

A Screening Questionnaire for Asperger Syndrome and Other High-Functioning Autism Spectrum Disorders in School Age Children

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The high-functioning Autism Spectrum Screening Questionnaire (ASSQ) is a 27-item checklist for completion by lay informants when assessing symptoms characteristic of Asperger syndrome and other high-functioning autism spectrum disorders in children and adolescents with normal intelligence or mild mental retardation. Data for parent and teacher ratings in a clinical sample are presented along with various measures of reliability and validity. Optimal cut-off scores were estimated, using Receiver Operating Characteristic analysis. Findings indicate that the ASSQ is a useful brief screening device for the identification of autism spectrum disorders in clinical settings.

KEY WORDS: Asperger syndrome; autism spectrum disorders; children; screening questionnaire.

INTRODUCTION

Autistic disorders can occur in association with any level of cognitive ability. There is a need for reliable *screening* tools for the whole range of autistic disorders. The Autistic Behavior Checklist (ABC) developed by Krug, Arick, and Almond (1980) is a standardized rating scale of autistic behavior. However, this instrument was originally developed for identifying autistic behavior in severely disabled children. Thus, the items are geared to identifying some of the more severe autistic features that Kanner (1943) characterized and not to the more subtle impairments typical of individuals with autism in the near normal or normal range of intelligence (Goodman & Minne, 1995; Rutter & Schopler,

1987; Wadden, Bryson, & Rodger, 1991; Yirmiya, Sigman, & Freeman, 1994).

On the other hand, a vast number of general rating scales exist for the purposes of assessing the most common dimensions of psychopathology in children (i.e., hyperactivity, attention deficit conduct problems, and emotional symptoms). Two of the most widely and generally used and brief measures in clinical work are the Rutter scales (Goodman, 1994; Rutter, 1967; Rutter, Tizard, & Whitmore, 1970) and the Conners scales (Conners, 1990). These scales are available in separate versions for teacher and/or parent rating. Using multiple informants when screening for childhood disorder is important because teacher and parent scales tend to select different children (Achenbach, McConaughy, & Howell, 1987; Rutter, Graham, & Birch, 1966; Szatmari, Archer, Fisman, & Streiner, 1994). Teacher reports may be particularly important in screening and workup of disorders characterized by social impairment. Dysfunction of this kind may be most obvious to teachers because they have the opportunity to compare children's functioning within a larger group of peers. Therefore, teachers may identify problems or deviance not noted

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by parents (Sanford, Offord, Boyle, Peace, & Racine, 1992; Verhulst & van der Ende, 1991). However, these broad-band behavior measures are not very useful for identification of rare or specialized disorders such as autistic disorders (Barkley, 1988).

In the present paper, a screening instrument for autistic disorders in high-functioning children, particularly Asperger syndrome, is described. Asperger syndrome (Asperger, 1944, 1991) has become increasingly recognized as a high-functioning variant of autism (Gillberg, 1991; Wing, 1981, 1986). It is now included in the diagnostic manuals as a separate disorder among the pervasive developmental disorders (American Psychiatric Association [APA], 1994; World Health Organization [WHO], 1993). However, as pointed out by Miller and Ozonoff (1997) and Gillberg and Ehlers (1998), there is no universal agreement on diagnostic characteristics of Asperger syndrome.

In the DSM-IV (APA, 1994) and the ICD-10 (WHO, 1993) Asperger syndrome is differentiated from autistic disorder by specifying that there is no clinically significant general delay in spoken or receptive language or cognitive development up to 3 years of age. Also, self-help skills, adaptive behavior, and curiosity about the environment should be developing normally during this period of age. Abnormalities of social interaction and circumscribed interests or repetitive behavior should fit the criteria for autistic disorder. An important problem with this definition is that it differs markedly from Asperger's description of the early development and current clinical features of his syndrome. According to Miller and Ozonoff (1997), not even Asperger's own cases (Asperger, 1944) were identified by the current DSM-IV and ICD-10 diagnostic criteria. Interestingly, Eisenmajer *et al.* (1996), in a study of the diagnostic criteria for Asperger disorder and autistic disorder used by clinicians, found that they had generally accepted the criteria outlined by Asperger rather than the ICD and DSM systems. The Gillberg and Gillberg (1989) criteria—elaborated in Gillberg (1991)—are based on Asperger's description. The high-functioning Autism Spectrum Screening Questionnaire (ASSQ) was originally developed in a joint project involving the present authors for use as a first-stage population screening instrument in a prevalence study of Asperger syndrome in mainstream schools with teachers as target raters (Ehlers & Gillberg, 1993).

Based on long-term clinical—and population—experience with a variety of problems on the autistic spectrum, and review of pertinent literature (Asperger, 1944, 1991; Bowman, 1988; Gillberg & Gillberg, 1989;

Kerbeshian & Burd, 1986; Rutter & Schopler 1987; Tantam, 1988; van Krevelen, 1971; Wing, 1981; Wing & Gould, 1979; Wolff & Barlow, 1979) a pool of items were chosen considered to best reflect behavior characteristic of Asperger syndrome in children 7 to 16 years of age.

Several preliminary drafts of the Swedish ASSQ were tested in collaboration with special teachers in Göteborg. Items were revised or omitted if conceived as ambiguous or misunderstood by the teachers. An English translation was submitted to the third author who suggested some changes and additions. The "new" version was translated back to Swedish and special teachers again tested this version. Minor changes were suggested and an English version was again submitted to the third author.

The final ASSQ comprises 27 items rated on a 3-point scale (0, 1, or 2; 0 indicating normality, 1 some abnormality, and 2 definite abnormality). The range of possible scores is 0–54. Eleven items tap topics regarding social interaction, 6 cover communication problems, and 5 refer to restricted and repetitive behavior. The remaining items embrace motor clumsiness and other associated symptoms (including motor and vocal tics). The questionnaire was designed for completion by lay informants. It needs no prior training before completion, and takes about 10 minutes to fill in. The ASSQ was designed as a screening instrument due to the fact that lay informants' ratings on scales, such as this, are highly subjective and biased judgments. Thus, the ASSQ is not intended for diagnostic purposes, but as a measure for identifying children who need a more comprehensive evaluation.

The mean ASSQ teacher score for all 1,401 7- to 16-year-old children participating in the epidemiological study (Ehlers & Gillberg, 1993) was 0.7 (*SD* 2.6). The mean total ASSQ score among the five definite Asperger syndrome cases in this community sample was 26.2 (*SD* 10.3). In this study the test-retest reliability for teacher ASSQ total scores, over an 8-month period was Pearson $r = .90$; $n = 139$; $p = .001$ and the interrater reliability for two different teachers rating the same child was Pearson $r = .79$; $n = 139$; $p = .001$.

The epidemiological study (Ehlers & Gillberg, 1993) showed that in addition to children fitting Asperger syndrome, the ASSQ also identified children with other autistic-like conditions who were in the borderline, average, or superior range of intelligence. This is consistent with the finding of the overlap between Asperger syndrome and other autistic disorders as manifested in the "higher functioning" individuals

(Bosch, 1970; Gillberg, 1992; Schopler, 1985, 1996; Wing, 1991).

In our clinical workup of children with various behavioral disorders we found that the ASSQ was easy to manage for parents and schoolteachers and, thus, provided important information about the child's social and behavioral functioning in different settings. It seemed to be a valuable complement to measures of more general psychopathology, such as the Rutter and the Conners scales, due to better item coverage for social and behavioral impairment. We experienced that children with Asperger syndrome and other high-functioning autistic disorders, generally, scored higher on the ASSQ than on the Rutter and the Conners scales. Thus, we wanted to go further and evaluate the ASSQ, and compare it to the Rutter and Conners scales, in a clinical setting.

The aims of the present study were then to evaluate (a) the reliability and (b) the validity of the ASSQ as a parent and teacher rating scale for screening of high-functioning autism spectrum disorders in a clinical setting. The discriminative ability of the instrument was examined in respect of the following broad diagnostic categories in a sample of children referred consecutively for neuropsychiatric assessment:

1. Autistic spectrum disorders as defined above.
2. Attention-deficit and disruptive behavior disorders (DSM-IV definition).
3. Learning disorders (DSM-IV definition).

In the present paper the whole range of autistic conditions are referred to as the "autistic spectrum disorders" characterized by the triad of abnormalities of social interaction, communication, and imagination and a narrow repetitive pattern of behavior, as defined by Wing and Gould (1979). This overlaps with the pervasive developmental disorders (PDDs) as defined in the DSM-IV (APA, 1994) and the ICD-10 (WHO, 1993) (Szatmari, 1992).

Also, in the present paper, the term "high-functioning" has been extended to include those with mild mental retardation, because autistic spectrum disorders in this group tend to be manifested in ways that are similar to those in individuals with average or high intelligence rather than those with moderate, severe, or profound mental retardation. In any case, individuals with autistic spectrum disorders whose IQ is in the mildly retarded range tend to have patchy profiles on psychological testing with one or more subscale scores in the average or high range, making it difficult to assign them to a particular range of ability.

METHODS AND MATERIALS

Two study groups were included: the main sample with various behavioral disorders, and a sample with Asperger syndrome included for validation of some of the findings obtained in the main sample.

Main Sample

The sample comprised 110 6- to 17-year-old children with various kinds of behavior disorders consecutively referred to a statewide child neuropsychiatric clinic during a period of 8 months. All children were seen individually and examined for at least 2 hours by a child psychiatrist and (separately by) a child psychologist (who administered appropriate IQ tests). One (or both) of the parents (usually the mother) was interviewed in great detail about medical and family history, early development, and psychiatric symptoms in the child. Diagnoses were assigned at a clinical case conference. Moderately and severely mentally retarded children were excluded due to the fact that the ASSQ does not tap features characteristic for such low-functioning subjects. Mildly mentally retarded children, on the other hand, were retained in the evaluation because these children often present a clinical picture very similar to intellectually normal children with social impairment.

As the aim of this study was to evaluate ASSQ as a screening instrument and aid for the identification of those behaviorally disturbed children at risk of having autistic spectrum disorder, this sample was not classified into specific diagnoses, but rather into broad categories. Thus, the diagnostic subclassification of autism spectrum disorders below is presented for convenience and was not used in the statistical analyses.

Autism Spectrum Disorders. This subgroup comprised 21 cases, 13 of whom met the Gillberg and Gillberg (1989) criteria for Asperger syndrome, 4 of whom met criteria for DSM-IV (APA, 1994) autistic disorder, and 4 of whom met criteria for autism spectrum disorder NOS (Nordin & Gillberg, 1996) (corresponding to PDDNOS in DSM-IV). All 13 cases meeting the Gillbergs' Asperger syndrome criteria also met the DSM-IV and the ICD-10 (WHO, 1993) *symptom criteria* for Asperger syndrome. However, 1 of these 13 cases clearly did not meet the DSM-IV and ICD-10 inclusion criterion requiring normal early language development (and would have been classified as autistic disorder/childhood autism under these systems), and in at least another 3 cases the early language development history

was such that it was impossible in retrospect to document if they met this criterion.

Attention-Deficit and Disruptive Behavioral Disorders. This subgroup comprised 58 cases, all of whom met DSM-IV criteria either for attention-deficit/hyperactivity disorder, conduct disorder, or oppositional defiant disorder, and who did not meet criteria for autistic disorder, Asperger syndrome, or autism spectrum disorder NOS.

Learning Disorders. This subgroup comprised 31 cases, all of whom met criteria for reading disorder and disorder of written expression listed in the DSM-IV. A minority, in addition, fulfilled criteria for mathematics disorders, but this was not investigated thoroughly. None met criteria for autism spectrum disorders or attention-deficit and disruptive behavioral disorders.

Of the 110 cases, 13 (12%) had mild mental retardation (IQ 50–70) in addition to being diagnosed in one of the above subgroups. Table I shows the distribution of diagnostic categories, age, sex, and mild mental retardation.

Asperger Syndrome Validation Sample

A group of 34 6- to 16-year-old boys with Asperger syndrome and normal intelligence was used for validation of the findings obtained in the main sample. Including this group gave a possibility to compare ASSQ scores across two similar clinical samples. These subjects had been referred to the same clinic before the period when the main sample was collected. All individuals included met the Gillberg and Gillberg criteria (1989) and 26 met the ICD-10 (WHO, 1993) and the DSM-IV (APA, 1994) criteria for Asperger syndrome. Of the 8 cases not meeting the ICD-10 and DSM-IV criteria, 5 had shown clearly delayed language development. In another 3 cases, it was not possible to document in retrospect a history of normal early language development as required in the ICD-10 and the DSM-

IV. In all 34 cases the parents had completed the ASSQ. In 14 cases the teacher also had completed the ASSQ.

Questionnaires

The parents of all children included in the study, at the first visit to the clinic (Time 1), were asked to complete the ASSQ, the 10-item Conners abbreviated symptom questionnaire (Goyette, Conners, & Ulrich, 1978), the 20-item Rutter parent scale (including those 20 items that are identical with the 26-item Rutter teacher scale, and that can be rated by parents) (Rutter *et al.*, 1970). If the parents agreed, the child's teacher was asked to complete the ASSQ, the 39-item Conners teacher scale, and the Rutter teacher scale (Rutter, 1967). All 110 parents and 107 teachers agreed to complete a set of questionnaires at Time 1. The Rutter and Conners scales were included for the evaluation of validity and reliability of the ASSQ.

The Rutter parent and teacher scales cover some of the most frequent emotional and behavioral symptoms in children. It is designed for use with 9- to 13-year-old children for the discrimination of clinic and nonclinic children (Rutter, 1967). The Conners teacher rating scale has a design and symptoms coverage similar to the Rutter scales, (i.e., conduct problems, hyperactivity, attention deficit, and emotional problems). Normative data are available for ages 4 to 12 years (Barkley, 1988). The Conners abbreviated symptom questionnaire includes 10 items for assessment of hyperactive and conduct problems. It can be used for ages 3 to 17 years (Barkley, 1988).

Parents and teachers received a new set of the three questionnaires, by mail, 2 weeks after completion of the first set (Time 2). They had not been informed on the first occasion that they would receive a second set of questionnaires for completion later on. A cover letter explained that the purpose of this second rating was to evaluate the reliability of the questionnaires. No in-

Table I. Background Factors in the Main Sample ($N = 110$)^a

Diagnostic category	Age		Girls (<i>n</i>)	Boys (<i>n</i>)	Total (<i>n</i>)	Mild MR	
	<i>M</i>	<i>SD</i>				<i>n</i>	%
ASD ^b	9.6	2.9	6	15	21	7	33
ADDBD	10.9	2.4	9	49	58	2	3
LD	12.2	2.3	8	23	31	4	13

^a ASD: autism spectrum disorders; ADDBD: attention-deficit and disruptive behavioral disorders; LD: learning disorders.

^b Three out of the 4 cases with autism and all 4 cases with autistic-like condition had mild mental retardation.

formation about diagnosis had been conveyed to parents or teachers at Time 2. All the questionnaires completed at Time 1 had been mailed back to the first author at the time of the distribution of the second set of questionnaires.

To maximize the basis for validity analyses, questionnaires with incomplete scoring at Time 1 were omitted and, if possible, replaced by a questionnaire without omitted items completed at Time 2. Seven parent and 6 teacher ASSQs, 1 parent and 6 teacher Rutter scales, and 5 parent and 2 teacher Conners scales were replaced in this way.

Analyses

Attrition Analysis

Seventeen parents and 39 teachers refused to complete a second set of questionnaires. The most common reasons for refusal were: "could not find a good reason to participate in the evaluation of questionnaires," or "could not find the time to fill in the questionnaires once more." Dropouts were not asked a second time. Comparison of Time 1 ASSQ parent and teacher scores across dropouts and non-dropouts was performed in order to evaluate possible attrition bias.

Reliability Assessment

The ASSQ, Rutter, and Conners scales were all designed to be used as continuous measures. Thus, Pearson correlation was calculated for evaluation of overall agreement between the test-retest scores and interrater scores. However, since this measure is insensitive to systematic biases across administration times and raters, paired *t* test was used in addition to determine whether disagreement was systematic or random. We did not use the intraclass correlation statistic because this index takes account of systematic and random errors simultaneously and hence gives no possibility to ascertain type of error (Szatmari *et al.*, 1994).

Validity Assessment

Criterion validity is defined as the extent to which test scores can be used to make a specific prediction on another measure. Two types of criterion validity, divergent and concurrent, were assessed

Divergent Validity. The parent total scores on the ASSQ and corresponding scores from the Rutter and Conners scales were compared. In this way, the degree of correlation between results obtained using the ASSQ, which focus on autistic behavioral impairment, and re-

sults obtained on the two other scales, with a more general behavioral focus, was evaluated. According to Streiner (1993), in cases like this, the developer should look for a correlation in the range of .30 and .70. A higher correspondence than .70 indicates that the scales are equivalent in psychometric properties rather than complementary, that is, probably measure the same phenomena.

Concurrent Validity. The concurrent validity of the ASSQ across study groups was assessed by measuring how well the total score distinguished between subjects who had been clinically diagnosed (gold standard) as autism spectrum disorders vis-à-vis attention-deficit and disruptive behavioral disorders, and learning disorders. Repeated measures of analysis of variance (ANOVA) was used to assess the mean total scores and unpaired *t* test to compare the mean differences on total score across the diagnostic groups in the main clinical sample.

Effects of Sex, IQ, and Age

Effects of sex and mild mental retardation on mean total score were assessed using factorial measures of ANOVA. Effects of age were evaluated using Pearson correlation.

Establishing an Optimal ASSQ Cutoff Score

Sensitivity is defined as the proportion of subjects with a disorder who have a positive test for the disorder. A sensitive test rarely misses subjects with the disorder. Specificity is the proportion of subjects without the disorder who have a negative test. A specific test rarely misclassifies subjects without the disorder as abnormal. A trade-off between sensitivity and specificity is required when rating takes on a range of values. In such situations, the location of a cutoff point, the point on a continuum between normal and abnormal, is an arbitrary decision. As a consequence, for any given score on a measure, sensitivity can only be increased at the expense of specificity.

Another way to express the relationship between sensitivity and specificity for a given instrument is to construct a Receiver Operating Characteristic (ROC) curve. The ROC curve is a plot of the true positive rate (sensitivity) against the false positive rate (1 - specificity) for each of the family of contingency tables generated by placing the cutoff for defining a case successively at each total questionnaire score (Einfeld & Tonge, 1995; Fombonne, 1991). It is not a straightforward matter to determine the optimal cutoff from the ROC curve, since the choice depends on the researcher's evaluation of the relative "cost" of false positives and false negatives.

However, if the cost of the two types of error is taken to be equal, then the point of an ROC curve that comes closest to the top left-hand corner—which is the point that maximizes the sum of sensitivity and specificity—is the optimal cutoff (Goodman, 1994).

A ROC analysis was performed in order to measure the ability of the ASSQ total score to differentiate autism spectrum disorder cases from other cases (the collapsed attention-deficit and disruptive behavioral disorders, and learning disorders cases) over the full range of scores. The clinical diagnostic classification served as the gold standard against which the ASSQ classification into cases and noncases was tested. At any given cutoff score on the questionnaire, a 2×2 contingency table was constructed that summarized the accuracy with which the instrument correctly classified each subject.

Likelihood ratios were also calculated. The likelihood ratio is the ratio of the true positive rate to the false positive rate at any given score. Thus, a set of likelihood ratios contains all the information in a ROC curve for the same measure. Likelihood ratios express how many times more likely a test result is to be found in abnormal when compared with normal subjects. In this way, likelihood ratios put more weight on extremely high or low scores than on marginal ones, when estimating the probability that a particular disorder is present (Fletcher, Fletcher, & Wagner, 1988). Another powerful property that likelihood ratios possess is stability, that is, they do not change with changes in the prevalence of the target disorder (Sackett, Haynes, Guyatt, & Tugwell, 1991).

RESULTS

All of the analyses, except for the last paragraph, apply to the main sample, not the Asperger syndrome validation sample.

Attrition Analysis

The mean difference between dropouts and non-dropouts on the ASSQ (unpaired t test) was nonsignificant for parents and teachers. Also, corresponding analysis on the Rutter and Conners scales showed nonsignificant differences.

Test-Retest Reliability of the ASSQ, the Rutter and the Conners Scales

The test-retest reliability (Pearson r)—over a 2-week period—for teacher ASSQ total scores in the main

sample was $r = .94$; $n = 65$; $p < .0001$. The corresponding correlation for parent ASSQ total scores was $r = .96$; $n = 86$; $p < .0001$. Comparative values for Rutter teacher and parent scales were $r = .94$; $n = 73$; $p < .0001$ and $r = .90$; $n = 92$; $p < .0001$. For the Conners original teacher rating scale, the correlation was $r = .95$; $n = 72$; $p < .0001$ and for the 10-item questionnaire completed by parents, it was $r = .88$; $n = 87$; $p < .0001$. The mean test-retest difference between teacher and parent assessments at Time 1 and Time 2 on the ASSQ (paired t test) was nonsignificant.

Interrater Reliability

The interrater reliability (Pearson r) of the ASSQ mean total score for parent and teacher ratings at Time 1 in the main sample was $r = .66$; $n = 105$; $p < .0001$. The correlation across informants for each diagnostic group was $r = .77$ for autism spectrum disorders $n = 20$; $p < .0001$, and $r = .27$ for attention-deficit and disruptive behavioral disorders $n = 57$; $p = .0385$, and $r = .19$ for learning disorders $n = 28$; ns. Corresponding values for Rutter parent and teacher scales were $r = .54$ for the total sample $n = 105$; $p < .0001$, and $r = .66$ for autism spectrum disorders $n = 19$; $p = .0014$, and $r = .41$ for attention-deficit and disruptive behavioral disorders $n = 58$; $p = .0011$, and $r = .12$ for learning disorders $n = 28$; ns. The mean interrater difference (i.e., between parent and teacher scoring) on the ASSQ (paired t test) was -1.96 ; $t(104) = -2.39$; $p = .0188$; 95% CI: -3.59 — $.33$.

Divergent Validity

Pearson correlation between parent ratings on the ASSQ and Rutter scale was $r = .75$; $n = 107$; $p < .0001$, and on the ASSQ and Conners 10-item questionnaire $r = .58$; $n = 107$; $p < .0001$. The correspondence between teacher ratings on the ASSQ and Rutter scale was $r = .77$; $n = 102$; $p < .0001$, and on the ASSQ and Conners original teacher rating scale $r = .70$; $n = 102$; $p < .0001$. The correlation across Rutter and Conners parent and teacher scales was $r = .83$; $n = 107$; $p < .0001$ and $r = .91$; $n = 102$; $p < .0001$, respectively.

Concurrent Validity

The mean total scores and 95% confidence limits of parent and teacher scorings of the three diagnostic groups on the ASSQ, Rutter and Conners scales are plotted in Figs. 1 and 2. Analysis of parent and teacher mean total score differences across the three diagnos-

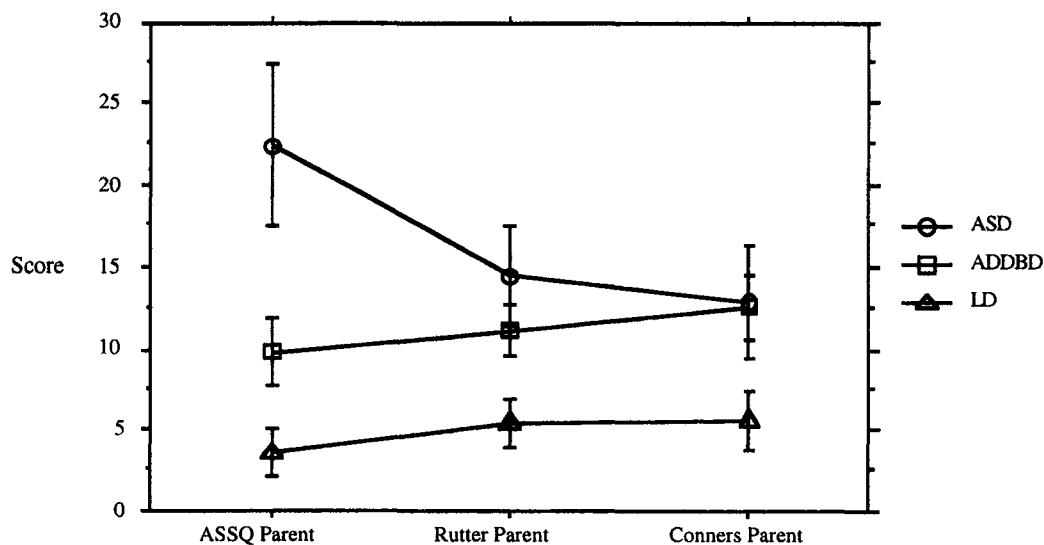


Fig. 1. The mean total scores and 95% confidence levels on the ASSQ, Rutter, and Conners parent scales of the 3 diagnostic groups ASD = autism spectrum disorder; ADDBD = attention-deficit and disruptive behavioral disorders; LD = learning disorder.

tic groups on the ASSQ, Rutter, and Conners scales in the Main sample demonstrated that the Rutter and Conners measures did not differentiate autism spectrum disorders from attention-deficit and disruptive behavioral disorders. The parent and teacher ASSQ, on the other hand, showed a clear correspondence between total score and clinical diagnoses ($p = .0001$) for both scales. Detailed data are available upon request.

Sex, IQ, and Age Effects

The sample comprised 87 boys and 23 girls ranging in age from 6 to 17 years. A few of the subjects ($n = 13$) were mildly mentally retarded. No significant gender differences or differences across normal and intellectually disabled subjects were found regarding mean total score on the ASSQ, or any of the Rutter and

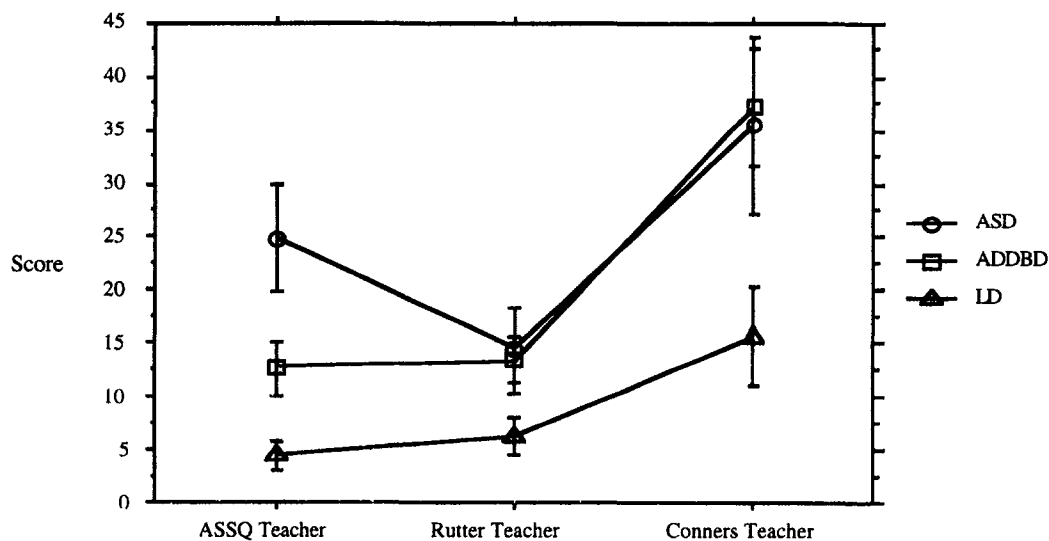


Fig. 2. The mean total scores and 95% confidence levels on the ASSQ, Rutter, and Conners teacher scales of the 3 diagnostic groups.

Conners scales. Overall, low correlations between age and mean total scores on all six questionnaires indicated no significant age effect on total score (the highest Pearson coefficient was $r = .38$; $p = .0043$) for the attention-deficit and disruptive behavioral disorders groups on the Conners teacher scale.

ASSQ Cutoff Scores

Figure 3 shows the ROC curves for parent and teacher scorings. The true positive rate is plotted against the false positive rate for each score on the ASSQ. The points on the graph that come closest to the top left-hand corner (and thus maximize the sum of sensitivity and specificity) have cutoffs exposed. In addition, the numerical results with corresponding likelihood ratios are detailed in Table II.

Asperger Syndrome Validation Sample

The mean ASSQ parent and teacher scores in the Asperger syndrome validation sample were 25.1 (SD , 7.3) and 26.4 (SD , 11.7). These scores are similar to those of the autism spectrum disorder group in the main sample.

DISCUSSION

The major purpose of this study was to evaluate the ASSQ's ability to identify children with possible high-functioning autism spectrum disorders in a clinical setting. For this reason we decided to use a sample of consecutively referred patients for neuropsychiatric assessment including a mixture of mild and severe behavioral disorders of various kinds. Generalizations of

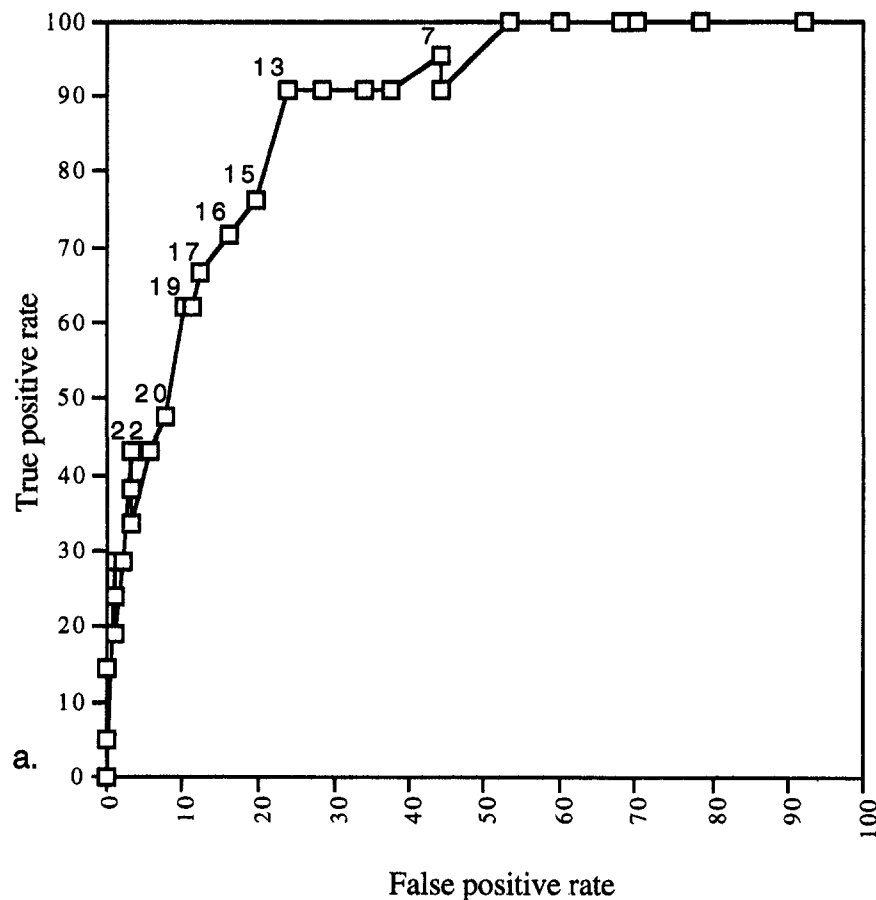


Fig. 3a. ROC curves for the prediction of autism spectrum disorders from parent ASSQ.

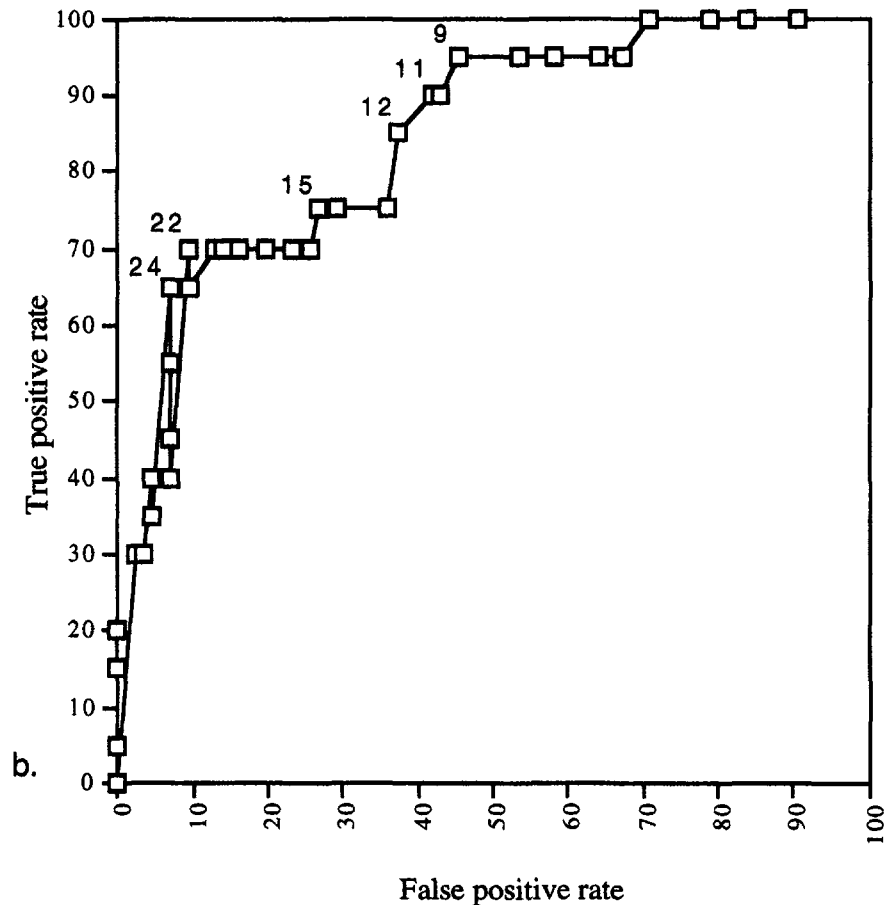


Fig. 3b. ROC curves for the prediction of autism spectrum disorders from teacher ASSQ.

the findings should be limited to clinical settings assessing children with the present type of disorders.

The ASSQ assesses a broad array of common features characteristic of high-functioning cases on the autism spectrum, particularly of Asperger syndrome. However, the 27 items cover a wider range of symptoms and more subtle social impairments than the DSM-IV and the ICD-10 diagnostic criteria for Asperger syndrome.

The rationale for using a mixed sample of Asperger syndrome and other high-functioning autism spectrum disorders for the present evaluation was (a) that there is a clear overlap of symptoms at the behavioral level across autism and Asperger syndrome, reflected in the DSM-IV (APA, 1994) and the ICD-10 (WHO, 1993) criteria for PDD, and (b) that the ASSQ is not intended for specific diagnostic purposes but as a measure for easier identification of autism spectrum disorders (including Asperger syndrome) cases in the primary evaluation of children with social impairment. In other words, a parent and/or teacher score above cutoff (see

below) indicates that a detailed history focused on high-functioning autism spectrum disorders (ASDs) is worthwhile. It should be pointed out that the ASSQ was designed as a screening instrument, and not as a diagnostic tool, due to the fact that parent and teacher rating scores on measures, such as the ASSQ, are merely quantified opinions. Accordingly, the ASSQ should not be used as a stand-alone diagnostic instrument.

Test-retest reliability for total ASSQ scores over a 2-week interval, as well as for total Rutter and Conners scale scores, was very high for both types of informants. The results pertaining to the Rutter and the Conners scales are in agreement with earlier findings (Barkley, 1988; Boyle & Jones, 1985). No systematic biases between first and second rating on the ASSQ were found.

The agreement between parent and teacher ratings on the ASSQ was higher than expected considering that earlier studies of interrater reliability overall have reported relatively low correspondence across parent and

Table II. Different Parent and Teacher ASSQ Cutoff Scores with True Positive Rate, False Positive Rate, and the Likelihood Ratio of Having Autism Spectrum Disorder Among the Main Sample

Cutoff score	True positive rate (%)	False positive rate (%)	Likelihood ratio
Parent ^a			
7	95	44	2.2
13	91	23	3.8
15	76	19	3.9
16	71	16	4.5
17	67	13	5.3
19	62	10	5.5
20	48	8	6.1
22	43	3	12.6
Teacher ^b			
9	95	45	2.1
11	90	42	2.2
12	85	37	2.3
15	75	27	2.8
22	70	9	7.5
24	65	7	9.3

^a Parent scoring included a total of 109 patients (21 autism spectrum disorders cases, 88 other cases, autism spectrum disorders prevalence = 19.27%)

^b Teacher scoring included a total of 106 patients (20 autism spectrum disorders cases, 86 other cases, autism spectrum disorders prevalence = 18.87%)

teacher scorings. A clear understanding of the mechanisms responsible for this disagreement is still lacking (Achenbach *et al.*, 1987; Goodman, 1994). However, regarding Asperger syndrome and other high-functioning ASDs it is notable that Szatmari *et al.* (1994) found good teacher and parent agreement in the assessment of adaptive skills, but poor agreement on autistic behaviors.

In the present study the correlation between parent and teacher ratings on the ASSQ was much higher in the autism spectrum disorders group than in the attention-deficit and disruptive behavioral disorders, and learning disorders groups. The same—albeit considerably less pronounced—trend was found for the Rutter scales. The good parent and teacher agreement for ASDs may be accounted for by the more pervasive social impairment in the ASDs group in comparison with the other two study groups. The ASSQ's focus on features characteristic of high-functioning ASDs may have facilitated the assessment and hence contributed to the higher convergence across informants on this measure. However, further studies are required before any firm conclusions can be drawn.

There was an overall systematic tendency for teachers to score the subjects on average 2 points higher

than parents on the ASSQ. Teacher ratings of disordered children against the background of normal children's behavior may partly explain the higher rating.

Divergent validity was demonstrated by correlations between the ASSQ and the Rutter and Conners scales, two valid instruments for assessing behavioral disorders in children and adolescents (Boyle & Jones, 1985; Barkley, 1988). The best divergence was found between the ASSQ and the 10-item Conners questionnaire and the poorest between the ASSQ and Rutter parent scale. In other words, the correlation between the parent and teacher ratings on the ASSQ and on the Rutter scales was somewhat higher than Streiner's (1993) suggested correlation value $r = .70$. This relatively high agreement across the ASSQ, the Rutter scales, and Conners 39-item teacher scales, may be explained by the fact that the Rutter scales and Conners teacher scale tap a wide range of symptoms, including some features reflecting autism spectrum disorders. The relatively low convergence between the ASSQ and Conners 10-item scale, on the other hand, is not surprising considering the latter instrument's focus on attention-deficit/hyperactivity disorder features (Barkley, 1988). Furthermore, it is noteworthy that the correlation across Rutter and Conners teacher scales was excellent indicating that these instruments tap similar problems (and appear to be possibly interchangeable).

However, in spite of relatively high correlations across different types of screening instruments, analyses of the concurrent validity based on mean total scores (Figs. 1 and 2) demonstrate that the ASSQ significantly differentiated autism spectrum disorders from attention-deficit and disruptive behavioral disorders on both parent and teacher ratings. The Rutter and Conners scales, on the other hand, did not significantly distinguish between these two groups. It seems reasonable to assume that this difference between the ASSQ and the other scales could be explained by the ASSQ's special focus on autism spectrum symptoms. The mean total ASSQ scores in the Asperger syndrome validation sample were very similar to those of the autism spectrum disorder group in the main sample. Thus, in clinics to which cases with a mixed bag of neuropsychiatric disorders are referred for diagnosis, the ASSQ appears to be a useful supplement to measures of more general psychiatric disorders.

The cutoff scores and other relevant data of the ROC analysis, shown in Fig. 3 and Table II, allow a flexible assessment of the ASSQ. The likelihood ratios represent the odds that an autism spectrum disorder is present rather than nonautism spectrum disorder for

each cutoff score. Thus, the likelihood ratios facilitate the evaluation of the relative "cost" of false positives and false negatives when deciding the optimal cutoff. If a cutoff that favors high sensitivity is essential, for instance, when minimizing the risk of missing mild autism spectrum disorders cases, parent ratings of 13 and teacher scores of 11 seems preferable. These scores identify 91 and 90%, respectively, of all autism spectrum disorders cases in the main sample. However, the *price* you have to pay with such low cutoffs is a relatively high number of children with other disorders (attention-deficit and disruptive behavior disorders in the present sample) demonstrated by 23 and 42% false positives, respectively. Accordingly, the corresponding likelihood ratios for ASDs are rather low. Yet, for use in clinical settings, such as educational psychology, where the primary purpose may be to pick out children referred for difficulties in school for more detailed assessment, a parent rating of 13 and a teacher score of 11 seem to be a reasonable choice. These cutoffs seem to identify socially impaired children, although not necessarily with autism spectrum disorders.

In general psychiatric or neuropsychiatric units, such as the present setting, the primary task may instead be to distinguish possible cases of ASDs from other types of behavior problems with social impairment. In this situation, a cutoff with a low ratio of false positives would probably be preferable. A cutoff, for instance, of 19 for parental rating identifies 62% of true positive cases (ASDs) with a rate of only 10% of false positives. The likelihood ratio demonstrates that it is 5.5 times more likely that subjects with a score of 19 or above suffer from ASDs rather than any other behavior disorder represented in the main sample. Further, a cutoff

score of 22 for teachers rating identifies 70% of true positive cases and 9% of false positives, with the odds of 7.5:1 that subjects with a score of 22 or above suffer from autism spectrum disorders.

Applying the cutoff of 19 for parent rating on the Asperger syndrome validation sample yields 82% (28/34) correctly identified subjects, and the cutoff of 22 for teacher rating yields a corresponding "hit rate" of 65% (9/14).

Higher cutoff scores, such as 22 for parent rating and 24 for teacher rating decrease the false positive rates even further as reflected by high likelihood ratios i.e., 12.6 and 9.3, respectively, for autism spectrum disorders. However, the flipside of the coin is that such high scores fail to identify 57 and 35% of the present autism spectrum disorder cases, respectively.

In conclusion, the present data suggest that the ASSQ is a reliable and valid parent and teacher screening instrument for high-functioning autism spectrum disorders in a clinical setting. The ROC analysis and likelihood ratios provide a good basis for deciding the optimal cutoff scores depending on the purpose of the screening procedure. On a balance, cutoff scores of 19 for parent rating and 22 for teacher rating are suggested as reasonable trade-off scores for identifying likely autism spectrum disorder cases while reducing to a minimum the rate of false positives among patients with a wide spectrum of neuropsychiatric disorders. The present findings do not indicate that the ASSQ distinguishes between Asperger syndrome and other high-functioning autistic disorders.

Finally, considering the rather low number of autism spectrum disorders in the present sample, further evaluations of the ASSQ are needed.

APPENDIX

The High-Functioning Autism Spectrum Screening Questionnaire (ASSQ)

Name of child Date of birth

Name of rater Date of rating

This child stands out as different from other children of his/her age in the following way:

	No	Somewhat	Yes
1. is old-fashioned or precocious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. is regarded as an "eccentric professor" by the other children	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. lives somewhat in a world of his/her own with restricted idiosyncratic intellectual interests	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	No	Somewhat	Yes
4. accumulates facts on certain subjects (good rote memory) but does not really understand the meaning	[]	[]	[]
5. has a literal understanding of ambiguous and metaphorical language	[]	[]	[]
6. has a deviant style of communication with a formal, fussy, old-fashioned or "robotlike" language	[]	[]	[]
7. invents idiosyncratic words and expressions	[]	[]	[]
8. has a different voice or speech	[]	[]	[]
9. expresses sounds involuntarily; clears throat, grunts, smacks, cries or screams	[]	[]	[]
10. is surprisingly good at some things and surprisingly poor at others	[]	[]	[]
11. uses language freely but fails to make adjustment to fit social contexts or the needs of different listeners	[]	[]	[]
12. lacks empathy	[]	[]	[]
13. makes naive and embarrassing remarks	[]	[]	[]
14. has a deviant style of gaze	[]	[]	[]
15. wishes to be sociable but fails to make relationships with peers	[]	[]	[]
16. can be with other children but only on his/her terms	[]	[]	[]
17. lacks best friend	[]	[]	[]
18. lacks common sense	[]	[]	[]
19. is poor at games: no idea of cooperating in a team, scores "own goals"	[]	[]	[]
20. has clumsy, ill coordinated, ungainly, awkward movements or gestures	[]	[]	[]
21. has involuntary face or body movements	[]	[]	[]
22. has difficulties in completing simple daily activities because of compulsory repetition of certain actions or thoughts	[]	[]	[]
23. has special routines: insists on no change	[]	[]	[]
24. shows idiosyncratic attachment to objects	[]	[]	[]
25. is bullied by other children	[]	[]	[]
26. has markedly unusual facial expression	[]	[]	[]
27. has markedly unusual posture	[]	[]	[]

Specify reasons other than above:

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