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Evaluation of the Validity of the Autism Spectrum Quotient (AQ) in Differentiating High-Functioning Autistic Spectrum Disorder from Schizophrenia

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The aim of this study is to examine the validity of the Autism Spectrum Quotient (AQ) to differentiate high-functioning autistic spectrum disorder (ASD) from schizophrenia (SCH). The AQ was developed by Baron-Cohen et al. to measure autistic traits. In addition to the original AQ items, we created self-administered questions about psychotic symptoms (S-scale). We administered the modified AQ to 51 ASD patients and 46 SCH patients, and we compared these two groups in terms of total AQ score, AQ subscale scores and S-scale score. We applied receiver operating characteristic (ROC) curves to examine the discriminating power of the AQ. The mean total AQ score of the ASD group (32.6; $SD=6.8$; range: 8-48) was significantly higher than that of the SCH group (21.8; $SD=7.4$; range: 10-39) ($p<0.001$). All AQ subscale scores of the ASD group were significantly higher than those of the SCH group. By using a cut-off score of 29 for the AQ total score, we were able to correctly classify 80% of the subjects. At this cut-off, the positive and negative predictive values were 0.83 and 0.78, respectively. Inclusion of additional questions of the S-scale did not increase the power of differentiation. These results indicate that the usefulness of the AQ in differentiating high-functioning ASD from SCH is limited.

In clinical practice, differential diagnosis of high-functioning autistic spectrum disorder (ASD) and schizophrenia (SCH) is difficult but important. It is especially difficult when adult patients with ASD have psychotic symptoms as a result of maladjustment to their circumstances. Diagnosis of ASD requires a knowledge of early developmental history, but sometimes that is difficult to clearly ascertain when the patient is an adult. If such patients were not diagnosed as having ASD during their childhood, we cannot distinguish their symptoms from the positive symptoms of SCH. Similarly, when ASD patients are in social withdrawal or in an autistic state, it is difficult to distinguish their state from the negative symptoms of SCH. Thus, a reliable measurement for differentiating the two disorders is needed.

The modern concept of autism was first described in a thesis ("Infantile autism") by Kanner (7) and independently in a paper ("Autistic psychopathy in childhood") by Asperger (3). Kanner borrowed the term "autism" from Bleuler (1911), who originally coined the word to describe the loss of contact with reality in schizophrenia. Autism was previously considered as a form of childhood SCH, but findings in the 1960s and 1970s revealed that

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VALIDITY OF AQ TO DIFFERENTIATE ASD FROM SCH

the two disorders were completely different (8, 9, 10, 17). Core autism (the typical autistic disorder) and SCH can be differentiated by age of onset, sex, family history, clinical appearance, and outcome. However, one study identified three patients with both autism and SCH (13). Several case studies were reported on the comorbidity of high-functioning ASD and SCH (1, 6, 11). In a study of 163 cases with autism, SCH was found to be no more common among individuals with autism than in the general population (18). The exact relationship between ASD and SCH remains unclear.

ASD and SCH have been compared in studies of the Theory of Mind (ToM) (14, 15) and in studies of cognitive functioning using the Wechsler Intelligence Scale for Children-Revised (WISC-R) and the Wechsler Adult Intelligence Scale-Revised (WAIS-R) (5). However, these methods can not absolutely differentiate between ASD and SCH, and are used only for providing supporting evidence for a diagnosis.

The Autism Spectrum Quotient (AQ) (4) is a self-administered instrument for measuring the degree to which an adult with normal intelligence has autistic traits, with higher scores indicating more severe symptoms. The AQ can be used for measuring autistic traits in the general population and for clinical screening of an autistic individual. The AQ is comprised of 50 questions, made up of 10 questions assessing 5 different areas called "social skill", "attention switching", "attention to detail", "communication" and "imagination".

In past studies, ASD patients had higher AQ scores than the general population (4, 19). However, AQ scores of patients with SCH have not yet been analyzed. In a clinical population of 100 referrals, Woodbury-Smith et al. (20) found only two individuals that had a previous diagnosis of SCH: one was later diagnosed with Asperger Syndrome (AS) and scored 45 on the AQ and the other did not have AS and scored only 20 on the AQ.

The aim of this research was to examine whether AQ is useful for the distinction of high-functioning ASD and SCH. We hypothesized that patients with SCH would have higher scores on the AQ than the general population, especially in three subscales of the AQ (social skill, attention switching and communication) as a result of social impairment or cognitive dysfunction. Therefore, we investigated whether total AQ scores are significantly different between high-functioning ASD and SCH, and whether the scores of some AQ subscales (e.g., attention to detail and imagination) may be different. We also hypothesized that patients with SCH will show higher scores in questions about psychotic symptoms than high-functioning ASD, and we explored whether new self-administered questions about psychotic symptoms would be helpful for differentiating between high-functioning ASD and SCH.

MATERIALS AND METHODS

Participants

Outpatients of two hospitals, Kobe university hospital and Kansai-Seishonen Sanatorium, a psychiatric hospital, were recruited for the survey. The present study was approved by the ethics committee of the Kobe University Graduate School of Medicine.

The patients were split into two groups. The first group was comprised of 51 patients with ASD (40 males, 11 females). The mean age was 28.8 y ($SD=9.4$; range: 17-44). All of them had been diagnosed by experienced psychiatrists as having ASD, using the Diagnostic and Statistical Manual of Mental Disorders fourth edition, text revision (DSM-IV-TR) (2) criteria for pervasive developmental disorder, which is approximately the same as ASD. The patients were classified into the three subcategories of pervasive developmental disorder as follows: autistic disorder, $n=8$; AS, $n=30$; pervasive developmental disorder not otherwise specified, $n=13$. The patients' developmental histories were examined, especially about impairment in social interaction and communication; restricted, repetitive, and stereotyped patterns of behavior, interests, and activities. The patients' IQs were all in the normal range

and the mean FIQ was 96.2 ($SD=12.8$; range: 70-122) measured by WAIS-R or wais-III. The second group was comprised of 46 patients with SCH (23 males, 23 females). The mean age was 34.1 y ($SD=9.6$; range: 17-57). They had been diagnosed by experienced psychiatrists as having SCH, using the DSM-IV-TR criteria for SCH. At the time that the participants with SCH were recruited, they were in a residuum and their positive symptoms were mild as a result of pharmacotherapy. Everyone in the study had at least a high school education. The mean onset-age of SCH was 22.2y ($SD=6.2$; range: 13-40).

After the consultation, we obtained informed consent before asking the participants to complete the questionnaire. We did not provide any incentive to participate. Some participants completed the scale during the day, and others completed it at home and returned it during their next visit to the hospital.

Instruments

1. Autism Spectrum Quotient (AQ)

The AQ was previously shown to have good discriminant validity and good screening properties for high-functioning ASD at a threshold score of 26 (20), i.e., patients with scores of 26 or more were considered to have ASD. A Japanese version of the AQ (12) also recommended 26 points as the cut-off for screening. In this study, we used another Japanese version of AQ (19). In the latter study, the mean total AQ scores of participants with ASD and the general population were 37.9 ($SD=5.31$) and 18.5 ($SD=6.21$), respectively.

2. Additional questions about psychotic symptoms (S-scale)

We created a self-administered “S-scale” to identify psychotic symptoms that consisted of 16 questions (see Appendix). The items were based on questions about psychotic disorders in the Mini International Neuropsychiatric Interview (M.I.N.I.) and Minnesota Multiphasic Personality Inventory (MMPI) or other original questions about psychotic symptoms. Symptoms such as auditory hallucination and broadcasting of thought are often seen in patients with SCH. The questions were rated by the subjects themselves on a 4-point scale of ‘definitely agree’, ‘slightly agree’, ‘slightly disagree’, and ‘definitely disagree’, the same choices that are in the AQ. Answers to ‘definitely agree’ and ‘slightly agree’ were scored 1 and answers to ‘definitely disagree’ and ‘slightly disagree’ were scored zero. The 16 questions of the S-scale were randomly distributed among the 50 questions of the AQ, for a total of 66 questions.

Procedure

We conducted an analysis of covariance (ANCOVA) with groups as independent variables, sex and age as covariables, and total AQ score, AQ subscale scores, and S-scale score as dependent variables. By using the receiver operating characteristic (ROC) curves, we calculated cut-off scores, sensitivity, specificity, predictive values, percentage of patients that were correctly classified and area under the curve (AUC). Differences in the percentages of patients in each group that had a score of 1 in each item were analyzed by chi-square test of independence. Values of $p<0.05$ were regarded as statistically significant. Statistical analyses were conducted by SPSS version 16 J for Windows.

RESULTS

Comparison of total AQ score between groups

The mean total AQ score in the ASD group (32.6, $SD=6.8$) was significantly higher than that in the SCH group (21.8, $SD=7.4$) ($F(1, 93)=50.85$, $p<0.001$, $\eta^2=0.35$, see Table I). Overlaps in the scores were observed between groups, especially in the range from 24 to 39.

VALIDITY OF AQ TO DIFFERENTIATE ASD FROM SCH

Cronbach's alpha coefficients of total AQ were 0.80 in the ASD group and 0.81 in the SCH group. This suggests that the internal consistency of the total AQ score was high in both groups.

Comparison of AQ subscales and S-scale between groups

All subscale scores of AQ were significantly higher in the ASD group than in the SCH group (Table I). The S-scale scores of the two groups were significantly different, but unexpectedly, the mean S-scale score was higher in the ASD group (6.0) than in the SCH group (4.7) (Table I).

In the ASD group, Cronbach's alpha coefficients were moderate to high as follows: social skill=0.77; attention switching=0.53; attention to detail=0.50; communication=0.52; imagination=0.43; S-scale=0.77. In the SCH group, Cronbach's alpha coefficients were low to high as follows: social skill=0.58; attention switching=0.61; attention to detail=0.43; communication=0.73; imagination=0.38; S-scale=0.77.

Table I. Mean score (*SD*) of total AQ, AQ subscale, and S-scale in groups

	ASD group (<i>N</i> =51)	SCH group (<i>N</i> =46)	<i>F</i> ^a	<i>p</i>	η^2
total AQ	32.6 (6.8)	21.8 (7.4)	50.85	<0.001	0.35
social skill	7.3 (2.5)	4.7 (2.3)	22.01	<0.001	0.19
attention switching	7.0 (1.9)	4.8 (2.2)	33.73	<0.001	0.27
attention to detail	5.0 (2.1)	3.8 (1.9)	5.22	0.025	0.05
communication	7.2 (1.9)	4.2 (2.5)	46.26	<0.001	0.33
imagination	6.2 (1.9)	4.3 (1.9)	18.29	<0.001	0.16
S-scale	6.0 (3.4)	4.7 (3.4)	5.16	0.025	0.05

AQ, Autism-Spectrum Quotient; ASD, Autistic Spectrum Disorder; SCH, Schizophrenia
a) all *df*=(1,93)

Discriminating power of the AQ

The AUC was 0.87, and the optimum predictive cut-off score of the AQ was 29 (Figure 1). At this cut-off, the sensitivity, specificity, and positive and negative predictive values were 0.78, 0.83, 0.83 and 0.78, respectively. By using a cut-off score of 29, we were able to differentiate 40 of the 51 ASD patients (78%) and 38 of 46 SCH patients (83%), for an overall successful differentiation rate of 80% (78 of the 97 participants).

Comparison of items between groups

Thirty-one of the 50 items on the AQ were significantly associated with ASD diagnosis. Of the 31 items, seven were in "social skill", six were in "attention switching", three were in "attention to detail", ten were in "communication", and five were in "imagination" (Table II). None of the AQ items was significantly associated with SCH diagnosis.

Three of the 16 S-scale items were significantly associated with ASD diagnosis. These were "I am sure I am being talked about.", "My thoughts have been removed from my mind and my mind has become a complete blank." and "When I am alone, a wandering idea will

appear and I can not stop it by myself.” A twelfth S-scale item (i. e. “I have heard things other people couldn’t hear, such as hearing voices or experiencing telepathy”) was significantly associated with SCH diagnosis.

We considered that both groups could be distinguished using these 35 items (31 AQ items and 4 S-scale items). However, the total scores of the two groups still overlapped, and the ROC indicated a cut-off score of 20 and 81% correct classification. So the total scores were not sufficient for distinguishing ASD from SCH.

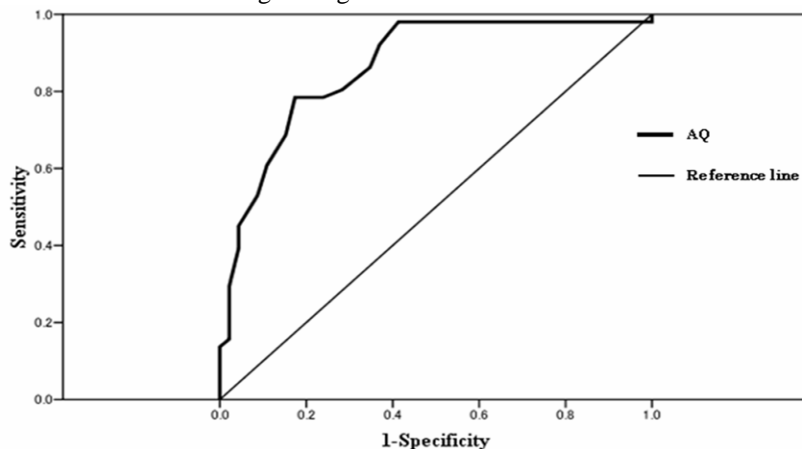


Figure 1. Receiver operating characteristic (ROC) curves for the AQ corresponding to ASD showed that the AUC was 0.87 and the optimum predictive cut-off score of the AQ was 29.

Table II. AQ and S-scale items in which the rate of score 1 was significantly different between groups

Subscale: no. items (abbreviated)	Rate (%) of score 1		χ^2	<i>p</i>
	ASD group (N=51)	SCH group (N=46)		
Social skill:				
1. Like to do things with others	76.5%	41.3%	12.44	0.000
15. Drawn to people more than things	58.8%	32.6%	6.68	0.010
36. Easy to work out other’s thinking	82.4%	54.3%	8.88	0.003
44. Enjoy social occasions	62.7%	41.3%	4.46	0.035
45. Hard to work out other’s intention	82.4%	47.8%	12.85	0.000
47. Enjoy meeting new people	68.6%	45.7%	5.32	0.022
48. I am a good diplomat	84.3%	65.2%	4.74	0.030
Attention switching:				
2. Like to do things the same way	74.5%	47.8%	7.30	0.007
4. Strongly absorbed in one thing	76.5%	47.8%	8.50	0.004
16. Tend to have strong interests	43.1%	15.2%	9.00	0.003
25. Not upset if routine is disturbed	76.5%	45.7%	9.74	0.002
37. Can go back to task quickly	76.5%	34.8%	17.12	0.000
46. New situation make me anxious	88.2%	63.0%	8.49	0.004

VALIDITY OF AQ TO DIFFERENTIATE ASD FROM SCH

Attention to detail:

5. Notice small sounds	64.7%	43.5%	4.40	0.036
6. Notice car number plates	51.0%	30.4%	4.21	0.040
28. <i>Concentrate more on the whole</i>	68.6%	43.5%	6.23	0.013

Communication:

7. Say impolite things naively	56.9%	19.6%	14.12	0.000
17. <i>Enjoy social chit-chat</i>	72.5%	37.0%	12.42	0.000
18. Hard to get a word in edgeways	45.1%	13.0%	11.86	0.001
26. Hard to keep a conversation	82.4%	56.5%	7.70	0.006
27. <i>Easy to read between the lines</i>	94.1%	60.9%	15.76	0.000
31. <i>Know how to tell boring listeners</i>	90.2%	65.2%	8.90	0.003
33. Unsure of turn to talk on phone	66.7%	37.0%	8.56	0.003
35. Often the last to understand a joke	64.7%	39.1%	6.35	0.012
38. <i>Good at social chit-chat</i>	80.4%	58.7%	5.43	0.020
39. Tend to talk about the same thing	64.7%	28.3%	12.88	0.000

Imagination:

14. <i>Find making up stories sasy</i>	82.4%	47.8%	12.85	0.000
20. Hard to know others' intentions	56.9%	30.4%	6.85	0.009
24. <i>Prefer a theatre to a museum</i>	78.4%	43.5%	12.52	0.000
40. <i>Used to enjoy pertnding games</i>	52.9%	21.7%	9.98	0.002
41. Like categories of things	70.6%	47.8%	5.21	0.022

S-scale (*):

3. Idea of persecution	51.0%	30.4%	4.21	0.040
6. Ththought withdral	62.7%	23.9%	14.78	0.000
12. Auditory hallucination	3.9%	32.6%	13.77	0.000
14. Autochthonous idea	64.7%	28.3%	12.88	0.000

AQ, Autism-Spectrum Quotient; ASD, Autistic Spectrum Disorder; SCH, Schizophrenia

Table II was made with reference to Kurita, Koyama, & Osada (12).

In italic items in the table, disagree (definitely/slightly) responses scored 1.

In the other non-italic items in the table, agree (definitely/slightly) responses scored 1.

A significant association with SCH diagnosis existed in only one item (S-scale No.12).

Other 34 items (31 AQ items and 3 S-scale items) were associated significantly with ASD group.

S-scale (*) consists of 16 self-administered questions to identify psychotic symptoms. When total scores of the 35 items (31 AQ items and 4 S-scale items) were calculated, disagree (definitely/slightly) response scored 1 in one S-scale item (No.12) and agree (definitely/slightly) response scored 1 in the other 3 S-scale items (No.3, 6, 14).

DISCUSSION

The total AQ score and all subscale scores of the AQ were significantly higher in the ASD group than in the SCH group. The ROC analysis indicated a cut-off score of 29, which yielded correct classifications for only 80% of the participants. Patients with lower AQ scores were more likely to have SCH. High AQ patients with SCH cannot be distinguished from ASD by using only the scores of the total AQ and its subscales. The result was the same when the S-scale was used.

None of the participants with SCH had a complication of ASD at the time of participation. In the current study, the developmental histories of participants with SCH were not examined in detail. It was recently suggested that in the general population there may be a percentage of individuals who have many autistic traits but who do not require any clinical support (20). High AQ patients with SCH might have high autistic traits congenitally, but they also might have other determinants. Recent reviews point out that a close relation between childhood onset schizophrenia (COS) and premorbid ASD (1, 16). It remains unclear whether the two conditions are categorically distinct or have some overlapping symptoms. We were unable to clarify the relationship of the two conditions by using the AQ.

The mean S-scale score was higher in the ASD group than in the SCH group. ASD was significantly associated with some items in the S-scale, such as “idea of persecution”, “thought withdrawal” and “autochthonous idea”, while SCH was significantly associated with “auditory hallucination”. Further studies are needed to determine whether these associations are true. An ASD individual might interpret the questions of the S-scale differently from an SCH individual. Questions about psychotic symptoms might cause individuals in the two groups to recall different experiences. For example, the question “My thoughts have been removed from my mind and my mind has become a complete blank” might indicate “thought withdrawal” to a patient with SCH, but it might indicate “I can no longer think clearly” to a patient with ASD. In order to test this hypothesis, we should ask the patients of both groups each question of the S-scale and make certain that the answers are correctly interpreted.

To our knowledge, this is the first study to examine the usefulness of the AQ for distinction of high-functioning ASD from SCH. A limitation of this study was that the participants with SCH were permitted to have mild positive symptoms and their onset-age was not limited. In addition, differences among SCH subgroups were not investigated. In future studies, it is necessary to analyze participants with schizoid personality disorder or schizotypal personality disorder and with SCH in childhood and adolescent onset. It is also necessary to examine each SCH subgroup.

The ASD group showed significantly higher scores on the AQ compared to the SCH group, but neither the AQ and its subscales nor the S-scale could completely distinguish between high-functioning ASD and SCH. The usefulness of the AQ in differentiating high-functioning ASD from SCH is limited. There is a need for further studies of patients with SCH that have AQ scores in the high range.

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VALIDITY OF AQ TO DIFFERENTIATE ASD FROM SCH

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Appendix: Additional questions about psychotic symptoms (“S-scale”)

1. I have believed that people were spying on me, or that someone was plotting against me, or trying to hurt me.
2. I have believed that someone or some force outside of myself put thoughts in my mind that were not my own, or made me act in a way that was not my usual self.
3. I am sure I am being talked about.
4. I have believed that I could actually read or hear what another person was thinking.
5. When I am awake, I have visions or have seen things other people couldn't see.
6. My thoughts have been removed from my mind and my mind has become a complete blank.
7. My relatives or friends have considered that some of my beliefs are strange or out of reality.
8. Several times a week I feel as if something dreadful is about to happen.
9. I have believed that someone was reading my mind or could hear my thoughts.
10. I am bothered by people outside, on streetcars, in stores, etc., watching me.
11. I have heard my own thoughts as a voice speaking to me.
12. I have heard things other people couldn't hear, such as hearing voices or experiencing telepathy.
13. I have believed that I was being sent special messages through the TV, radio or newspaper.
14. When I am alone, a wandering idea will appear and I can not stop it by myself.
15. I often feel that an impending occurrence is not actual.
16. Sometimes I feel that I am not myself.