ozonoff, Pennington, & Rogers, 1991; Rumsey & Hamburger, 1988). Different groups of investigators have characterized the core impairment as involving executive function (Ozonoff, 1995) or selective impairment of complex information processing (Minshew, Goldstein, & Siegel, 1997). Thus, we may anticipate finding normal level functioning on tasks involving a variety of abilities in many domains of cognitive function, but impairment when the information-processing load in any of the domains becomes sufficiently complex. The one exception appears to be spatial cognition in which individuals with high-functioning autism often do well even on more complex tasks (Minshew et al., 1997).

If schizophrenia can be classified into several cognitive function-based subtypes (Goldstein, 1994), then while it is possible that while cognitive function in autism may not resemble schizophrenia as a whole, it may resemble one or more of these subgroups. As indicated above, several groups of investigators have identified such subgroups encompassing broad variation in level and pattern of cognitive function. Over numerous studies, it has been shown that these subgroup differences are not largely accounted for by age, education, medication status, and a number of clinical variables including symptom severity or profile, length of illness, age of onset of illness, and length of hospitalization (Goldstein & Shemansky, 1995; Seaton, Allen, Goldstein, Kelley, & van Kammen, 1999). We are hypothesizing that while level and pattern of performance on pertinent cognitive tests may be quite different in high-functioning autism and schizophrenia as a whole, findings for autism might closely resemble one or more of the cognitive subgroups of schizophrenia. Such resemblances might indicate the presence of common areas of intactness or impairment of cognitive function despite differences in clinical phenomenology, age of onset, and course.

In this study, we compared cognitive function in autism with clusters of patients with schizophrenia using the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981), as a comprehensive assessment of intellectual abilities and several executive function measures, the Wisconsin Card Sorting test (WCST) (Heaton, Chelune, Talley, Kay, & Curtiss, 1993), Halstead Category test, and Trail Making test (Reitan & Wolfson, 1993). These tests were chosen for several reasons, notably the large literature available concerning their application in studies of autism (e.g., Minshew et al., 1997) and of schizophrenia (e.g., Braff et al., 1991; Goldstein, 1990; Goldstein, Allen, & Seaton, 1998), the relevance of these tests to establishment of what has been purported to be core cognitive deficits in both disorders (Goldstein, 1994; Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff, 1995), and the use of these tests in previous studies by our group (reviewed in Goldstein, 1994; Seaton, Goldstein, & Allen, 2000) that provided a stable cluster solution for patients with schizophrenia. These studies of patients with schizophrenia consistently generated a four-cluster solution containing groups characterized by severely and globally impaired cognitive function, normal cognitive function in several areas but a specific impairment in cognitive flexibility, and two moderately impaired groups with differing profiles; one characterized by substantial impairment of psychomotor function relative to other abilities and the other by a flat, moderately impaired profile. A recent study indicated that there were CT scan differences among the clusters, particularly with regard to the prominence of sulcal widening in the severely globally impaired cluster (Allen et al., 2000). There is an extensive literature for both autism and schizophrenia concerning cognitive dysfunction in domains other than the ones considered here, notably memory (Minshew & Goldstein, 1993) and attention (Townsend & Courchesne, 1994), but the intent here was primarily that of comparing an autism sample within the framework of an established system for empirically based classification of schizophrenia. That system was based upon the tests used here, which were initially specifically chosen for their widespread use in schizophrenia research but that have also been used extensively in autism research (Ozonoff, Strayer, McMahon, & Filloux, 1994; Rumsey & Hamburger, 1988, 1990; Siegel, Minshew, & Goldstein, 1996).

2. Method

2.1. Participants

The autistic sample consisted of 31 well-diagnosed adults with high-functioning autism, defined as having Verbal and Full Scale IQ scores of 70 or higher. The diagnosis of autism was established through expert clinical evaluation in accordance with accepted clinical descriptions of high-functioning autism and two widely used research instruments, the Autism Diagnostic Interview (ADI; LeCouteur et al., 1989) and the Autism Diagnostic Observation System (ADOS; Lord, Rutter, & Goode, 1989). Examiner reliability in the administration and scoring of these instruments has been established through ongoing training and consultation with one of the developers of these instruments. Ongoing reliability of administration, scoring, and independent confirmation of diagnostic accuracy were documented through review and rescoring of the audiotaped ADI and videotaped ADOS for all subjects with autism by members of the group that developed these instruments. Consistency of diagnosis across all assessments was required for study eligibility, with instances of disagreement excluded. Potential autistic subjects were also excluded if found to have an associated neurological, genetic, infectious, or metabolic disorder such as tuberous sclerosis, fragile-X syndrome, or fetal cytomegalovirus infection or a known etiology for their autism such as neurofibromatosis, tuberous sclerosis, Fragile-X syndrome, intrauterine infection, or postnatal meningitis. Since high-functioning autism shares many features in common with Asperger's disorder, efforts were made to exclude individuals with Asperger's disorder from this sample. DSM-IV criteria for Asperger's disorder require that there be no significant delays in language, cognitive development, curiosity about the environment, and age-appropriate self-help skills. All of the participants in the present study had evidence of such delays, documented by the ADI and associated clinical interviewing, ruling out Asperger's disorder. The participants with autism were comparable in age and intelligence to subjects in the shifting attention and executive function studies of Ozonoff et al. (1994) and to the earlier studies of Lord et al. (1989) and Rumsey and Hamburger (1988).

The schizophrenia sample consisted of 80 male inpatients at a veteran's hospital, all of whom met DSM-III-R (American Psychiatric Association, 1987) criteria for schizophrenia. All subjects were diagnosed using the Structured Clinical Interview for DSM-III-R (SCID-P; Spitzer, Williams, Gibbon, & First, 1990) or the Schedule for Affective Disorders and Schizophrenia-Lifetime Version (SADS-L; Spitzer & Endicott, 1979) and through consensus at interdisciplinary case conferences. Thorough medical and neurological evaluations were conducted. Individuals with other psychiatric diagnoses, substance abuse, or medical/neurological disorders that could impair cognitive function were excluded. Only male participants were used because very small numbers of female schizophrenic patients are treated in veteran's hospitals. Participants were stabilized on appropriate medication, usually haloperidol, when tested. Stability was defined as absence of symptom change over at least a 6-week period of chronic treatment with sufficient remission of positive symptoms to allow for capability of cooperating for the neuropsychological testing. It is

noted that extensive reviews by Green (1998) and Medalia and Gold (1992) indicated that antipsychotic medication as well as anticholinergics had only minimal effects on tests of the type used here and clearly do not cause impairment. Mean age of onset of schizophrenia was 23.14 (S.D. = 4.86). Demographic and psychometric data for both groups are presented in Table 1.

2.2. Procedure

Each subject received the WAIS-R, the Halstead Category test, the Trail Making test, and the WCST. Testing was done by trained neuropsychology technicians under the supervision of professional psychologists. Both the technicians working with the autism and the schizophrenia patients had extensive experience with their respective patient groups. The 11 subtest scores from the WAIS-R, error score from the Category test, time scores from Parts A and B of the Trail Making test, and perseverative error score from the WCST were used as dependent measures. The data analysis was directed towards comparing the test profile obtained by the autism group with the profiles found for the various clusters formed by the subjects with schizophrenia. Therefore, a cluster analysis of the cognitive test data was performed using the schizophrenia sample and the cluster profiles were compared to that obtained by the autism sample.

As in previous studies (Goldstein, 1994), Ward's method of cluster analysis was used, as was squared Euclidean distance as the similarity measure. Ward's method is a hierarchical agglomerative method designed to optimize the minimum variance within clusters (Aldenderfer & Blashfield, 1984). Determination of number of clusters was made through inspection of the dendograms and plotting of clusters in discriminant function space, seeking clear separation among the clusters. Stability of the cluster solution was evaluated by applying an iterative partitioning method to the same data. A large number of cluster reassignments would connote poor stability. Preliminary evaluation of the data indicated substantial agreement between Ward's method and the iterative partitioning method for a

Table 1
Demographic and psychometric data for the four schizophrenia clusters and the autism group

Variable	Moderately impaired		High functioning		Severely impaired		Severe psychomotor		Autism	
	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.
Age	42.15	7.89	40.35	7.83	48.54	9.91	42.60	5.68	21.39	9.82
Education (years)	12.76	1.69	13.48	1.97	11.77	1.64	12.20	1.93	10.68	2.88
Verbal IQ	92.09	12.32	101.57	12.12	85.00	6.14	101.68	16.35	101.68	16.35
Performance IQ	86.71	10.67	98.26	8.44	81.54	5.99	76.80	8.67	97.39	11.53
Full Scale IQ	88.94	11.05	99.13	8.74	82.54	5.56	80.40	9.48	99.58	13.06

The autism sample was significantly ($P < .05$) younger and had significantly ($P < .05$) fewer years of education than the schizophrenia clusters, which did not differ from each other. The autism group and schizophrenia cluster 2 differed from the other clusters in Verbal, Performance, and Full Scale IQ scores, with the other clusters not differing among themselves.

four-cluster solution. Analyses of variance were performed for evaluation of the group differences on the various tests. There is a general consensus of opinion among statisticians that standardized scores should not be used in cluster analyses (Aldenderfer & Blashfield, 1984). We therefore used raw scores for the Category test, WCST, Trail Making test, and WAIS-R-scaled scores uncorrected for age in the cluster analysis. However, there was a substantial age difference between the autism and schizophrenia groups. We therefore converted the raw scores of the neuropsychological tests to corrected scores (Heaton, Grant, & Matthews, 1991) for purposes of placing the scores on the same scale for graphic presentation. The WAIS-R subtests were already all on the same scale. A preliminary review of the WAIS-R data obtained from age-corrected scaled scores revealed no substantial difference from the uncorrected scaled scores, thus supporting retention of the uncorrected scores for measurement stability considerations.

3. Results

Consistent with previous research (Goldstein, 1994; Goldstein et al., 1998), examination of the cluster analysis results supported a four-cluster solution. The first cluster reflected moderate, generalized impairment with below average but not severely impaired performance on the neuropsychological tests. The WAIS-R scores ranged from 5.62 on Digit Symbol to 9.53 on Information, again reflecting moderate but not severe impairment. The second cluster is readily characterized as a high-functioning group with normal to close to normal scores on the neuropsychological tests and WAIS-R subtests ranging from 7.74 to 11. The third and fourth clusters both reflect substantial impairment. The fourth cluster did slightly better than the third on conceptual reasoning tasks but less well on psychomotor tasks marked in particular by an exceptionally low mean score on Part B of the Trail Making test. We will call the third cluster a severely impaired cluster and the fourth cluster a severely impaired psychomotor cluster. The solution found here is almost identical to those reported by Goldstein (1990) using the neuropsychological tests and Goldstein et al. (1998) using a combination of the neuropsychological tests and the WAIS-R.

Comparisons among the schizophrenia clusters and the autism group are presented in Table 2, and the WAIS-R data are presented graphically in Fig. 1. In that the schizophrenia sample was substantially older than the autism sample, the neuropsychological test scores were converted to corrected T scores (Heaton et al., 1991), and mean T score profiles for each of the schizophrenia clusters and the autism group were prepared. These profiles are presented in Fig. 2. They reflect essentially the same relationship among profiles as was found for the uncorrected scores. That is, the autism profile resembled the profile of the high-functioning schizophrenia cluster more than it did the other schizophrenia clusters. On the WAIS-R Verbal scale, the autism and high-functioning schizophrenia groups both had a low point on Comprehension; on the Performance scales, the scores were quite close together, except that the autism group did more poorly on Digit Symbol. There is some resemblance between the autism profile with that of the

Table 2
Comparisons between the four schizophrenia clusters and the autism sample

Test	Moderately impaired		High functioning		Severely impaired		Severe-Motor		Autism		<i>F</i>	A vs. C ^a
	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.	<i>M</i>	S.D.		
Category errors	79.85	27.56	54.09	15.65	104.62	22.37	88.70	24.07	51.87	26.28	16.30***	A > 1,3,4
Trail Making A	43.71	13.35	33.09	10.80	56.00	15.13	79.20	37.23	32.71	15.14	18.10***	A > 3,4
Trail Making B	115.88	31.19	61.83	14.21	188.77	38.42	300.90	0.32 ^a	66.68	36.02	157.43***	A > 1,3,4
WCST errors	36.53	20.99	20.30	16.06	64.15	25.52	59.10	30.48	19.63	16.44	17.12***	A > 1,3,4
WAIS-R subtests												
Information	9.53	3.33	11.00	2.04	8.08	1.44	8.50	1.78	10.97	3.29	4.12**	
Comprehension	7.24	2.41	8.96	2.34	5.69	1.70	6.50	2.01	7.74	3.59	3.63**	A < 2
Arithmetic	7.59	2.22	10.09	2.70	7.00	1.22	6.90	2.96	9.94	3.78	6.35***	A > 1,3,4
Similarities	8.29	2.44	9.61	3.14	6.69	2.21	6.60	3.57	10.52	2.63	7.36***	A > 1,3,4
Digit Span	9.21	2.90	10.09	2.70	7.00	1.78	7.00	3.43	9.93	3.92	3.70 *	
Vocabulary	8.82	2.28	9.91	2.04	7.15	2.23	7.40	1.96	9.39	3.08	3.85 *	A < 2
Digit Symbol	5.62	1.58	7.74	1.57	4.31	1.03	4.50	1.51	4.81	4.49	5.42***	A < 2
Picture Completion	7.24	2.30	9.78	1.81	6.08	1.61	6.30	2.45	8.71	2.19	10.33***	A > 1,3,4
Block Design	7.68	1.92	9.74	1.96	5.54	1.27	5.30	2.58	10.68	3.26	18.50***	A > 1,3,4
Picture Arrangement	6.79	2.38	8.65	2.21	6.08	1.80	5.10	1.85	10.23	2.59	16.10***	A > 1,3,4
Object Assembly	7.35	2.72	8.78	2.76	5.77	2.17	5.60	3.10	9.81	3.73	6.87***	A > 1,3,4

^a This value is unusually low because all cases in this cluster obtained minimal scores.

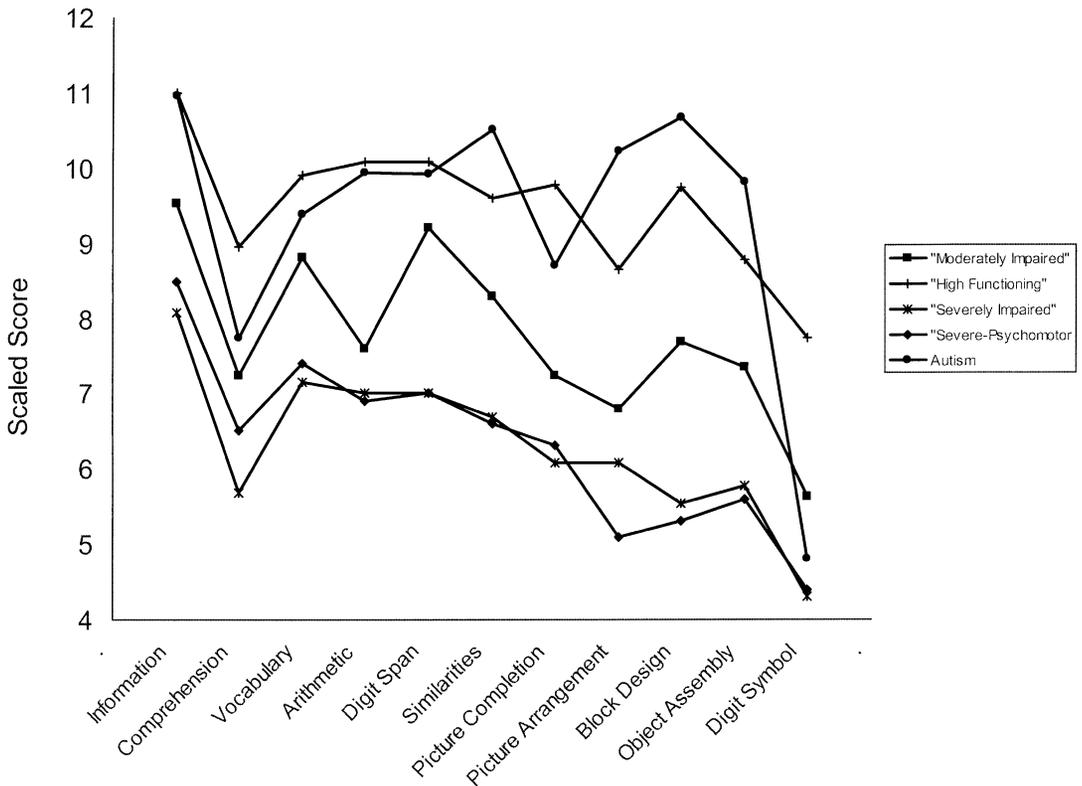


Fig. 1. WAIS-R profiles for the four schizophrenia clusters and the autism group.

moderately impaired cluster, particularly with regard to verbal abilities, but very little resemblance with the severely impaired clusters, both of which showed moderate to substantial impairment of almost all cognitive abilities tested.

In order to provide a quantitative estimate of the differences among the five profiles, we determined the number of significant differences ($p < .01$) between the autism group and the four schizophrenia clusters in the manner of planned comparisons. There were 11 significant differences between the autism group and the moderately impaired cluster: 2 in the case of the high-functioning cluster, 14 for the severely impaired cluster, and 12 for the severe psychomotor cluster. Sign tests were performed to test the hypothesis that the direction of the differences would exceed chance expectation or an equal number of significant and nonsignificant differences. The results were that for the moderately impaired schizophrenia cluster, there were not significantly ($p > .05$) more significant than nonsignificant differences. For the high-functioning cluster, there were significantly ($p < .01$) fewer nonsignificant than significant differences. There were significantly more significant than nonsignificant difference for the severely impaired cluster ($p < .001$) and the severe psychomotor cluster ($p < .05$). These results indicate that the autism group was most like the high-functioning schizophrenia cluster and least like the severely impaired

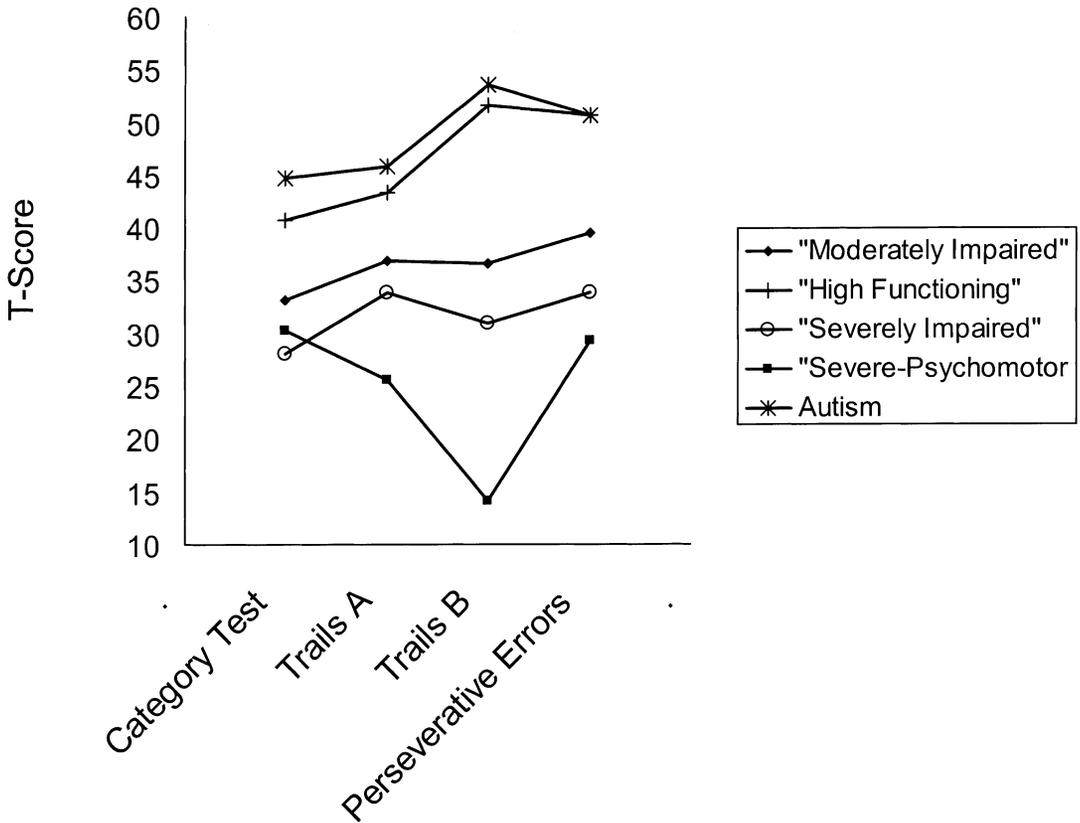


Fig. 2. Neuropsychological test *t* scores for the four schizophrenia clusters and the autism group.

schizophrenia cluster. In most cases, the difference was in the direction of the autism group performing better than the schizophrenia cluster, with the one exception that the schizophrenia high-functioning cluster significantly outperformed the autism sample on Digit Symbol. Thus, the general conclusion was that the autism group resembled only one of the schizophrenia clusters even when age correction is made for the age-sensitive neuropsychological tests.

4. Discussion

A sample of individuals with carefully diagnosed high-functioning autism was compared with four cognitively based clusters of patients with schizophrenia. This comparison demonstrated that individuals with high-functioning autism have a cognitive profile that resembles that of an empirically derived subgroup of patients with schizophrenia but that does not resemble profiles found in other schizophrenic subgroups. Thus, while level and pattern of cognitive function in high-functioning autism resembles that of some individuals with

schizophrenia, they do not resemble most individuals with schizophrenia. The schizophrenia cluster that the autism sample strongly resembled was characterized by a pattern of impaired and average level abilities, with a WAIS-R profile marked by a relatively depressed score on the Comprehension subtest among the Verbal subtests and a relatively elevated score on Block Design and Picture Completion among the Performance subtests. This profile, with the exception of the elevated Picture Completion, has been characterized as a prototypic profile for high-functioning autism (Siegel et al., 1996).

It is possible that this finding will be attributable to the fact that only high-functioning, nonretarded subjects with autism were included in the study, while a more diverse schizophrenia sample was used. The result obtained might have been produced by excluding individuals with autism who had IQs below 70. However, only two of the subjects with schizophrenia had IQs below 70, both cases being in the high 60s. It is therefore unlikely that the findings are an artifact of selecting a nonretarded group of subjects with autism to compare with a more intellectually diverse group of patients with schizophrenia.

With regard to the role of general intelligence, the results suggest that there are patients with schizophrenia with average intelligence who do exceptionally poorly on tests of abstract reasoning and problem solving, as is clearly the case for the moderately impaired schizophrenia cluster. This dissociation was not as distinct in the autism sample. Perhaps, the distinction lies in part in the fact that individuals with schizophrenia may develop relatively normal intelligence until onset of illness, at which time the classic signs of schizophrenic thought disorder appear rapidly. In the case of autism, intelligence develops along with the autism throughout life, possibly attenuating the sharp discrepancies among types of thinking seen in schizophrenia.

Individuals in the high-functioning schizophrenia cluster appear to have a cognitive profile that has been characterized in the case of autism as a disorder of complex information processing, with sparing of simpler, more basic abilities and sometimes remarkable intactness of spatial-constructional abilities (Minschew et al., 1997). The high-functioning schizophrenia profile has this characteristic with a mildly depressed score on the Category test and better scores on tests involving simple attention and language skills, notably WAIS-R Information. It is noted that several of the mean WAIS-R-scaled scores for both the autism group and the high-functioning schizophrenics closely approach or slightly exceed the average score of 10 for the general population. However, the autism group and the high-functioning schizophrenia cluster did poorly on Digit Symbol and Comprehension relative to their other subtest scores. Utilizing the Heaton et al.'s (1991) age and education-corrected norms, the autism group performed at an average level for Part B of the Trail Making test and perseverative errors on the WCST but slightly below average for their age and educational level on the Category test and Part A of the Trail Making test. Taking into consideration the WAIS-R and neuropsychological data, the high-functioning schizophrenia cluster can be seen as representing selective impairment of complex information processing and psychomotor speed tasks with sparing of semantic memory, simple numerical skills, and spatial-constructional abilities. These data would not support the view that the high-functioning individuals with schizophrenia and autism participants are cognitively normal and actually performed no differently from normal,

healthy individuals of their age and education. Two considerations are raised. First, some of the scores were not average level, with low scores on the Category test and Digit Symbol in both the high-functioning schizophrenia and the autism groups. Second, the profiles are not normal but are marked by atypical relations among psychomotor, abstraction, and social judgement tests, which are done relatively poorly, and fund of knowledge and verbal skill tests that are done well. Furthermore, previous research in high-functioning autism has indicated that when participants with autism are carefully demographically matched with controls, significant differences appear on tests of abstraction and problem solving (Minshew et al., 1997; Ozonoff et al., 1994).

The present results raise the possibility that high-functioning autism and one form of schizophrenia share a profile of cognitive dysfunction, despite the fact that the two disorders are associated with varying times of onset, courses, and severity levels. In both schizophrenia and autism, we may have individuals with the full clinical syndromes, as was the case here, but with selective deficits in complex information processing as opposed to blatant mental retardation or dementia, as is found in the more severe forms of both disorders. The findings do not challenge the view that autism and schizophrenia are separate disorders. Indeed, they support it in that most of the participants with schizophrenia had cognitive profiles that were quite different from what was found for the autism group. Furthermore, the developmental pattern implied from the relationships among the various tests suggests that similar cognitive profiles found among adults may have developed differently. In the case of the present study, for example, impairment of abstraction ability may only appear in schizophrenia during adulthood after onset of acute illness, while it may exist over the full life span in autism.

If cognitive function is a marker for neurobiology and if the high-functioning schizophrenics have a pathophysiology similar to individuals with high-functioning autism, several possibilities follow relevant to course and treatment. First, these schizophrenic individuals may have developmental histories of poor social relationships, and although they may develop well intellectually, they may have poor social skills throughout life. Although autism has not generally been found to evolve into schizophrenia, high-functioning schizophrenic individuals may have a type of schizophrenia with a developmental history of poor interpersonal relations and detachment, maintenance of intelligence in the nonretarded range, and normal basic communicative abilities, who share some of the clinical phenomenology of high-functioning autism but who ultimately acquire the positive symptoms of schizophrenia at the point of a first psychotic episode. Individuals with autism are generally not responsive to the traditional antipsychotic medications (Minshew, 1996). If high-functioning schizophrenics physiologically resemble individuals with high-functioning autism, it is possible that they will benefit more from some of the behavioral methods that are sometimes helpful in the management, if not the definitive treatment, of autism. Aside from these considerations, there would also be a possibility for refinement of diagnosis in that while autism and schizophrenia may be different disorders, tests of cognitive function might provide objective criteria to implement Eisenberg and Kanner's (1958) observation that the two disorders are related generically. The present findings might suggest that one form of schizophrenia might have a pathophysiology

similar to that of autism. However, the limitations of this study with regard to the absence of a more detailed neuropsychological assessment and of neurobiological data make this point only a suggestion for future research.

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