

The French Version of the Autism-Spectrum Quotient in Adolescents: A Cross-Cultural Validation Study

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Abstract We assessed the accuracy of the French version of the *Autism Spectrum Quotient (AQ)* in adolescents with Asperger syndrome (AS) and high-functioning autism (HFA) compared to healthy controls and adolescents with psychiatric disorders (PDs). Three groups of adolescents, aged 11–18, were assessed: 116 with AS/HFA (93 with $IQ \geq 85$ and 20 with $70 \leq IQ < 85$), 39 with other PDs, and 199 healthy controls. The AS/HFA group scored significantly higher than the healthy control and PD groups. A cut-off score of 26 was used to differentiate the autism

group from healthy controls with 0.89 sensitivity and 0.98 specificity. Scores did not vary by age or sex.

Keywords Adolescent · Asperger syndrome/diagnosis · Autism spectrum disorders/diagnosis · Cross-cultural comparison · France · Personality assessment

Abbreviations

ANCRA Association Nationale des Centres de Ressources Autisme
ANOVA Analysis of variance

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AQ	Autism Spectrum Quotient
AS	Asperger syndrome
ASD	Autism spectrum disorder
FRAPA	Fédération Rhône-Alpes de Pédiatrie Ambulatoire
HFA	High-functioning autism
ICD	International classification of diseases
IQ	Intelligence quotient
OCD	Obsessive compulsive disorder
PD	Psychiatric disorder
PDD-NOS	Pervasive developmental disorder not otherwise specified
ROC	Receiver-operating characteristic
SD	Standard deviation

Introduction

Asperger syndrome (AS) and high-functioning autism (HFA) are pervasive developmental disorders, also commonly known as autism spectrum disorders (ASDs). They are defined in terms of difficulties in reciprocal social interaction and communication, in the context of stereotyped behaviors, interests, and activities, but without delays in cognitive development (Aussilloux and Baghdadli 2008; Mottron 2004). The difference between AS and HFA with respect to outcome is still unclear and is currently based on the absence of significant language delays in AS, although language impairment is possible in HFA. The characteristics of AS were originally described by Hans Asperger, an Austrian pediatrician, in 1994. A British psychiatrist, Lorna Wing developed these ideas further and coined the term AS in 1981 (Aussilloux and Baghdadli 2008).

The current rate of AS is estimated at 11/10,000, ranging from 2 to 28/10,000. The prevalence of all ASDs combined is 70/10,000 (52–80/10,000) and 70 % of these are without intellectual deficiency. (Fombonne 2009). A recent literature review on the prevalence of AS showed that available evidence is low quality and estimates are highly variable, ranging from 0.3 to 48.1/10,000 (Fombonne et al. 2011).

Contrary to typical autism, AS may be more subtle and is often delayed until adolescence or adulthood when social impairment becomes more obvious. A delayed diagnosis and late intervention may result in the development of comorbid conditions, such as anxiety and depression. The *Autism Spectrum Quotient (AQ)* was first developed by Baron-Cohen et al. (2001) to quantify autistic traits in adults with normal intelligence. This self-report questionnaire has proved to be a reliable instrument for screening autism spectrum conditions in a clinical population. Five studies in adults (Wakabayashi et al. 2004; Freitag et al. 2007; Kose et al. 2010; Kurita and Koyama 2006; Lepage

et al. 2008) and one in children (Wakabayashi et al. 2007) made cross-cultural comparisons of the AQ questionnaire. In 2009, 100 healthy controls and 23 adults with autism took the French-Canadian versions of the AQ and *Empathy Quotient (EQ)* for adults. There was a significant difference between their AQ scores. The French-Canadian study included a small sample of autistic participants with a large proportion of female participants with ASDs (8 women and 15 men) with a ratio of 1.9:1.

Parent-reported versions of the AQ questionnaire were developed to screen children and adolescents (Baron-Cohen et al. 2006; Wakabayashi et al. 2007; Auyeung et al. 2008). The questionnaire is made up of 50 questions that are subdivided into five different areas (social skills, attention switching, attention to detail, communication, and imagination). It does not take long to fill out and is easy to score. Using a four-point Likert scale, the subject checks whether he definitely agrees, slightly agrees, slightly disagrees, or definitely disagrees with each statement. Each of the items is worth one point if the subject records autistic-like behavior either mildly or strongly. In the UK study, the mean score was significantly different between the HFA/AS group and the control group (AS/HFA mean AQ = 37.3, SD = 5.8; Control mean AQ = 17.7, SD = 5.7) (Baron-Cohen et al. 2006). The Japanese version replicates these results in a clinical population study (AS/HFA mean AQ = 31.9, SD = 6.93; controls mean AQ = 11.7, SD = 5.94) and included a group of patients with pervasive developmental disorders not otherwise specified (PDD-NOS mean AQ = 28.0, SD = 6.88) (Wakabayashi et al. 2007). Even though the definition of cut-off scores needs to be tested in general population studies, we wanted to investigate whether the French version shows the same pattern of results in a clinical sample of French adolescents. We also added a psychiatric disorder (PD) group because they frequently have social difficulties or obsessive behaviors. We predicted that the AS/HFA groups would have higher scores than the two other groups.

Methods

Participants

The study was approved by an ethics committee in Lyon, France called: Le Comité de Protection des Personnes dans la Recherche Biomédicale Sud-Est III (no. 2007-026-2) and was registered on ClinicalTrials.gov (no. NCT00505830). Participants were divided into three groups: the AS/HFA group, the PD group, and the healthy control group. The AS/HFA group was made up of 126 adolescents (111 boys, 15 girls). All participants in this group had been diagnosed by psychiatrists using *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*

(ICD-10) criteria (WHO 1992). All attended ordinary schools (including special classes in ordinary schools). Their mean age was 14.1 years ($SD = 1.93$) and all had an IQ higher than 70 (80 % with $IQ \geq 85$ and 20 % with $70 < IQ < 85$). They were recruited in the diagnosis centers of the ANCRA (Association Nationale Des Centres de Ressources Autisme), an association of professionals from different fields specialized in autism. Investigators in these centers gave the AQ questionnaires to parents on the day of inclusion.

The PD group was made up of 49 adolescents (15 boys, 34 girls). All participants in this group were hospitalized in adolescent psychiatric wards and diagnosed with depression, obsessive compulsive disorder (OCD) or social phobia. They attended ordinary schools except when hospitalized. Their mean age was 15.3 years ($SD = 1.84$). Adolescents with PDs were recruited by three hospitals: Flavigny care unit at Vinatier Hospital (Lyon, France), the Ulysse adolescent unit at Saint Jean de Dieu Hospital (Lyon, France) and the pediatric unit at Charles Perrens Hospital (Bordeaux, France).

The healthy control group included 213 adolescents (84 boys, 129 girls), who attended ordinary schools and were aged 14.1 years ($SD = 1.66$). Participants in this group were recruited by the Fédération Rhône-Alpes de Pédiatrie Ambulatoire (FRAPA), a pediatric association.

AQ Questionnaire and Item Translation

The French translation of the AQ questionnaire followed standard cross-cultural translation methods and is described in detail elsewhere (Sonié et al. 2011). The minimum score on the AQ is 0 and the maximum is 50. A questionnaire was considered valid when at least 45 questions were answered.

Mean scores between the three groups were compared using analysis of variance (ANOVA) by group and sex for total AQ scores and each sub-domain. Then, a *t* test was used to compare scores between groups. The global performance of AQ for various cut-off scores was studied using a receiver operating characteristic (ROC) curve and the area under the ROC curve.

Results

Out of a total of 388 participants, 354 sent back completed questionnaires. We had to exclude 10 questionnaires from the AS/HFA group, 10 from the PD group, and 14 from the healthy control group because subjects did not provide answers for more than five items. The rate of missing answers for each item varied from 7 to 9 %. Items 14 (“S/he finds making up stories easy.”), 24 (“My child would

Table 1 Item analysis: percentage of subjects in each group scoring on each item

Item	Autistics IQ > 85	Autistics IQ ≤ 85	TP	Controls	Sub-domain
1	80	58	31	15	S
2	7	76	37	12	A
3	49	48	23	11	I
4	8	82	41	28	A
5	70	70	44	24	D
6	62	70	15	35	D
7	64	55	18	13	C
8	46	64	18	6	I
9	40	45	5	6	D
10	78	70	64	24	A
11	89	91	51	11	S
12	89	82	49	43	D
13	79	61	8	12	S
14	53	61	32	38	I
15	78	75	38	23	S
16	84	85	59	15	A
17	72	52	31	12	C
18	63	70	41	33	C
19	40	45	8	9	D
20	67	76	44	6	I
21	42	55	41	24	I
22	89	91	46	16	S
23	58	58	28	19	D
24	62	50	37	30	I
25	86	85	51	24	A
26	71	82	38	17	C
27	91	88	54	39	C
28	87	76	49	24	D
29	58	52	59	74	D
30	56	73	64	75	D
31	83	73	18	12	C
32	85	76	58	34	A
33	52	58	8	2	C
34	84	88	38	26	A
35	67	73	21	14	C
36	77	73	36	29	S
37	57	58	46	18	A
38	77	64	41	25	C
39	80	82	45	16	C
40	89	88	46	30	I
41	74	70	29	24	I
42	79	85	41	32	I
43	72	85	46	28	A
44	51	45	23	7	S
45	88	91	53	24	S
46	89	88	74	41	A
47	65	39	33	13	S

Table 1 continued

Item	Autistics IQ > 85	Autistics IQ ≤ 85	TP	Controls	Sub-domain
48	84	82	54	27	S
49	51	58	64	70	D
50	78	82	41	25	I

S Social skills, A attention switching, D attention to detail, C communication, I imagination

rather go to the theatre than a museum.”), and 45 (“S/he finds it difficult to work out people’s intentions.”) were not answered by 9 % of participants mainly in the PD group (22 %; 95 % CI 11–34 %).

The item analysis (Table 1) shows that on items 29 (“S/he is not very good at remembering phone numbers.”), 30 (“S/he doesn’t usually notice small changes in a situation, or a person’s appearance.”), and 49 (“S/he is not very good at remembering people’s date of birth.”), the control group scored higher (by checking “disagree”) than the two clinical groups. On all other items, scores differed between the control and clinical groups. Internal consistency, measured by Cronbach’s alpha coefficient, was 0.88 for all AQ items, 0.90 for communication, 0.91 for social skills, 0.92 for imagination, 0.95 for attention to detail, and 0.91 for attention switching. We also tested whether the distribution of scores on adolescent AQ for the control group was normal. Skewness was 0.01 and kurtosis was 0.84, suggesting that AQ scores are almost normally distributed in the control group (Fig. 1).

We used an ANOVA to compare total AQ scores by group and sex. There was a main effect of group

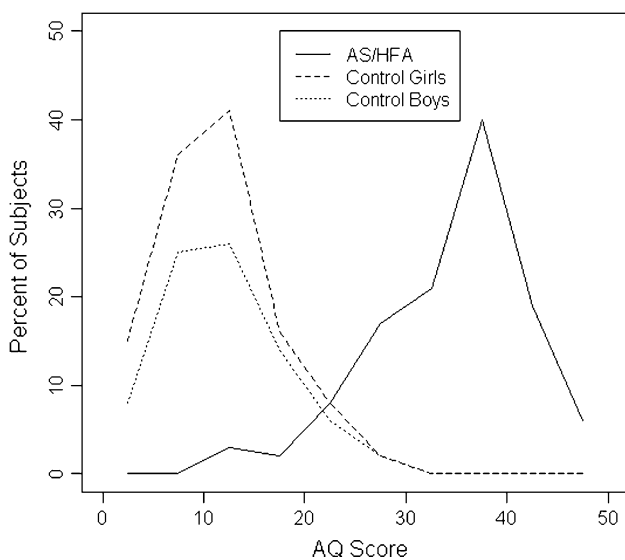


Fig. 1 Percent of each group scoring at each group score

($F(2, 354) = 344.84, p < 0.001$). The clinical groups differed from the control group on all sub-domain scores. The main effect of sex was not significant ($F(2, 354) = 0.96, p = 0.32$). There was no interaction of group by sex ($F(2, 354) = 0.39, p = 0.67$). Gender difference did not influence scores in AS/HFA ($t = 1.02, p = 0.15$), PD ($t = -0.07, p = 0.21$) or in healthy controls ($t = 0.75, p = 0.22$) (Fig. 1). Adolescents with an IQ score ≥ 85 scored 34.85 and those with an IQ < 85 scored 36.7 ($t = -0.77, p = 0.78$). IQ ($r = 0.1, p = 0.30$) and age ($r = -0.1, p = 0.25$) did not influence AQ scores.

Mean AQ scores for each group, broken down by sex, are shown in Table 2. The AS/HFA and PD groups scored significantly higher than the healthy control group. The AS/HFA group also scored significantly higher on total and sub-domain AQ than the PD group.

The ROC curve for AQ is shown in Fig. 2. The area under the curve was 0.98 (95 % CI 0.96–0.99). A cut-off score of 26 distinguished the autism group from healthy controls with a sensitivity of 0.89 and a specificity of 0.98.

Discussion

Results of a psychometric analysis of the French version of the AQ questionnaire showed that 88.8 % of AS/HFA participants scored above a critical minimum of 26 compared with 5.9 % of healthy controls. In their study, Baron-Cohen et al. (2006) showed that the two clinical groups scored significantly higher (AS/HFA mean = 37.3, SD = 5.8; autism mean = 38.3, SD = 6) than the control group (mean = 17.7, SD = 5.7). About 90 % of adolescents with AS/HFA or with classic autism scored above a critical minimum of 30+, but none of the controls did. Our results are very close to the Japanese study’s results (Wakabayashi et al. 2007). We have a mean AQ score for all groups that is lower than in the British study (Baron-Cohen et al. 2006).

The three groups included in our study were comparable except for age. Patients in the PD group were slightly older (15.3 year) than adolescents in the two other groups (14.1 years). This difference may be explained by the late onset of symptoms of psychiatric disorders in adolescents. Because AQ scores are not influenced by age in our study or past ones we can still attribute our results to the presence of psychiatric disorders.

The French version appears to have slightly better internal consistency than the British and Japanese versions. As in the British study, our control group scored higher than autistic participants to items 29, 30, and 45. This confirms the questionnaire’s ability to distinguish participants. Our results confirm the absence of gender differences on AQ scores in the AS/HFA group. The gender

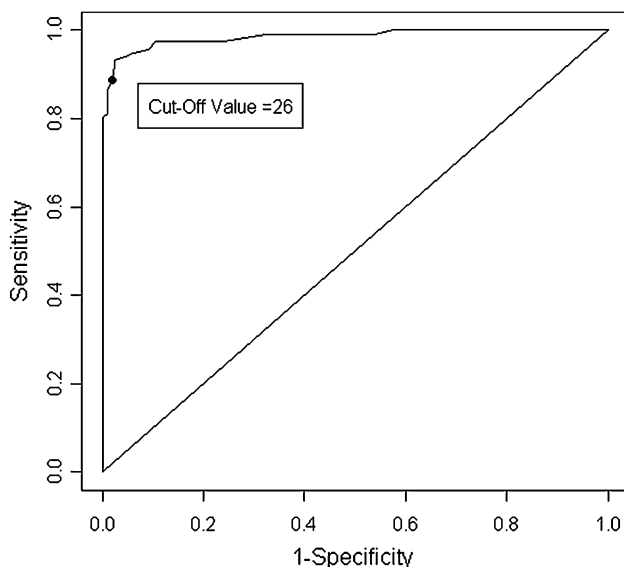
Table 2 Mean AQ and subscale scores (and SDs) by group

		Communication	Social	Imagination	Attention to detail	Attention switching	Total AQ
<i>AS/HFA group</i>							
(n = 116)	Mean	7.09	7.58	6.42	6.09	7.88	35.06
	SD	1.99	2.19	2.19	2.39	2.14	7.46
Boys (n = 103)	Mean	7.15	7.61	6.44	6.15	7.96	35.32
	SD	2.01	2.13	2.13	2.46	2.04	7.26
Girls (n = 13)	Mean	6.61	7.31	6.31	5.61	7.23	33.08
	SD	1.71	2.66	2.72	1.71	2.83	8.97
<i>Healthy control group</i>							
(n = 199)	Mean	1.82	1.77	2.25	3.78	2.51	12.13*
	SD	1.48	1.71	1.83	2.11	1.99	5.55
Boys (n = 81)	Mean	1.83	1.76	2.48	3.81	2.60	12.49
	SD	1.59	1.78	2.04	2.14	2.11	5.71
Girls (n = 118)	Mean	1.82	1.77	2.09	3.75	2.45	11.88
	SD	1.40	1.66	1.66	2.09	1.93	5.45
<i>PD group</i>							
(n = 39)	Mean	3.13	3.72	3.49	3.85	5.13	19.31 ^{+,++}
	SD	2.12	2.86	2.50	2.17	2.58	8.46
Boys (n = 12)	Mean	3.08	3.83	3.75	3.58	4.92	19.17
	SD	2.11	3.54	2.56	2.27	3.20	8.47
Girls (n = 27)	Mean	3.15	3.67	3.37	3.96	5.22	19.37
	SD	2.16	2.59	2.51	2.16	2.31	8.62

* Healthy control versus AS/HFA, $p < 0.001$

+ PD versus healthy control, $p < 0.001$

++ PD versus AS/HFA, $p < 0.001$

**Fig. 2** ROC curve of the AQ score questionnaire

differences found in the control group were not significant. The mean AQ scores in our healthy controls (12.49) were close to those observed in Japanese boys (12.4) but slightly

higher than Japanese girls (11.85 vs. 11.0). The smaller sample size of our control group with 118 girls but only 81 boys and the fact that they were not randomly selected could explain differences between our results and those observed in the UK and Japan. The AQ questionnaire also seems useful for distinguishing the PD group from autistic participants and healthy controls. PD participants scored higher than healthy controls but lower than autistic participants.

This first cross-sectional case–control study confirms that the French version of the AQ could be used as a screening tool in autistic and potential PD patients. Our cut-off score was obtained from adolescents already diagnosed with autism compared with healthy controls. The next step will be to estimate the AQ performance for the screening of AS/HFA adolescents in routine clinical practice and to determine its true cut-off score.

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