A Comparison of WAIS–R Profiles in Adults With High-Functioning Autism or Differing Subtypes of Learning Disability

Gerald Goldstein
VA Pittsburgh Healthcare System and School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Sue R. Beers, Don J. Siegel, and Nancy J. Minshew
School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA

To examine cognitive differences among adults with differing developmental disorders, a comparison of Wechsler Adult Intelligence Scale–Revised profiles was made with samples of 35 individuals with high-functioning autism (HFA) and 102 individuals with adult learning disability (LD). All participants had Verbal and Performance IQ scores of 70 or higher. The LD group was divided into 3 subtypes based on relative achievement levels in mechanical reading and arithmetic. The group with HFA had a profile characterized by a high score on Block Design with a low Comprehension score. The HFA group most resembled the LD subtype that had superior achievement in reading relative to arithmetic, with the exception of their poor performance on measures of social perception and judgment. Results are discussed in terms of the substantial differences in cognitive structure between these 2 neurodevelopmental disorders and are considered in the context of the learning deficits reported for Asperger’s Disorder and nonverbal learning disability.

Key words: autism, learning disability subtypes, WAIS–R

Clinical and neuropsychological prototypes in the form of Wechsler Adult Intelligence Scale (WAIS) profile configurations of the scaled scores (Wechsler, 1944, 1955, 1981, 1998) have been described from the time of Rapaport, Gill, and Schafer (1945) to more recent times (Reitan & Wolfson, 1993). Numerous group comparisons have been reported, demonstrating often substantially different intellectual profiles in numerous developmental and psychiatric disorders. Administration of an intelligence test is often advised or required for diagnosis and description of the client being assessed, not only to rule out mental retardation but also to provide information about the profile of cognitive abilities that may contribute to the academic deficit or to provide data about potentially compensatory abilities (Francis, Espy, Rourke, & Fletcher, 1991). Although the intelligence test may be supplemented with additional psychoeducational and neuropsychological tests, it provides unique information about complex abilities in a number of areas, such as working memory or complex spatial problem-solving skills.

In this research, we provide a comparison between high-functioning autism (HFA) and adult learning disability (LD). Such a comparison is of interest because both are neurodevelopmental disorders that emerge early in life but persist into adulthood (McCue & Goldstein, 1991). Shea and Mesibov (1985) believed that there may be an unclear boundary between HFA and severe LD and remarked on the resemblance between the core deficits of autism and those of the social and nonverbal developmental disorders. An uneven profile of skills involving aspects of language, cognition, and social adjustment is common to each disorder. HFA and LD are distinguished from each other, however, by differences in the nature of deficient language and communication and academic and social skills.
Extensive neuropsychological research has demonstrated substantial differences in the cognitive functioning of children and adults with HFA and individuals with LD. Individuals with autism have been characterized alternatively as having executive dysfunction (Griffith, Pennington, Wehner, & Rogers, 1999; Ozonoff, 1995) or impaired complex information processing (Minshew, Goldstein, & Siegel, 1997) as the core dysfunction. Their weakness lies in conceptualizing and organizing information. However, they typically have intact mastery of the mechanical aspects of language, including phonetics, spelling, and simple calculation, and often remarkably good spatial skills (Minshew, Goldstein, Muenz, & Payton, 1992). Individuals with LD may have fully adequate nonverbal abstract reasoning abilities and spatial skills but are typically significantly impaired in phonetics and related mechanical aspects of language (Ozols & Rourke, 1991). Individuals with autism typically have substantial difficulties with the pragmatic and metaphoric aspects of language (Brook & Bowler, 1992) and may often show a pattern marked by fully intact oral reading but poor reading comprehension (Frith & Snowling, 1983; Minshew, Goldstein, Taylor, & Siegel, 1994; Whitehouse & Harris, 1984). In a direct demonstration of such differences in the adult population, Rumsey and Hamburger (1990) found no differences between groups of average-IQ adults with either autism or dyslexia on measures of perceptual organization, word fluency, tactile perception, and motor speed and coordination. The performance of these groups on measures of simple language and visual–spatial skills was similar. The group with autism performed more poorly on tests of verbal and nonverbal reasoning, comprehension, and recall of complex verbal and visual material, but they outperformed the dyslexia sample with respect to auditory recall of simple information and on tests of basic academic skills. Thus, the literature suggests the presence of important cognitive differences between individuals with HFA and with LD.

Studies using Wechsler Adult Intelligence Scale–Revised (WAIS–R; Wechsler, 1981) subtest profiles also suggest the presence of such a difference. A study and literature review of WAIS–R performance in adults with autism noted the high prevalence of a pattern of relatively elevated scores on Block Design, with diminished performance on Comprehension (Siegel, Minshew, & Goldstein, 1996). In the case of a heterogeneous sample of adults with LD, McCue and Goldstein (1991) described a WAIS–R profile characterized by relatively low scores on Information, Vocabulary, and Arithmetic, with Performance IQ subtests, except for Digit Symbol, approaching the average range. However, the use of a heterogeneous LD sample may have obscured the possible existence of differing profiles among LD subtypes.

A comparison between HFA and LD in general may be misleading because although HFA is a reasonably well-defined condition, LD is not a unitary disorder. Various subtyping systems have been developed based on characteristic behavioral and psychometric patterns (Fletcher & Satz, 1985; Rourke, 1985, 1991). Rourke (1982) developed an empirically based system that classifies individuals with LD on the basis of performance on reading and arithmetic tests. Utilizing the Wide Range Achievement Test–Revised (WRAT–R; Jastak & Wilkinson, 1984), it encompasses individuals uniformly deficient on the Reading and Arithmetic subtests (Global group), individuals who are poor in Reading but better in Arithmetic (A > R group), and individuals who are at least average in Reading, but poor in Arithmetic (R > A group). The Global group is characterized by deficient reading and mathematical achievement relative to general intellectual level. The A > R group typically does not exceed average-level arithmetic ability, but arithmetic performance is substantially better than reading. Thus, individuals in this group are often severely dyslexic. The R > A group is characterized by average-level reading skill but is deficient in arithmetic. Rourke’s (1985) research showed that these subtypes are associated with differing neuropsychological characteristics. Summarizing this work briefly, the R > A group is characterized by relatively good verbal abilities and relatively poor spatial, fine rapid psychomotor, and higher conceptual skills. The A > R group has the reverse pattern. Good spatial and relatively poor linguistic abilities also characterized the group that was disabled in both reading and arithmetic.

This investigation compared WAIS–R performance of adults with HFA and those with the three Rourke LD subtypes to investigate differences in the WAIS–R subtest profile of each group. A major concern was that the consideration of LD subtypes may substantially reduce the confounding that may result from a comparison with a heterogeneous LD sample. We hypothesized that adults with HFA and LD would have distinct WAIS–R profiles. In regard to subtest patterns, an elevated Block Design and Digit Span with depressed Comprehension was anticipated in the autism group. Many studies have demonstrated that individuals with HFA have intact mechanical reading abilities (Minshew et al., 1994). The WRAT–R Reading subtest involves only mechanical reading and not comprehension, particularly in adults (Coneley & Kramer, 1989).
We therefore predicted that the HFA profile would most greatly resemble the R > A LD subtype profile, not because remarkably poor Arithmetic scores are anticipated but because of the excellent mechanical oral reading abilities often shown by individuals with HFA. Indeed, children with autism have been characterized as having hyperlexia, or advanced ability to read and pronounce written words (Frith & Snowling, 1983).

Method

Participants

To meet accepted diagnostic criteria for HFA, and to exclude individuals with mental retardation in both groups, all participants had Verbal, Performance, and Full Scale WAIS–R IQ scores of 70 or above. The group with HFA consisted of 35 participants (12% women). The diagnosis of autism was established through expert clinical evaluation in accordance with accepted clinical descriptions of HFA (Minshew, 1996; Minshew & Payton, 1988; Rapin, 1991; Rutter & Schopler, 1987) and two structured diagnostic instruments, the Autism Diagnostic Interview (ADI; LeCouteur et al., 1989; Lord, Rutter, & LeCouteur, 1994) and the Autism Diagnostic Observation Schedules (ADOS; Lord et al., 1989). A review and rescoring of the videotaped ADI and ADOS for all participants with autism by a developer of these instruments documented diagnostic accuracy. Eligibility for inclusion was dependent on consistency of diagnosis across all assessments, with cases of disagreement excluded. Individuals with impairments in social interaction and restricted patterns of behavior, but with no clinically significant delay in language, cognition, and adaptive behavior, were considered to have Asperger’s Disorder and were also excluded, as were cases of autism with a known etiology, such as Fragile-X syndrome. These participants constituted essentially the same sample as was used in the Siegel et al. (1996) study.

The LD group consisted of 102 participants (34% women). All were referrals to a neuropsychological clinic from the Office of Vocational Rehabilitation or other community agency. The sample included only individuals meeting Diagnostic and Statistical Manual of Mental Disorders (3rd ed., rev. [DSM–III–R]; American Psychiatric Association, 1987) criteria for specific developmental disorder. These criteria require marked impairment of academic skills not explained on the basis of mental retardation, inadequate education, or sensory defects. Appropriate clinical and psychometric assessment documenting a history of academic difficulties and significantly impaired performance on psychoeducational tests established the presence of these criteria. Individuals with acquired academic deficits (e.g., acquired alexia) were excluded. This sample was utilized in several other studies (Goldstein, Katz, Slomka, & Kelly, 1993; Katz, Goldstein, Rudisin, & Bailey, 1993) where more detail concerning the establishment of the diagnoses is provided. To summarize, all participants met both DSM–III–R and State of Pennsylvania Office of Vocational Rehabilitation requirements for an LD diagnosis. Demographic and academic data for the autism group and the three LD subtypes are presented in Table 1.

Procedure

To classify participants in the group with an LD diagnosis into the Rourke subtypes, we used standard scores from the Reading and Arithmetic subtests of the WRAT–R. A presence or absence of a 15-point dis-
crepancy between Reading and Arithmetic determined subtype membership. WAIS–R profiles were compared with multivariate analysis of variance (MANOVA) followed by individual comparisons. Scheffe’s test \((p < .05)\) was used for making multiple comparisons.

Because autism is a rare disorder, it took some time to obtain a sufficient sample, and data collection began before the recently published Wechsler Adult Intelligence Scale–Third Edition (WAIS–III; Wechsler, 1998) appeared. However, because of the stability of structure and subtest composition of the different editions of the Wechsler scales, and because the study involved an evaluation of cognitive profile rather than assessment of individuals relative to the most contemporary norms, it was felt that WAIS–R data remain pertinent. The user of the WAIS–III, which has an extended set of subtests, would, of course, have to use the WAIS–R subtest set to make comparisons with this study.

WRAT–R data were not available for the HFA participants. Because we wished to provide information concerning their level and pattern of academic achievement, we reported data from the Reading Decoding and Mathematics Computation subtests of the Kaufman Test of Educational Achievement (Kaufman & Kaufman, 1985). We provided descriptive data using those tests for the HFA sample only for reference purposes with regard to academic status, without any implication concerning the presence or absence of LD in any individual case. The academic performance of the HFA group was found to be commensurate with general intellectual level and not suggestive of substantial difficulties in mechanical reading or calculation.

Results

Demographic and academic data are presented in Table 1. There was not a statistically significant difference among groups in education, but there was in age. The A > R group was significantly older than the R > A and Global groups but was not older than the autism group. The autism group was significantly older than the R > A group. Correlations between age and the WAIS–R scales were significant \((p < .05)\) for the Information, Vocabulary, Picture Arrangement, and Digit Symbol subtests. However, analyses of covariance using age as the covariate did not substantially alter the findings for these four subtests with regard to statistical significance. A MANOVA of the 11 WAIS–R subtests providing comparisons among the HFA and the three subtypes of the LD sample resulted in a statistically significant main effect, \(F(33, 363) = 3.68, p < .001\). The subtest profiles for the four groups are presented graphically in Figure 1. Univariate \(F\) tests indicated significant differences for all subtests except Similarities, Block Design, Object Assembly, and Digit Symbol. Further analyses were accomplished by multiple comparisons utilizing Scheffe’s test \((p < .05)\). In the cases of Information, Digit Span, and Arithmetic, the HFA group performed significantly better than the A > R and the Global group, but not the R > A group. For Comprehension, Picture Completion, and Picture Arrangement, the R > A group performed significantly better than the HFA group. Although an overall significant difference was found for Vocabulary, there were no significant between-group differences. These data are reported in Table 2.

Discussion

This study compared WAIS–R subtest mean profiles between groups of adults with HFA and individuals with three different academic profiles in an effort to determine cognitive profile characteristics that discriminated among these groups. The adults with LD were divided into subtypes based on performance levels in mechanical reading and arithmetical computation. In general, the HFA group performed better than the LD subtypes on the WAIS–R subtests. Examination of the profiles suggests that the HFA group was most like the R > A LD subtype with regard to both verbal and performance abilities. The HFA group, however, did more
poorly than the R > A subtype on subtests involving social judgment, including Comprehension, Picture Completion, and Picture Arrangement. Otherwise, there were no significant differences, or the HFA group outperformed the A > R group and the Global group but not the R > A group.

The results of this study suggest that individuals with HFA have a very different cognitive profile from LD subtypes. Individuals with HFA have relatively strong points in the areas of semantic memory, attention, and spatial–constructional abilities. They are relatively weak with regard to tasks requiring social judgment and perception. The strengths of the LD participants depend to some extent on the subtype. The R > A subtype had relatively good social judgment, verbal reasoning, and spatial–constructional abilities. The A > R subtype had generally low subtest scores but relatively good spatial–constructional abilities. Rourke (1989) described this subtype as being low functioning in the sense that although arithmetic may be better than reading, it is typically at a below-average level. The Global subtype has almost precisely the same WAIS–R subtest profile as does the A > R subtype, but it is slightly elevated.

These results indicate that the cognitive profile of individuals with HFA is most like what is seen in individuals with LD who are not significantly impaired in reading but who have academic difficulties in other areas. Examination of the R > A WAIS–R profile indicates that this group did most poorly on those subtests that involve numbers, with other test scores ranging around the average level. They may be best characterized as having the DSM–III–R diagnosis of Developmental Arithmetic Disorder. That is, the members of this group typically did not have dyslexia and appeared to have relatively good social cognition, but they had a rather specific difficulty with working with numbers.

Klin, Volkmar, Sparrow, Cicchetti, and Rourke (1995) reported that the cognitive profile in Asperger’s Disorder, but not HFA, is similar to nonverbal LD (Rourke, 1989). Findings from this study would therefore parallel their conclusions in that although we did not study individuals with Asperger’s Disorder, the profile of the HFA participants contained many differences from what is observed in nonverbal LD. Particularly notable in the HFA profile was the absence of deficits in arithmetic and in spatial–constructional abilities. Perhaps the profile for the HFA group can be best characterized as being similar to the R > A group with the exception of tasks requiring social judgment, on which the HFA group demonstrated relatively impaired performance both in verbal and performance modalities. Thus, the difference is better conceptualized in terms of social versus nonsocial task requirements, rather than verbal versus performance abilities.

Although this study was conducted with an adult sample, there are implications for children in a number of respects. With regard to autism, the course of this disorder is lifelong and there is no indication of a remission during adolescence or adulthood. However, there is a developmental pattern characterized by differing courses for different cognitive abilities. The situation appears to be that individuals with autism do not deteriorate but, rather, do not keep up with their normal age peers for certain abilities. For basic language skills such

### Table 2. WAIS-R Subtest Scores for the High-Functioning Autism and Learning Disability Groups

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Autism</th>
<th>A &gt; R</th>
<th>R &gt; A</th>
<th>Global</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>9.03</td>
<td>6.28</td>
<td>7.38</td>
<td>6.68</td>
</tr>
<tr>
<td>Comprehension</td>
<td>7.35</td>
<td>8.28</td>
<td>10.44</td>
<td>8.57</td>
</tr>
<tr>
<td>Arithmetic</td>
<td>8.68</td>
<td>6.39</td>
<td>6.88</td>
<td>6.56</td>
</tr>
<tr>
<td>Similarities</td>
<td>8.53</td>
<td>7.72</td>
<td>10.38</td>
<td>8.72</td>
</tr>
<tr>
<td>Digit Span</td>
<td>9.00</td>
<td>5.94</td>
<td>8.06</td>
<td>6.76</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>8.41</td>
<td>6.39</td>
<td>8.56</td>
<td>6.97</td>
</tr>
<tr>
<td>Digit Symbol</td>
<td>6.85</td>
<td>6.89</td>
<td>7.31</td>
<td>7.25</td>
</tr>
<tr>
<td>Picture Completion</td>
<td>7.41</td>
<td>8.06</td>
<td>9.94</td>
<td>8.43</td>
</tr>
<tr>
<td>Block Design</td>
<td>9.21</td>
<td>8.11</td>
<td>9.00</td>
<td>8.26</td>
</tr>
<tr>
<td>Picture Arrangement</td>
<td>8.24</td>
<td>7.39</td>
<td>10.63</td>
<td>8.38</td>
</tr>
<tr>
<td>Object Assembly</td>
<td>8.74</td>
<td>8.72</td>
<td>8.56</td>
<td>8.29</td>
</tr>
</tbody>
</table>

*a = Autism; 2 = A > R; 3 = R > A; 4 = Global.

* $p < .05$, ** $p < .01$, *** $p < .001$. 

GOLDSTEIN ET AL.
as phonetics, they start out at normal levels and retain normal function into adulthood. However, for comprehension skills, they start out at a level comparable to age peers but lose ground as they grow older. Still other abilities, particularly those involving conceptual reasoning, start out abnormally and remain that way. This material is described in detail in a cross-sectional age-difference study by Goldstein, Minshew, and Siegel (1994). In the case of LD, it is now no longer believed that it is typically outgrown, and remarkable similarities have been found in academic profile and academic performance in children and adults (McCue & Goldstein, 1991).

Lincoln, Courchesne, Kilman, Elmasian, and Allen (1988) performed a factor analysis of the Wechsler scales based on a sample of individuals with autism. The first factor received high loadings from all of the Verbal Scale subtests, the second from Block Design, Object Assembly, and Digit Symbol/Coding, and the third from Picture Completion and Picture Arrangement. Thus, it was quite discrepant from the conventional Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility factors (Cohen, 1957). The factor structure obtained by Lincoln et al. (1988) would therefore be consistent with our finding of a large discrepancy in the HFA group between Block Design and both Picture Arrangement and Picture Completion, suggesting that the structure of intellectual function in HFA is quite different from what is the case for the general population and for LD.

For users of the WAIS–III, it has been reported that the factor structure of the WAIS–III is quite similar to that of the WAIS–R, containing Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility (now called Working Memory) factors, with a Processing Speed factor added. Furthermore, the correlations between the two editions are .94, .86, and .93 for Verbal, Performance, and Full Scale IQ, respectively (Tulsky, Zhu, & Prifitera, 2000). Thus, the findings reported here are likely to be applicable to the WAIS–III. Clearly, however, further research in this area should use this newly developed, state-of-the-art instrument. Limitations of this study are insufficient sample size to perform factor analyses and more advanced analyses of profile similarities and differences as well as use of the WAIS–R rather than the WAIS–III, necessitated by the low prevalence of HFA. As larger samples of individuals with HFA become available, further exploratory as well as confirmatory factor analytic studies might yield valuable new information regarding ability structures in these different developmental disorders.

References


*Original submission March 31, 2000
Accepted February 8, 2001*