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ORIGINAL PAPER

Estimation of the Intelligence Quotient Using Wechsler Intelligence Scales in Children and Adolescents with Asperger Syndrome

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Abstract Asperger syndrome (AS) patients show heterogeneous intelligence profiles and the validity of short forms for estimating intelligence has rarely been studied in this population. We analyzed the validity of Wechsler Intelligence Scale (WIS) short forms for estimating full-scale intelligence quotient (FSIQ) and assessing intelligence profiles in 29 AS patients. Only the Information and Block Design dyad meets the study criteria. No statistically significant differences were found between dyad scores and FSIQ scores ($t(28) = 1.757$; $p = 0.09$). The dyad has a high correlation with FSIQ, good percentage of variance explained ($R^2 = 0.591$; $p < 0.001$), and high consistency with the FSIQ classification ($\chi^2(36) = 45.202$; $p = 0.14$). Short forms with good predictive accuracy may not be accurate in clinical groups with atypical cognitive profiles such as AS patients.

Keywords Asperger syndrome · Intelligence · Cognitive profile · Wechsler Scales · Short forms · Dyads

Introduction

Intelligence tests provide a global measure of cognitive competence and can predict performance in several neuropsychological parameters (Leckliter and Matarazzo 1989; Reitan 1985). The most widely used intelligence quotient (IQ) tests are the Wechsler Scales (Weschler 1974, 1997). As the administration time of the Wechsler Scales is long—between 75 and 105 min—(Ryan et al. 1998), many clinicians and researchers use an abbreviated version—between 15 and 20 min—to estimate full-scale intelligence quotient (FSIQ) score to facilitate participation of subjects in studies and to make feasible the clinical practice.

Different methods of estimating general intellectual functioning have been examined by investigators. Short forms of Wechsler full test batteries have been developed by either selecting items from subtests or by selecting specific subtests. The selection of certain subtests has numerous advantages (provides estimated IQ scores with substantial time savings, in some cases 85–90%, for patients who exhibit impaired attention and/or deficient motivation) over short forms based on item reduction (Allen et al. 1997). Different combinations of subtests have been examined as clinical screening methods for estimating FSIQ (Kaufman et al. 1991; Reynolds et al. 1983; Silverstein 1982; Ward 1990). Satler (2001) provided different short-form combinations of two (dyad), three (triad), four (tetrad), and five (pentad) subtests of the Wechsler Adult Intelligence Scale-Third Edition (WAIS-III), and examined their reliability and validity and conversion of the score into an estimated FSIQ.

Several authors have studied the application of the short versions of the Wechsler Scales in healthy adults and adolescents (Hunter et al. 1989; Lange and Iverson 2008), children with behavioral problems (Finch et al. 1979; Haynes 1982, 1983), patients with traumatic brain injury (Donders 1992; Shoop et al. 2001) or schizophrenia (Allen et al. 1997; Blyler et al. 2000; Missar et al. 1994), and people with elderly dementia (Brooks and Weaver 2005; Donnell et al. 2007). The results of these studies suggest that short forms have universally shown to misclassify IQ; the longer short forms (four, five, or seven subtests) have better correlations and classification rates than dyads, and

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practitioners should only select those if time is really a priority. To our knowledge up to date there is no study that evaluates the efficacy of IQ short forms in Asperger syndrome (AS) population.

Asperger syndrome is an autism spectrum disorder (ASD), characterized by altered social interactions, restricted interests, stereotyped and obsessive behaviors, and altered pragmatic use of language (Gillberg 1995; Wing 1993). Compared with other ASD, individuals with AS are defined by a history of no language or cognitive delay (American Pyschiatric Association 1994), although this criterion is questioned by several authors (Bennett et al. 2008; Gillberg 1998; Szatmari 2000).

Cognitive profile data in Asperger syndrome are controversial. For instance, studies based on distinguishing IQ differences between AS and high functioning autism (HFA) have yielded inconsistent results. In some studies (Ehlers et al. 1997; Klin et al. 1995; Ozonoff et al. 1991), verbal IQ (VIQ) scores obtained by individuals with AS were significantly higher than performance IQ (PIQ) scores (differences of 12 points or more), and this asymmetry was initially taken to be a characteristic psychometric value in this group. Subsequent studies, however, have been unable to replicate this discrepancy in a consistent manner (Ghaziuddin and Mountain-Kimchi 2004; Siegel et al. 1996; Szatmari et al. 1990). The inconclusiveness of these studies may be a result of various factors, such as small sample size and difference in diagnostic criteria, especially for AS.

Other authors as Klin et al. (1995) stated that patients with AS showed problems with visuomotor integration, visuospatial perception, visual memory, and nonverbal concept formation, and established an analogy between AS and Nonverbal Learning Disorder (NVLD; Rourke 1989; Rourke and Tsatsanis 2000). Neither their data nor the analogy with NVLD has been replicated. On the contrary, there are studies in which patients with AS have good performance in Wechsler Intelligence Scale block design, object assembly, and picture completion, their capacity being in the normal functioning range (Ghaziuddin and Mountain-Kimchi 2004; Siegel et al. 1996; Szatmari et al. 1990). In addition, other studies show that some patients with Asperger syndrome have Verbal and Performance IQs under the normal range (Ehlers et al. 1997).

To our knowledge, only one study analyzes the applicability of short-form Wechsler Intelligence Scales in patients with HFA (Minshew et al. 2005). The authors reported that short-form Wechsler Scales can be used to assess patients with HFA, but that caution must be exercised in the case of dyadic short forms, as these provide approximations of IQ scores that lack the precision of more extensive short forms. The literature suggests that short forms for assessing IQ in individuals with autism can be used in many settings, but Silverstein (1990) cautions that short form use is legitimate in certain circumstances and not in others.

Resnick and Entin (1971) presented a series of criteria to confirm the validity of short-form IQ assessment, as follows: (a) the difference between the means of the short-form IQ and the standard FSIQ must be small and statistically nonsignificant; (b) the correlations between the dyad short form and FSIQ must be highly significant and account for a substantial percentage of the variance shared by the measures; and (c) there must be a high congruence between short-form IQ classification and standard FSIQ classification with regard to set levels of intelligence.

In this study, we aim to assess intelligence profiles in AS and to examine the validity of five dyadic short forms of Wechsler Scales in children and adolescents with AS, taking into account the criteria proposed by Resnick and Entin (1971).

Our first hypothesis is that, in AS patients, the short forms of IQ assessment do not meet the validity criteria mentioned above. Our second hypothesis is that patients with AS present heterogeneous intelligence profiles and show statistically significant differences between VIQ and PIQ.

Methods

Participants

Recruitment was conducted at the outpatient Adolescent Unit of the Department of Psychiatry, Hospital General Universitario Gregorio Marañón, Madrid, Spain between May 2005 and February 2009. The participants were already enrolled in a more extensive naturalistic longitudinal study on oxidative status in early developmental disorders. The inclusion criteria were as follows: (a) age between 7 and 17 years of age; (b) Spanish as a first mother tongue; (c) diagnosis of AS; and (d) written informed consent to participate from parents or legal guardians and assent from patient. The exclusion criteria were: (a) comorbid Axis I disorder at the time of enrolment; (b) history of head injury with loss of consciousness; (c) mental retardation; (d) significant disease unrelated to ASD; (e) pregnancy and lactation; and (f) substance abuse or dependence.

Thirty-five patients met the inclusion criteria. Two patients were excluded, one due to mental retardation and the other due to a comorbid attention-deficit/hyperactivity disorder (ADHD). Three patients refused to complete the neuropsychological evaluation and one patient failed to complete the visual tests of the neuropsychological protocol, as he was blind. The examined final sample comprised 29 participants. Mean age was 12.97 ± 2.73 years (range, 7–17) and 93.1% (27) of the sample was male. Twenty-eight (96.6%) patients were Caucasian and one was Indian. Parental socio-economic status was distributed as follows: high level, 10 (34.48%) patients; high-middle level, 2 (6.9%) patients; middle level, 7 (24.14%) patients; low-middle level, 9 (31.03%) patients; and low level, 1 patient (3.45%). Seven patients (24.1%) were receiving antipsychotic treatment at enrolment. One patient was taking Aripiprazole (3.45%) and six Risperidone (20.6%), while three were also treated with an antidepressant (2 with Sertraline, 1 with Fluoxetine). We did not find a statistically significant difference in FSIQ between the two groups, with or without antipsychotic treatment ($p = 0.84$).

After receiving a full explanation of the study, all parents or legal guardians gave written informed consent before the patients were enrolled in the study and patients gave their assent to participate. The study was approved by the Hospital General Universitario Gregorio Marañón Clinical Research Ethics Committee.

Measures

Demographic Data

Demographic data were collected at baseline using a structured interview with the patients and their parents or legal guardians. Parental socio-economic status was measured using the Hollingshead–Redlich Scale (Hollingshead and Redlich 1958) and classified as low, middle-low (score of 1 or 2, respectively), middle (score of 3), or high-middle, high (score of 4 or 5, respectively).

Clinical Data

All diagnoses were made according to Gillberg criteria (Gillberg and Gillberg 1989) and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; APA 1994); the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al. 1989) was administered when DSM-IV criteria and Gillberg criteria were not coincident (12 patients). The Kiddie-SADS-Present and Lifetime Version (Ulloa et al. 2006) was used to rule out comorbid psychiatric disorders in the sample.

Procedure

Intelligence Profile Assessment

Intelligence profiles were assessed using the Spanish translation of the WAIS-III or Wechsler Intelligence Scale for Children-Revised (WISC-R; Weschler 1974, 1997), according to age, as part of a more comprehensive neuropsychological assessment. The WAIS-III includes six verbal subtests and five performance subtests. The 11 subtests combined comprise the full-scale score. WISC-R has 10 obligatory subtests (five verbal and five performance tasks) to compose a full-scale score.

We selected five short-form dyads for the assessment of intelligence from Sattler's manual (Satler 2001) on the basis that these were the best dyads for rapid screening with one performance subtest and one verbal subtest. We excluded those dyads that required the Matrix Reasoning subtest, as this is only present in WAIS-III. Taking these criteria into account, we chose the following five dyads: Information and Digit Symbol-Coding (I-DSC), Arithmetic and Picture Completion (A-PC), Information and Picture Completion (I-PC), Information and Block Design (I-BD), and Vocabulary and Block Design (V-BD). Patients were administered the complete WISC-R or WAIS-III according to the standardized procedures outlined in their manuals (Weschler 1974, 1997) by three experienced neuropsychologists trained in the use of this instrument. Inter-rater reliability for the vocabulary subtest was calculated by examining 10 cases with an interclass correlation coefficient (ICC) ranging from 0.80 to 0.99.

The five short-form dyad scores were calculated by summing the prorated scores of the selected subtest and converting this number using the tables provides in the WISC-R and WAIS-III manuals (Weschler 1974, 1997; Table 1). The estimated FSIQ and IQ scores for the five short-form dyads were classified using the ranges (very superior (130 and above), superior (120–129), high average (110–119), average (90–109), low average (80–89), borderline (70–79), extremely low (69 and below)) proposed by the Wechsler manual.

Statistical Analysis

Kolmogorov–Smirnov tests were performed and confirmed that all FSIQ and IQ scores were normally distributed. ANOVA tests were used for statistical analysis with post hoc Bonferroni corrections to compare FSIQ between

Table 1 Calculation of the five short-form dyads

Version	Subtest combinations and prorating	
	Sum prorating Ss	
	WAIS-III	WISC-R
Sattler-2 (I, DSC)	(6xI) + (5xDSC)	(5xI) + (5xDSC)
Sattler-2 (A, PC)	(6xA) + (5xPC)	(5xA) + (5xPC)
Sattler-2 (I, PC)	(6xI) + (5xPC)	(5xI) + (5xPC)
Sattler-2 (I, BD)	(6xI) + (5xBD)	(5xI) + (5xBD)
Sattler-2 (V, BD)	(6xV) + (5xBD)	(5xV) + (5xBD)

I Information, *PC* picture completion, *A* arithmetic, *BD* block design, *V* vocabulary, *DSC* digit symbol-coding, *Ss* scalar score patients with and without antipsychotic treatment. We used the t test to compare the means of the five short-form dyads with the average FSIQ and to compare the PIQ and VIQ of the FSIQ. A linear regression model was used to calculate the degree to which the five short forms were associated with FSIQ. A χ^2 test was used to compare the classification of intelligence obtained by the five short forms with that of the FSIQ taking into account the ranges proposed by the Wechsler manual (Weschler 1974, 1997).

All statistical tests were two-tailed, and a p value of <0.05 was considered statistically significant. The analysis was performed using SPSS 16.0 for Windows.

Results

Table 2 shows the results of the three analyses done to determine whether the dyads met the three criteria. The dyads that meet the first criterion of Resnick and Entin are Information and Digit Symbol-Coding, Arithmetic and Picture Completion, Information and Block Design, and Vocabulary and Block Design. For the second criterion, the dyads that had a higher correlation and explain a large proportion of the variance with respect to the FSIQ are Information and Digit Symbol-Coding, Information and Block Design, and Vocabulary and Block Design. And finally, those with high consistency in the classification standard with respect to the FSIQ were Arithmetic and Picture Completion, Information and Picture Completion, and Information and Block Design.

The mean FSIQ of the AS patients was 96.86 ± 21.65. No statistically significant differences were observed between VIQ (97.90 ± 22.842) and PIQ (92.41 ± 18.592); $t(28) = 1.56$; $p = 0.13$. The mean in Wechsler subtests of AS patients and their profiles (differentiating the two Wechsler Scales) are shown in Table 3. Figure 1 show the different profiles depending on the Wechsler Scale used. Bearing in mind that for scalar scores the normal range is between 7 and 13, for patients with AS assessed using the WAIS-III the average score was below 7 for 7 subtests (Similarities, Arithmetic, Vocabulary, Comprehension, Block Design, Digits, and Digit Symbol-Coding). The scores for the remaining subtests were within the range considered normal. Moreover, in the case of patients evaluated with the WISC-R, only 1 subtest (Digit Symbol-Coding) had an average score below 7 and another (Information) was above 13.

Discussion

Our results indicate that the Information and Block Design dyad is the only one of the 5 dyads studied that meets the three study criteria (Resnick and Entin 1971) for confirming the validity of the short-form IQ assessment in this sample of patients with AS. As for the rest of dyads, three (Information and Digit Symbol-Coding, Arithmetic and Picture Completion, Vocabulary and Block Design) met only two criteria, while one (Information and Picture Completion) met only the third criterion. These results support previous studies that indicate that dyadic short forms are appropriate for "rough estimates of IQ" and thus may be good for screening purposes in different clinical conditions (Spreend and Strauss 1998). Caution should be exercised, however, when using the abbreviated dyadic short-forms in AS patients.

To our knowledge, this is the first study that has evaluated the utility of different dyadic short forms of the Wechsler Intelligence Scales in children and adolescents with Asperger syndrome. The Wechsler Intelligence Scales are a well understood composite measure of general cognitive functioning and a common component of more complete neuropsychological evaluations. There are many clinical situations, however, where the complete administration of these batteries is precluded by various constraints, including limitations of time and patients compliance. The use of a valid, reliable, and quick evaluation of intelligence is beneficial in these circumstances.

No significant differences were found between VIQ and PIQ. Other studies have found the same results (Ghaziuddin and Mountain-Kimchi 2004; Siegel et al. 1996; Szatmari et al. 1990). One of the advantages of our study is the

Table 2 Three analyses to confirm the validity of five IQ short forms based on criteria proposed by Resnick and Entin

Short-form dyads	First criterion		Second criterion			Third criterion
	T	B	T	R^2	p	χ^2
I, DSC	$t(28) = 0.918$; $p = 0.367$	0.754	$t(28) = 7.358$; $p < 0.001$	0.667	<0.001	$\chi^2(36) = 56.144$; $p = 0.017$
A, PC	$t(28) = 0.907$; $p = 0.372$	0.654	$t(28) = 4.677$; $p < 0.001$	0.448	<0.001	$\chi^2(30) = 37.257$; $p = 0.170$
I, PC	$t(28) = -4.861$; $p = 0.000$	0.648	$t(28) = 6.035$; $p < 0.001$	0.574	<0.001	$\chi^2(36) = 44.694$; $p = 0.152$
I, BD	$t(28) = -1.757$; $p = 0.090$	0.671	$t(28) = 6.248$; $p < 0.001$	0.591	<0.001	$\chi^2(36) = 45.202$; $p = 0.140$
V, BD	$t(28) = 1.927$; $p = 0.064$	0.720	$t(28) = 9.066$; $p < 0.001$	0.753	<0.001	$\chi^2(36) = 62.280$; $p = 0.004$

I Information, *PC* picture completion, *A* arithmetic, *BD* block design, *V* vocabulary, *DSC* digit symbol-coding

Table 3 Mean WISC-R or WAIS-III scores in Asperger syndrome patients

	Rating score											
	Ss (mean ± SD)											
	Verbal subtest					Performance subtest						
	I	S	A	V	C	PC	PA	BD	DSC	D	M	OA
WAIS-III N = 5	8.4 ± 1.14	6.6 ± 2.30	5.60 ± 4.40	5.40 ± 2.51	3.60 ± 1.52	7.80 ± 3.63	8.00 ± 4.64	5.20 ± 4.27	5.60 ± 2.97	6.40 ± 2.70	8.00 ± 5.10	NA
WISC-R N = 24	13.17 ± 3.87	12.54 ± 4.43	8.37 ± 3.39	10.42 ± 4.24	8.58 ± 3.97	11.13 ± 3.49	10.96 ± 3.64	8.75 ± 2.77	6.71 ± 3.82	NA	NA	9.46 ± 3.12

I Information, *PC* picture completion, *A* arithmetic, *BD* block design, *V* vocabulary, *PA* picture arrangement, *S* similarities, *DSC* digit symbol-coding, *C* comprehension, *D* digit span, *OA* object assembly, *M* matrix, *Ss* scalar score, *NA* not applicable

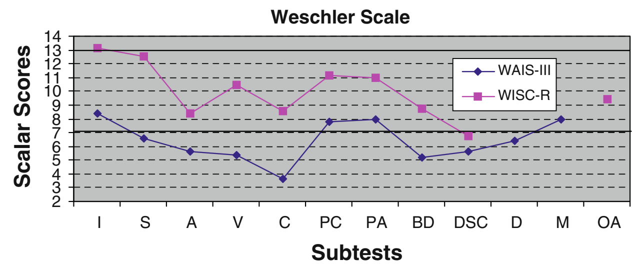

Fig. 1 Intelligence profile in Asperger syndrome patients. *I* Information, *PC* picture completion, *A* arithmetic, *BD* block design, *V* vocabulary, *PA* picture arrangement, *S* similarities, *DSC* digit symbol-coding, *C* comprehension, *D* digit span, *OA* object assembly, *M* matrix

homogeneous sample consisting of only children and adolescents with a diagnosis of AS. As in other studies (Taub 2001), our results do not support the PIQ-VIQ dichotomy used for years in patients with AS. The factor scale score and the subtest patterns provide a better representation of intelligence pattern (Spek et al. 2008).

Among the different Wechsler Intelligence Scales used, we found that those patients assessed with the WISC-R (up to 16 years of age) have high scores in Information and low scores in Digit Symbol-Coding. High scores in Information are related to the ability to acquire knowledge about the world (semantic memory), commonly preserved in people with autism—especially when it is studied with implicit tasks—(Bowler et al. 1997; Renner et al. 2000). Scores below normal in the Digit Symbol-Coding subtest involve impairment of psychomotor speed and short-term visual memory (Seisdedos et al. 1999; Wechsler 1997). On the other hand, when the patients were assessed with the WAIS-IIII (after 16 years of age), we found impairment in five verbal subtests (Similarities, Arithmetic, Vocabulary, Comprehension, and Digits), and two performance subtests (Block Design and Digit Symbol-Coding). These data are contradictory to previous studies that found better performance on verbal tasks in patients with AS (Ehlers et al. 1997; Klin et al. 1995; Ozonoff et al. 1991). Our results could be explained by the small sample size of patients who were assessed with the WAIS-III. Regardless of the very small sample, we found low scores in working memory (Digit and Arithmetic). Digit span taps working memory capabilities (Seisdedos et al. 1999), which can be defined as "the ability to hold in mind past states of the environment and past actions while currently performing an action" (Russel 1997). People with autism and AS tend to store information in details instead of using strategies, which often leads to problems in retaining information (Minshew et al. 1992). The low digit span scores found in the AS group may reflect problems in applying strategies to retain information.

The WAIS-III and WISC-R profiles follow a very similar distribution, although patients who were administered the WAIS-III obtained a larger number of scores falling below the normal range. One possible explanation may be the existence of higher social demands in adolescence that may affect cognitive performance in patients with AS at that stage of development.

The assessment of intellectual ability of children and adolescents with AS is necessary for differential diagnosis, also relevant for the assessment of evolutionary disharmony and dysfunctional characteristics of children with AS. Thus a full evaluation of the cognitive profile of children with AS will facilitate adaptation of the academic environment to potential academic performance based on observed IQ. Silverstein (Silverstein 1990) suggests that, in autism, the use of short forms of intelligence assessments can be used for characterization of samples in research studies and for preliminary screening, but not when an important decision, such as placement in special education, is being made.

The results of the present study should be interpreted with caution due to some methodological limitations. Firstly, we unified results obtained from the two different versions of the Wechsler Intelligence Scales to maximize the sample size, because they have basically the same structure. Secondly, the number of AS patients was small. The strengths of this study include homogeneous sample size and being the first study to assess five short-form IQ dyads in a sample of children and adolescents with AS. New studies would be necessary to study the use of these abbreviated forms in other psychiatric disorders that occur as heterogeneous cognitive profiles to demonstrate its validity and usefulness.

In conclusion, the use of a short form to estimate IQ in children and adolescents with AS, who have an atypical intelligence profile on Wechsler Intelligence Scales must be done with caution. The combination of subtests that best estimate the FSIQ in AS patients is Information and Block Design.

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