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BRIEF REPORT

Brief Report: The Autism Spectrum Quotient has Convergent Validity with the Social Responsiveness Scale in a High-Functioning Sample

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Abstract The Autism Spectrum Quotient (AQ) is widely used to measure autism spectrum disorder (ASD) symptoms and screen for ASD. It is readily available free of charge online and is easily accessible to practitioners, researchers and individuals who suspect that they may have an ASD. Thus, the AQ is a potentially useful, widely accessible tool for ASD screening. The objective of this study was to examine the convergent validity of the AQ using a well-established, published screening measure of autism: the Social Responsiveness Scale (SRS). Twenty-three high-functioning participants (aged 8–19) with ASD were administered both measures. Results indicated a significant correlation between the SRS and AQ ratings, providing evidence for convergent validity of the AQ with the SRS.

Keywords Autism spectrum disorder · Screening · Diagnosis · Autism quotient · Social responsiveness scale

Introduction

There is a growing demand in both research and clinical settings for a brief screening tool to identify individuals who may have autism spectrum disorder (ASD) symptoms. The Autism Spectrum Quotient (AQ) (Baron-Cohen et al. 2001) is a screening tool which provides continuous, quantitative measure of traits associated with autism. It is appealing for several reasons; it is free, easily accessible and applicable to a wide age range. The AQ has fifty items that are distributed into five subdomains characteristic of individuals with ASD including social, communication, attention switching, attention to detail and imagination. Items are responded to on a Likert scale, ranging from strongly disagree to strongly agree. In the original sample on which the AQ was normed, all participants who scored above the cut-off of thirty-two were called in for a follow-up interview, of which eleven agreed. The follow-up interview was conducted, and an ASD diagnosis was decided upon based on clinical judgement using the DSM IV criteria. Subsequent versions of the AQ including the AQ-Adolescent (Baron-Cohen et al. 2006), AQ-Child (Auyeung et al. 2008) and AQ-Short (Hoekstra et al. 2011) included groups of individuals with ASD diagnosed by DSM IV or ICD-10 criteria. The AQ was not validated with other diagnostic measures of ASD.

Construct validity, the degree to which an inventory assesses what it intends to measure, is an ongoing process in which a series of hypothesized relationships among constructs is examined and converging evidence is obtained (Clark and Watson 1995). Although construct validity cannot be definitively proven, it is supported by demonstrating a pattern of correlations that are consistent with hypothesized relationships with existing measures. One critical aspect of construct validity is criterion-related validity, wherein a prediction is made about how the operationalization of the construct will perform based on the theory of the construct. There are four types of criterion-related validity; predictive, concurrent, convergent, and discriminative validity. Predictive validity refers to the ability to predict something it should theoretically be able to predict. For instance, if the AQ is meant to measure ASD traits then it should be able to predict the diagnosis of ASD. Concurrent validity refers to the ability of the measure to distinguish between groups that it should

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theoretically be able to distinguish between. For example, the AQ should be high for people with ASD but not for people with learning disabilities. Convergent validity refers to the degree to which the measure is similar to (converges on) other measures that it theoretically should be similar to. For example, the AQ should provide similar results to other measures such as the SRS which is also meant to screen for ASD. With discriminant validity, the focus is on the degree to which the measure is not similar to (diverges from) other measures that it theoretically should not be similar to.

Some aspects of criterion-related validity of the AQ have been previously investigated and suggest that it is a promising measure. In one study, the AQ was administered to one hundred consecutively referred patients from health professionals throughout the UK to the Cambridge lifespan Asperger's syndrome service for a possible Asperger's syndrome diagnosis (Woodbury-Smith et al. 2005). Two clinicians independently rated the referred individuals on the DSM IV criteria for ASD. The AQ was found to have good discriminative and predictive validity with the clinicians' DSM IV diagnosis of ASD. In another study the AQ had good predictive ability in a Dutch sample of individuals diagnosed with ASD based on its correlation with the ASD diagnosis of the DSM IV criteria made by two independent clinicians, and a structured retrospective developmental interview (Hoekstra et al. 2008). In both of these studies the criteria for diagnosis of ASD was based on clinical judgement.

Finally, a recent study looked at a large *non-clinical* sample of over six hundred undergraduate students to which they administered three measures of the broader autism phenotype (BAP): the AQ, the social responsiveness scale (SRS)-A and the broad autism phenotype questionnaire (BAPQ) (Ingersoll et al. 2011). In this study the AQ was found to have adequate criterion validity, as measured by the bivariate correlation between total AQ score and variables that are theoretically and empirically related, such as social difficulties. This study also looked at the correlation between the SRS and the AQ in their non-clinical sample, and found a significant correlation of $r = .55$.

The objective of the current study was to examine the convergent validity of the AQ in a clinical sample using other measures that have previously been validated in a sample of children with ASD (age range 8–19 years). In order to examine convergent validity we administered the AQ and the SRS to children with ASD.

Methods

Measures

The SRS is 65-item parent or teacher rating scale designed to measure the severity of ASD spectrum symptoms among individuals from 4 to 18 years of age (Constantino and Gruber 2005). The questions are responded to on a Likert scale, including 'not true', 'sometimes true', often true' and 'almost always true'. The authors state that T-scores lower than 60 suggest functioning in the normal range; scores between 60 and 75 suggest ASD in the mild to moderate range, and are typical for high-functioning individuals with ASD such as pervasive developmental disorder- not otherwise specified (PDD-NOS); scores 76 and over suggest autistic disorder or more severe PDD-NOS (Constantino and Gruber 2005). The SRS takes approximately 15–20 min to complete.

The SRS provides a continuous measure of ASD symptoms (including subthreshold manifestations) in the process of differentiating children with ASD from typically developing (TD) children. The SRS provides subdomain scores in the areas of social awareness, social information processing, capacity for reciprocal social communication, social anxiety/avoidance, and autistic preoccupations and traits. However, factor analysis and latent class analysis results have not supported the existence of these independent subdomains; instead, a single continuous factor of impairment best characterizes the data provided by the inventory (Constantino et al. 2003, 2000). The SRS has well-established reliability and validity (Booker and Starling 2011). Ratings on the measure are correlated with scores on the autism diagnostic interview-revised (ADI-R).

The Wechsler Abbreviated Scale of Intelligence (WASI) was administered to obtain an IQ score for the participants. The WASI is nationally standardized and yields the three traditional verbal, performance, full scale IQ scores, and is linked to the *Wechsler intelligence scale for children—fourth edition* (WISC–IV), and the *Wechsler adult intelligence scale®—third edition* (WAIS–III). Full-scale IQ (FSIQ) was calculated for each participant, and participants were excluded if they had a FSIQ of <75. The mean IQ of this group was within the average range, and has an equivalent mean (106) and standard deviation (17) to another recently published study with a very large ($n = 498$) high-functioning ASD sample (e.g. Mazefsky et al. 2012).

Participants

Participants consisted of twenty-three high-functioning individuals ($IQ > 75$) with ASD between the ages of eight and nineteen years old who participated in a larger study on visual processing in ASD. Nineteen males and four females participated. Participants were recruited from the lab's database of individuals who had a clinical diagnosis of ASD and who had consented to be contacted for participation in research studies. This study was conducted in accordance with the standards of the university's Office of Research Ethics.

For the purposes of this study, the participants must have been previously diagnosed by a clinician using the DSM IV-TR criteria for ASD (American Psychiatric Association 2000). The ADI-R (Lord et al. 1994) was administered to all participants; fifteen by a trained researcher in the lab, and eight by a trained clinician in the community. Since 2004, clinical diagnoses of ASD in our jurisdiction must be conducted by clinicians who are trained on the use of the ADI-R and the autism diagnostic observation schedule (ADOS-G). The clinicians must use both of these tools in their diagnostic assessment of a child suspected of having ASD in order for the family to qualify for treatment funding. Diagnostic reports were obtained to verify that the ADI-R was recently administered and that the child's score exceeded the ASD cut-off. For those who had been diagnosed prior to 2004, the ADI-R was conducted by a trained clinical researcher in the lab. See Table 1 for more detailed participant information.

Procedure

Participants with ASD completed both the SRS and the AQ. The AQ-Child version was used for 8–11 year olds, the AQ-Adolescent was used for 12–16 year olds, and the AQ-Adult was used for 17–19 year olds. All versions of the AQ are comparable in content and make-up of questions; the difference is the wording which makes it appropriate for the given age group. In the original publications of the measures, the AQ-Adult and Adolescent had possible total scores of 0–50 with each item allowing for a score of 0–1. The AQ-Child allowed for possible total scores ranging from 0 to 150, with each item allowing for a score of 0–3. For comparability with the other versions being used for this study, the AQ-Child was scored in the same way as the AQ-Adolescent and AQ- Adult on the suggestion of the authors of the AQ-Child (B. Auyeung, personal communication, June 8, 2010). This method of scoring the AQ-Child with possible total scores of 0–50 has also been used in recent publications by the authors (Allison et al. 2012).

Results

AQ scores ranged from 15 to 46 with a mean of 35 and a standard deviation of 7. The distribution of AQ scores in this study is comparable to the high-functioning ASD sample in the original publication of the AQ (Baron-Cohen et al. 2001). The mean in our sample is one point lower than the mean of the ASD sample published in the original AQ paper, and the standard deviation is the same. To determine whether the participant who scored well below the cut-off for ASD (his full AQ score was 15) was significantly influencing the results, the analysis was re-run without that participant included. The exclusion of this participant did not change the results. This participant had a clinical diagnosis of ASD and scored above the cut-off for ASD on the ADI-R, thus he was included in our final analysis.

SRS T-scores ranged from 49 to 90 with a mean of 79. Only three participants fell within the 'normal range' with the remainder falling, as would be expected, in the range typical for high-functioning ASD (60–75) and the more severe range (>76) characteristic of people with Autistic Disorder. Since all three of the participants scoring within the 'normal' range (below 60) met the diagnostic cut-off for ASD on the ADI-R we included them in the final analysis. A correlation analysis was conducted to determine whether the AQ and SRS were related, with $p < .05$. The analysis indicated a significant correlation between SRS and AQ scores ($r = .64$, $p = .00$), and a large effect size (Cohen 1992) as shown in Fig. 1.

Table 1 Participant characteristics

	Age	FSIQ	AQ score	SRS T score
Range	8–19	78–131	15–46	49–90
Mean (SD)	14 (3)	106 (17)	35 (7)	79 (13)

Discussion

The AQ is used extensively as a screening questionnaire for ASD symptoms and there is a need to assess its validity, particularly as compared with other well-established screening measures for ASD. The aim of this study was to examine the convergent validity of the AQ with a well-validated measure, the SRS. The results indicated a strong

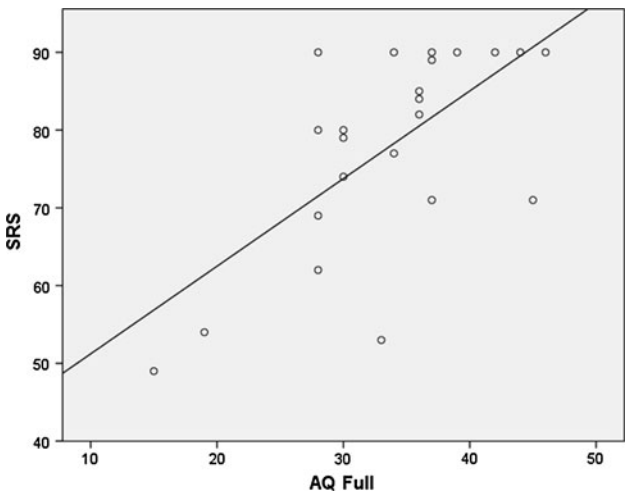

Fig. 1 Visual representation of each participant's SRS and AQ scores

correlation between the AQ and the SRS. Since all our participants were diagnosed with ASD, the range of scores was restricted in this sample and thus one would expect an even stronger correlation if the scores were not truncated. The results are consistent with previous findings in a non-clinical sample of young adults (Ingersoll et al. 2011).

This is the first study to show convergent validity between the SRS and AQ in high-functioning individuals with ASD, ranging in age from 8 to 19 years. This study did not address the question of the utility of using the AQ as an early screening measure in young children. Both the SRS and the AQ-Child have a lower age limit of 4 years and, therefore, are not appropriate for early identification purposes. Thus, there is a need to investigate other measures for this purpose. However, our findings do support the use of the AQ as a valid screening or population characterization measure in research, as well as a screening measure for professionals working in schools and clinics who query ASD in school age children and adolescents.

The criteria for diagnosis of ASD in the upcoming DSM V are changing and thus, the results of this study must also be considered within the new framework. Social and communication deficits will be amalgamated into one domain, while sensory hyper-or hypo-sensitivity is being incorporated into the second domain with restricted and repetitive behaviours. There is considerable controversy over the revision of the diagnostic criteria for ASD. The rationale is that the new criteria improves specificity, without significant decreases in sensitivity (DSM-5; American Psychiatric Association 2012). However, a number of studies published in the past year have found significant decreases in sensitivity with the new DSM V criteria, with as many as 30–45 % of individuals meeting criteria for ASD under the DSM IV-TR diagnostic criteria *not* meeting criteria under DSM V (McPartland et al. 2012; Matson et al. 2012a, b). A recent study found that sensitivity of the new criteria was improved when developmental information was combined with current behavioural observations (Mazefsky et al. 2012). The authors noted that historical information as well as capturing the range of repetitive behaviours will be essential for accurate diagnosis under the DSM V criteria.

We suspect that the convergent validity of the AQ and SRS will remain the same under the new criteria as both were based on the DSM IV-TR criteria for ASD. The specificity of the AQ should stay the same, or may increase given that the revised DSM-V criteria are more stringent. However, both measures will likely become less sensitive in screening for ASD under the new DSM V criteria with higher-functioning and verbally fluent individuals (similar to the current sample), especially since neither has incorporated historical information but rather measure current ASD symptoms. Both measures will also likely need to revise items to incorporate a wider range of repetitive behaviours, in order to better reflect the changing criteria and maintain their sensitivity. It will be important to revaluate the utility of both screening measures independently as well as their convergent validity once the new DSM V criteria are published. The goal would be to provide more precise data on the psychometric strengths and limitations of using these screening instruments for specific populations and in particular contexts.

This study provides evidence of convergent validity of the AQ with the SRS in a clinically diagnosed group of high-functioning individuals with ASD ranging from 8 to 19 years of age within the current diagnostic category of ASD in the DSM-IV-TR. The findings support the continued use and development of the AQ as a useful tool for research and practice. Future research on the validity of the AQ and the SRS is warranted once the proposed changes to the diagnostic criteria of ASD are published in the DSM-V.

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Conflict of interest The authors declare that they have no conflict of interest.

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