

The Autism-Spectrum Quotient (AQ) Children's Version in Japan: A Cross-Cultural Comparison

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Abstract In the current study, the child AQ was administered in Japan, to examine whether the UK results for reliability and validity generalize to a different culture. Assessment groups were: Group 1: $n = 81$ children with Asperger Syndrome (AS) or high-functioning autism (HFA); Group 2: $n = 22$ children diagnosed PDD-NOS with average IQ; and Group 3: $n = 372$ randomly selected controls from primary and secondary schools. Both clinical groups scored significantly higher than controls (AS/HFA mean AQ = 31.9, $SD = 6.93$; PDD-NOS mean AQ = 28.0, $SD = 6.88$; controls mean AQ = 11.7, $SD = 5.94$).

Among the controls, males scored significantly higher than females. The pattern of difference between clinical groups and controls was found to be similar in both countries.

Keywords Autism-Spectrum Quotient (AQ) · Asperger Syndrome · High-Functioning Autism · PDD-NOS · Autistic Traits · Children

The Autism Spectrum Quotient (AQ) is a self-report screening instrument which distinguishes adults with high functioning autism (HFA) or Asperger Syndrome (AS) from those in the general population (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). It also shows that autistic traits are normally distributed in the general population, with males scoring slightly but significantly higher than females, and with scientists scoring higher than non-scientists. The only cross-cultural study using the adult version of the AQ has been with Japanese data, which reported remarkably similar results across the two widely different cultures (Wakabayashi, Baron-Cohen, Wheelwright, & Tojo, 2006). More recently, a children's version of the AQ has been reported (Baron-Cohen, Hoekstra, Knickmeyer, & Wheelwright, in press). In the current paper, we report a cross-cultural comparison of the child AQ between the UK and Japan, in order to see if the pattern found in the adult AQ between the two countries also holds in childhood.

Like the adult AQ, the child AQ comprises 50 items, made up of 10 questions assessing 5 different areas: social skill (for example: 'S/he prefers to do things with others rather than on her/his own.'—reversal item); attention switching (for example: 'S/he prefers to do things the same way over and over again'); attention to

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detail (for example: ‘S/he often notices small sounds when others do not.’); communication (for example: ‘Other people frequently tell her/him that what s/he said is impolite, even though s/he thinks it is polite.’); imagination (for example: ‘When s/he reads a story, s/he can easily imagine what the characters might look like’—reversal item). Unlike the adult AQ, the child AQ is filled in by a parent about his or her child, and so is not self-report.

Each of the items scores 1 point if the respondent records the abnormal or autistic-like behaviour either mildly or strongly (Abnormality = poor social skill, poor attention-switching/strong focus of attention, exceptional attention to detail poor communication skill, and poor imagination). Approximately half the items are worded to produce a ‘disagree’ response, and half an ‘agree’ response, in a high scoring person with Asperger Syndrome (AS) or high functioning autism (HFA). This is to avoid a response bias either way. Items are randomized with respect to both the expected response from a high-scorer, and their domain. The items of the AQ were selected from the domains in the “triad” of autistic symptoms (APA, 1994; Rutter, 1978; Wing & Gould, 1979), and from demonstrated areas of cognitive abnormality in autism (Baron-Cohen et al., 2001).

In the study with the child AQ carried out in the UK (Baron-Cohen et al., in press), three groups of subjects were tested: 52 children with AS/HFA (38 males, 14 females), 79 children with classic autism (63 males, 16 females) who had an IQ below the normal range, and 50 children selected at random (25 males, 25 females). The UK study found, as predicted, that the AS/HFA group and classic autism group scored higher than controls, that the two clinical groups did not differ from each other, and that control males scored significantly higher than control females. There was no difference between mean AQ scores of males and females with two clinical groups. Using the rule that a useful cut-off point would discriminate the groups with as many true positives and as few false positives as possible, as AQ score of 30+ was chosen, since 90.4% of the AS/HFA group and 88.6% of the classic autism group score above this level, whilst none of the controls score above this level.

The aim of the study reported in the present paper was mainly to replicate the UK study with Japanese children, using a similar methodology, except that a group of children diagnosed PDD-NOS (PDD not other specified) with normal intelligence were included in place of the children with classic autism. The reason for this is that the purpose of the child AQ is to measure the extent of the autistic traits in the children with *normal* intelligence. Therefore, it would appear

inappropriate to apply the child AQ to children with autism who have an IQ below the normal range. If differences in the scores on the child AQ between children with classic autism and controls children were observed, this might be due to the difference in children’s intelligence level. Children diagnosed PDD-NOS with normal intelligence are therefore useful as a test of the child AQ, in order to examine the validity of applying the child AQ to all high-functioning children with PDD. Therefore, we compared the three groups of children, AS/HFA, high-functioning PDD-NOS, and normal controls, in this study.

The other interest of this study is to investigate whether the child AQ scores differ between the UK and Japan. Although identical diagnostic standards (DSM-IV and ICD-10) are used in the studies in both countries, there might be some cultural differences (Cox, 1986). Of course, given that autism spectrum conditions are thought to resulting from genetic and biological causes, their symptoms are unlikely to show much if any cultural variance. However, the child AQ is completed by children’s parents and there is a possibility of differences in how parents assess their children’s behaviour between the UK and Japan. Therefore, the differences of the score between clinical groups and normal controls in both countries may be of most interest.

In this study, the following issues were examined: (1) Can the child AQ be applied to the children in a different culture (Japan)? (2) Does the score of the child AQ differ between groups, and particularly, do the children with PDD-NOS differ from children with AS/HFA on the child AQ score? (3) Is there any relationship between the AQ score and IQ, and between the AQ score and age, in children with and without autism spectrum conditions? (4) Are there any differences in the results of the child AQ between children in the UK and Japan?

Method

Participants

In the Japanese study, three groups of subjects were tested: Group 1 comprised $n = 81$ children with AS/HFA (63 males, 18 females). This sex ratio of approximately 4:1 (m: f) was similar to that found in other studies (Klin, Volkmar, Sparrow, Cicchetti, & Rourke, 1995), and was closer to the typical sex ratio in autistic disorders than the original child AQ study in the UK (Baron-Cohen et al., in press). All subjects in this group had been diagnosed by child psychiatrists

(T.U. and Y.Y.), using established criteria (APA, 1994; WHO, 1992).

They were recruited via a specialist clinic (Yokohama Psycho-Developmental Clinic) carrying out diagnostic assessments. This specialist clinic is known as one of the most representative clinics for assessments of PDD in Japan. Their mean age was 10.4 years ($SD = 2.63$, range = 6 yrs 11 m–15 yrs 1 m). They were all assessed for intelligence using the WISC-III Japanese version (Azuma et al., 1998; Wechsler, 1991), (mean $FIQ = 102.5$ $SD = 14.59$, mean $VIQ = 105.0$, $SD = 15.61$, mean $PIQ = 99.5$, $SD = 15.80$), and all participants had an IQ of at least 85 or higher. These children were selected from a larger sample, but in order to correspond with the UK study, children with IQs in the borderline range (70–84) were omitted. Usually HFA is used to describe any individual with autism whose IQ is higher than 70, since this is the accepted point at which one is able to diagnose general learning difficulties and average intelligence. In fact, an IQ of around 70 is still likely to lead to considerable educational problems. Therefore in order to compare the autistic children with normal intelligence to controls, we selected the AS/HFA who have intelligence correspond to normal controls (85 and above). The cases of high-functioning autism and Asperger Syndrome were grouped together, rather than attempting to separate them into subgroups, as in the UK study. None of the participants were genetically related to each other.

Group 2 comprised $n = 22$ children with PDD-NOS (10 males, 12 females), who had a normal IQ range. In contrast with the Group 1, this sex ratio was approximately 1:1. Although this sex ratio cannot be assumed to be reliable as the number in the sample is small, Newton, Marechal and Davis (2003) suggested that the sex ratio in the PDD-NOS may be different from that in autism, because females may be more difficult to fit into the diagnostic standards of autistic disorders in DSM, and may be easier to diagnose with PDD-NOS, and Attwood (2005, pers. comm.) has said that the sex ratio for PDD-NOS is 1:1. All the children in this group had been diagnosed by the same psychiatrists in Group 1 using established criteria for PDD (APA, 1994, WHO, 1992). They too were recruited via the same specialist clinic for group 1. Their mean age was 10 years 11 months ($SD = 2.10$, range 7 yrs 3 m–14 yrs 11 m). They were also assessed using the WISC-III Japanese version (mean $FIQ = 101.0$, $SD = 14.59$, mean $VIQ = 100.8$, $SD = 14.43$, mean $PIQ = 100.7$, $SD = 16.00$), and all participants were confirmed to have an IQ of above 85, so as to correspond to Group 1. These children were selected from a larger sample too, and we excluded children who had borderline

intelligence level ($IQ = 70 < 84$) in order to correspond with the AS/HFA group.

Group 3 comprised 372 children selected at random ($n = 188$ males and 184 females). They were drawn from three primary schools and one secondary school in different areas in Japan. Their mean age was 10 yrs 9 m ($SD = 2.58$, range 6.9–15.8). All children in this group were administered intelligence tests twice (at ages 3 years and 6 years), and were confirmed to have an intelligence level in the normal range.

Diagnosis

Child psychiatrists who diagnosed children in-group 1 and 2 conducted assessments using the Diagnostic and Statistical Manual (DSM-IV) and ICD-10. All of the psychiatrists in this study were trained in diagnosis of autistic disorders under Dr. Wing, and were qualified to use the Diagnostic Interview for Social and Communication Disorders (DISCO) (Leekam, Libby, Wing, Gould, & Taylor, 2002; Wing, Leekam, Libby, Gould, & Larcombe, 2002). They essentially apply similar criteria to their diagnoses, and draw from shared clinical principles. Diagnostic processes were as follows. A team of one child psychiatrist and several clinical psychologists conducted full assessments in the course of one day. The psychiatrist interviewed the parents for several hours. Clinical psychologists conducted the intelligence test, and developmental test if necessary, such as the Japanese version of WISC-III and the Japanese version of the Psychoeducational Profile Revised (Shopler, Reichler, Bashford, Lensing, & Marcus, 1990). Diagnosis was based on clinical observations, interviews with the children, and parent interviews regarding the developmental history of their children's social, behavioural, and communicative functioning.

Item Translation

The item translation proceeded in an identical fashion to the Japanese version of the adult AQ, as follows: first, one of the Japanese authors (A.W.) translated the child AQ items from English into Japanese. Then the Japanese items were checked by an English-Japanese bilingual psychologist for whether they corresponded with the original English items. Finally, English-native speakers who could understand Japanese back translated the Japanese items into English, and they were checked for whether they corresponded with the original English items. The final version of the Japanese child AQ is similar to the original English version, and has the same format except as follows: In pilot research for the child AQ in Japan, many parents said that it

was difficult for them to respond some items, such as item Nos. 3, 8, 13, 23, 24. Three of those 5 items belong to the 'Imagination' sub-scale, suggesting that it is difficult to assess children's inner imagination even by their parents. Consequently, another response option of 'Don't know' was added, but parents were encouraged to use this option as little as possible.

Procedure

All of the parents of children in Group 1 and Group 2 were sent the child AQ by a psychiatrist or clinical psychologist in the specialist clinic. All of the parents of the control group children were sent the AQ through class teachers. They were instructed to complete it as quickly as possible (to avoid thinking about responses too long).

Scoring the Child AQ

'Definitely agree' or 'slightly agree' responses scored 1 point, on the following items: 2, 4, 5, 6, 7, 9, 12, 13, 16, 18, 19, 20, 21, 22, 23, 26, 33, 35, 39, 41, 42, 43, 45, 46. 'Definitely disagree' or 'slightly disagree' responses scored 1 point, on the following items: 1, 3, 8, 10, 11, 14, 15, 17, 24, 25, 27, 28, 29, 30, 31, 32, 34, 36, 37, 38, 40, 44, 47, 48, 49, 50. If a respondent chose 'Don't know' for more than 5 items in total, or more than 2 items in one

subscale, this AQ was deemed to be incomplete and was omitted from the sample.

Results

AS/HFA, PDD-NOS, vs. Controls, and Sex Differences

Mean total AQ scores for each group, broken down by sex and by sub-domain, are shown in Table 1. Comparing groups using an ANOVA of total AQ score by Group and Sex, there was a main effect of Group ($F(2, 469) = 381.665, p < 0.001$). Post hoc Bonferroni's multiple comparison revealed that children in two clinical groups (AS/HFA: mean = 31.9, $SD = 6.69$; PDD-NOS: mean = 28.0, $SD = 6.88$) scored significantly higher than the control group (mean = 11.7, $SD = 5.94$) ($p < 0.01$), and the AS/HFA group scored slightly but significantly higher than the PDD-NOS group ($p < 0.05$). The clinical groups differed from the control group on all sub-domain scores, and the AS/HFA group scored higher than the PDD-NOS group on 3 of 5 sub-domain scores (t tests: see Table 2).

Power calculations were also administered on the mean AQ scores between the groups. The results showed that the AS/HFA group and the PDD-NOS group scored higher than controls (both powers were 1.0, $p < 0.001$), but the two clinical groups did not differ from each other (power = 0.765, $p = 0.1$).

Table 1 Mean scores (and SD s) of Total AQ and sub-scales in each group

Group	N	Age	Total AQ	Social Skill	Att.Switch	Local detail	Communi.	Imagination
AS/HFA	81	10.4 (2.63)	31.9 (6.69)	6.9 (2.16)	6.2 (1.81)	5.1 (2.19)	7.2 (2.17)	6.5 (2.01)
Males	63	10.5 (2.61)	32.5 (6.72)	6.9 (2.27)	6.3 (1.82)	5.3 (2.14)	7.2 (2.27)	6.7 (1.96)
Females	18	10.2 (2.69)	29.7 (6.08)	7.1 (1.72)	5.8 (1.71)	4.2 (2.17)	6.9 (1.75)	5.7 (1.97)
PDD-NOS	22	10.10 (2.10)	28.0 (6.88)	5.7 (2.69)	5.5 (1.50)	5.2 (1.97)	6.1 (1.86)	5.6 (2.17)
Males	10	10.9 (1.56)	30.8 (7.55)	6.5 (2.69)	6.3 (1.10)	5.8 (1.83)	6.3 (2.15)	5.9 (2.66)
Females	12	10.11 (2.55)	25.7 (5.22)	5.0 (2.48)	4.8 (1.42)	4.7 (1.93)	5.9 (1.55)	5.3 (1.60)
Controls	372	10.9 (2.58)	11.7 (5.94)	2.2 (1.94)	2.3 (1.73)	3.6 (1.85)	1.3 (1.55)	2.4 (1.72)
Males	188	10.9 (2.57)	12.4 (5.52)	2.3 (1.83)	2.5 (1.69)	3.6 (1.95)	1.3 (1.44)	2.7 (1.69)
Females	184	10.9 (2.60)	11.0 (6.27)	2.1 (2.05)	2.2 (1.76)	3.5 (1.73)	1.2 (1.65)	2.0 (1.68)

Att Switch = Attention Switching, Communi = Communication

Table 2 T tests of total AQ and sub-domains between groups

AQ sub-domain	Controls vs. AS/HFA	Conttols vs. PDD-NOS	AS/HFA vs. PDD-NOS	Controls vs. All PDD
Total AQ	$t = 27.083^{***}$	$t = 12.189^{**}$	$t = 2.688^{**}$	$t = 28.544^{**}$
Social Skill	$t = 19.075^{**}$	$t = 7.832^{**}$	$t = 2.581^*$	$t = 19.706^{**}$
Attent Switch	$t = 18.495^{**}$	$t = 8.253^{**}$	$t = 1.901$	$t = 19.482^{**}$
Local Details	$t = 6.353^{**}$	$t = 3.866^{**}$	$t = 0.289$	$t = 7.134^{**}$
Communication	$t = 28.359^{**}$	$t = 12.968^{**}$	$t = 2.628^*$	$t = 29.925^{**}$
Imagination	$t = 19.158^{**}$	$t = 8.318^{**}$	$t = 2.180^*$	$t = 20.087^{**}$

* $p < 0.05$, ** $p < 0.01$

The main effect of Sex was also significant ($F(1, 469) = 9.440, p < 0.01$). There was no interaction of Group by Sex ($F(2, 469) = 1.453, p = 0.235$). T tests confirmed that there was a significant sex difference ($t = 2.209, p < 0.05$): in the control group, males scored slightly but significantly higher than females, corresponding with the result reported on the adult AQ in both the UK and Japan and also child AQ in the UK. There were no significant sex differences in the clinical groups (Group 1: $t = 1.585, p = 0.12$; Group 2: $t = 1.791, p = 0.09$). Figure 1 displays the Group and sex differences graphically.

The autism-spectrum hypothesis assumes that the distribution of scores on the child AQ for typically developing children is normal, as it is for typical adults. In order to examine this hypothesis, we calculated skewness and kurtosis scores in control group. The results showed that skewness was 0.72 and kurtosis was -0.39 , suggesting that the scores on the AQ are almost normally distributed in the control group. Of course, the scores in the clinical groups should not be normally distributed, but should be skewed to high scores. These results can be seen in Fig. 1 clearly.

Item Analysis

An item analysis (percentage of each group scoring on each item) is shown in Table 3. On one item out of 50 (item 29; ‘S/he is not very good at remembering phone numbers.’) controls scored higher than the clinical groups. On another two items (item 30; ‘S/he doesn’t usually notice small changes in a situation, or a person’s appearance.’ and item 49; ‘S/he is not very good at remembering people’s data of birth.’) the scores did not differ between controls and clinical groups. These three items were conservatively retained in the analysis since, if anything, they served to reduce the size of group differences. The internal consistency of total items of AQ, and items in each of the 5 domains, were also calculated, and Cronbach’s Alpha Coefficients were all high (Total AQ = 0.84, Communication = 0.79; Social

Skill = 0.81; Imagination = 0.76; Local Details = 0.69; Attention Switching = 0.74).

Cut-off Point

The percentage of each group scoring at or above each AQ score is shown in Table 4 and Fig. 2. A useful cut-off would discriminate the groups with as many true positives and as few false positives as possible. In the child AQ in the UK, an AQ score of 30+ was chosen as a useful cut-off, since all AS/HFA girls and 86.8% of the AS/HFA boys scored above this level, whilst none of the controls scored above this level. In the child AQ in Japanese version, 25+ would have been adequate, since 82.5% of the AS/HFA group (and 72.7% of the PDD-NOS group) scored at this level, whilst only 3.8% of controls did so. This point is lower than the cut-off point in the child AQ in the UK.

Comparison between AS/HFA and PDD-NOS

Although children with high-functioning PDD-NOS were not dealt with in the UK study, in the Japanese child AQ study we have the opportunity to compare AS/HFA with PDD-NOS. The results of Bonferroni’s multiple comparisons showed that the children in the PDD-NOS group scored slightly (28.0) lower than those in the AS/HFA group (31.9) ($p < 0.05$). On the sub-scales there were also slight differences between PDD-NOS and AS/HFA in Social Skill, Communication, and Imagination (all t tests $ps < 0.05$), children with AS/HFA scoring higher than children with PDD-NOS. However, it must be borne in mind that the number of children in PDD-NOS group was not large, and the result of the power calculation, which considers sample size showed no difference between the two clinical groups. In general, although it appears that these two groups do not differ from each other on child AQ scores, further investigation is needed to confirm this conclusion.

Fig. 1 AQ scores in AS/HFA group and control groups

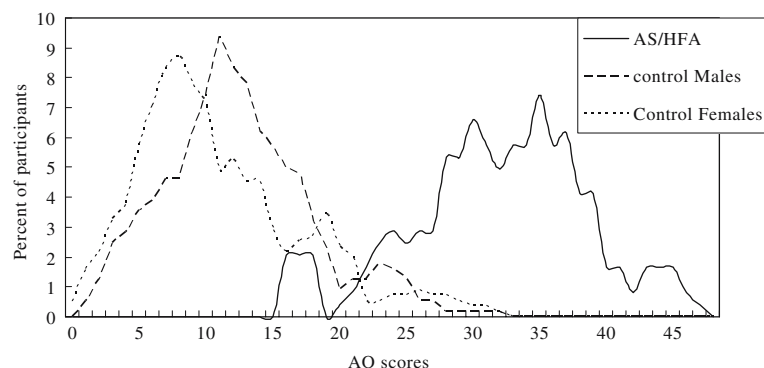


Table 3 Percentage of each group scoring each item

No	AS/HFA	PDD-NOS	Control Male	Control Female
1	69.1	50.0	20.9	20.7
2	85.2	77.3	30.4	27.6
3	44.4	36.4	10.2	8.7
4	75.7	72.7	49.4	42.3
5	46.6	50.0	28.9	28.7
6	38.3	45.5	23.1	11.9
7	54.4	45.5	9.6	9.8
8	58.0	54.5	20.3	15.6
9	35.9	31.8	12.8	12.6
10	82.7	63.6	18.7	17.6
11	72.8	72.7	23.7	21.5
12	59.3	45.5	32.6	33.3
13	48.1	27.3	11.2	11.5
14	69.9	68.2	42.9	32.6
15	73.8	59.1	38.7	40.6
16	54.4	40.9	17.6	15.5
17	60.5	45.5	3.7	3.8
18	45.7	40.9	21.4	18.6
19	35.9	40.9	12.3	10.3
20	72.8	68.2	26.6	19.0
21	53.1	50.0	22.9	15.4
22	62.1	63.6	19.4	16.8
23	40.8	40.9	20.3	20.7
24	53.1	36.4	32.6	25.2
25	59.2	40.9	22.1	18.7
26	84.5	68.3	8.6	9.2
27	86.4	81.8	21.4	22.8
28	77.7	72.7	43.9	46.2
29	57.3	68.2	71.7	70.2
30	63.1	68.2	65.2	64.5
31	89.3	86.4	32.9	28.2
32	75.7	63.6	37.4	33.2
33	69.1	50.0	9.6	8.9
34	43.2	36.4	3.7	3.3
35	71.6	72.7	6.4	6.9
36	69.9	63.6	21.8	22.8
37	42.0	40.9	10.7	9.8
38	76.5	68.2	9.6	8.6
39	77.8	45.5	6.9	6.9
40	82.5	63.6	25.1	18.6
41	69.9	54.5	39.7	27.9
42	67.9	68.2	11.7	8.6
43	39.5	36.4	25.6	21.7
44	74.1	50.0	13.3	9.2
45	94.2	86.4	23.4	22.3
46	64.2	77.3	29.9	25.8
47	64.1	50.0	33.9	29.1
48	65.4	45.5	19.8	19.0
49	50.5	59.1	51.6	51.1
50	76.7	59.1	39.8	26.6

The Relationship between the AQ and Intelligence in the Clinical Group

In order to examine if child AQ scores are influenced by intelligence level, we grouped together the children with AS/HFA and PDD-NOS to form a high-functioning PDD group. First, we calculated the correlations

between AQ score and the three intelligence quotients (FIQ, VIQ, and PIQ in WISC-III). All correlations were non-significant, with the Pearson's Product Moment Correlation coefficients as follows: $r = -0.136$ in FIQ, $r = -0.146$ in VIQ, and $r = -0.169$ in PIQ. Then, we attempted to apply a regression analysis in this group of high-functioning PDD children. A standard multiple regression analysis was performed with the AQ score as the predicted variable and the three IQs as the predictor variables. As expected from the low correlations, models predicting the AQ score from three intelligence quotients showed extremely small R^2 value (0.005).

The Relationship between the AQ and Age in Children

The relationship between AQ score and age was examined in both the high-functioning PDD group and the control group. We calculated the correlations between AQ score and children's age in clinical and control groups separately. The Pearson's Product Moment correlation coefficient between the AQ score and age in clinical group was $r = 0.022$ (n.s.), and those in control group was $r = 0.039$ (n.s.).

Similarities and Differences between the UK and Japan

Overall, the results of the Japanese data on the child AQ were very similar to the UK data, although the mean child AQ score in Japan was lower than in Britain in all three groups by about five points. We compared the Japanese data and the UK data for the AS/HFA and control groups using a *t*-test of the mean total child AQ score, for each pair of corresponding groups. We found that the mean score of the child AQ in the Japanese data was significantly lower than the UK data in both analyses (*t* scores were AS/HFA = 4.741, Controls = 6.761, both $p < 0.01$). However, the difference between the AS/HFA group and control group in the two countries was almost identical: in the UK the mean difference in AQ score between the AS/HFA group and the control group was 19.6 points, and in Japan was 20.2 points. This suggests that the child AQ distinguishes the children who have autistic traits at a clinical level from typically developing children equally well in both countries.

The mean sub-domain child AQ scores for the two groups in Japan were also lower than those in the UK. Comparing the UK and Japan data using *t* tests for each subscale in each corresponding group showed that there were significant differences between the scores of the UK and Japanese children on all subscales except

Table 4 Percentage of Participants in group 1, 2, and 3 scoring at or above each AQ score

Score	AS/HFA All	AS/HFA Males	AS/HFA Females	PDD-nos All	PDD-nos Males	PDD-nos Females	Controls All	Control Males	Control Females
0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	100.0	100.0	100.0	100.0	100.0	100.0	99.7	100.0	99.5
2	100.0	100.0	100.0	100.0	100.0	100.0	99.2	100.0	98.4
3	100.0	100.0	100.0	100.0	100.0	100.0	96.8	98.4	95.1
4	100.0	100.0	100.0	100.0	100.0	100.0	94.6	96.3	92.9
5	100.0	100.0	100.0	100.0	100.0	100.0	90.6	92.6	88.6
6	100.0	100.0	100.0	100.0	100.0	100.0	86.8	89.9	83.7
7	100.0	100.0	100.0	100.0	100.0	100.0	80.6	85.6	75.5
8	100.0	100.0	100.0	100.0	100.0	100.0	74.2	80.9	67.4
9	100.0	100.0	100.0	100.0	100.0	100.0	67.5	76.1	58.7
10	100.0	100.0	100.0	100.0	100.0	100.0	60.8	71.8	49.5
11	100.0	100.0	100.0	100.0	100.0	100.0	53.2	62.2	44.0
12	100.0	100.0	100.0	100.0	100.0	100.0	45.7	53.7	37.5
13	100.0	100.0	100.0	100.0	100.0	100.0	39.2	43.6	34.8
14	100.0	100.0	100.0	100.0	100.0	100.0	32.8	37.2	28.3
15	100.0	100.0	100.0	95.5	90.0	100.0	27.2	30.3	23.9
16	100.0	100.0	100.0	95.5	90.0	100.0	23.1	25.0	21.2
17	100.0	100.0	100.0	95.5	90.0	100.0	19.9	20.2	19.6
18	93.8	93.7	94.4	90.9	90.0	91.7	16.4	15.4	17.4
19	93.8	93.7	94.4	90.9	90.0	91.7	12.1	10.6	13.6
20	93.8	93.7	94.4	86.4	90.0	83.3	11.0	10.6	11.4
21	93.8	93.7	94.4	86.4	90.0	83.3	7.8	8.5	7.1
22	92.6	92.1	94.4	81.8	90.0	75.0	7.3	7.8	6.5
23	91.4	90.5	94.4	77.3	90.0	66.7	6.2	6.9	5.4
24	88.9	88.9	88.9	72.7	90.0	58.3	5.1	4.8	5.4
25	85.2	87.3	77.8	72.7	90.0	58.3	3.8	2.7	4.9
26	82.7	85.7	72.2	63.6	80.0	50.0	2.7	2.1	3.3
27	81.5	85.7	66.7	59.1	70.0	50.0	2.2	1.1	3.3
28	76.5	82.5	55.6	54.5	70.0	41.7	1.6	1.1	2.2
29	74.1	79.4	55.6	45.5	60.0	33.3	0.8	0.5	1.1
30	65.4	68.3	55.6	36.4	50.0	25.0	0.8	0.5	1.1
31	60.5	65.1	44.4	31.8	50.0	16.7	0.5	0.5	0.5
32	54.3	58.7	38.9	31.8	50.0	8.3	0.0	0.0	0.0
33	48.1	52.4	33.3	27.3	50.0	8.3	0.0	0.0	0.0
34	45.7	49.2	33.3	27.3	50.0	8.3	0.0	0.0	0.0
35	37.0	41.3	22.2	22.7	40.0	8.3	0.0	0.0	0.0
36	30.9	36.5	11.1	18.2	40.0	0.0	0.0	0.0	0.0
37	23.5	28.6	5.6	18.2	40.0	0.0	0.0	0.0	0.0
38	19.8	23.8	5.6	13.6	30.0	0.0	0.0	0.0	0.0
39	12.3	14.3	5.6	4.5	10.0	0.0	0.0	0.0	0.0
40	11.1	12.7	5.6	0.0	0.0	0.0	0.0	0.0	0.0
41	7.4	7.9	5.6	0.0	0.0	0.0	0.0	0.0	0.0
42	7.4	7.9	5.6	0.0	0.0	0.0	0.0	0.0	0.0
43	6.2	6.3	5.6	0.0	0.0	0.0	0.0	0.0	0.0
44	4.9	4.8	5.6	0.0	0.0	0.0	0.0	0.0	0.0
45	2.5	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	1.2	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

imagination for the AS/HFA group and social skills for the control group (Table 5).

Discussion

The main purpose of this study was to examine if the child version of the Autism Spectrum Quotient (AQ) could be applied to Japanese children, and compare

data from the original UK study with those obtained in Japanese children. As expected from the comparison of the adult AQ data between the two countries, the UK results were replicated in most respects: (1) The groups of children with AS/HFA scored significantly higher than controls; (2) A sex difference (males scored higher than females) was found in the control group, but there was no sex differences in both clinical groups; (3) There were no significant

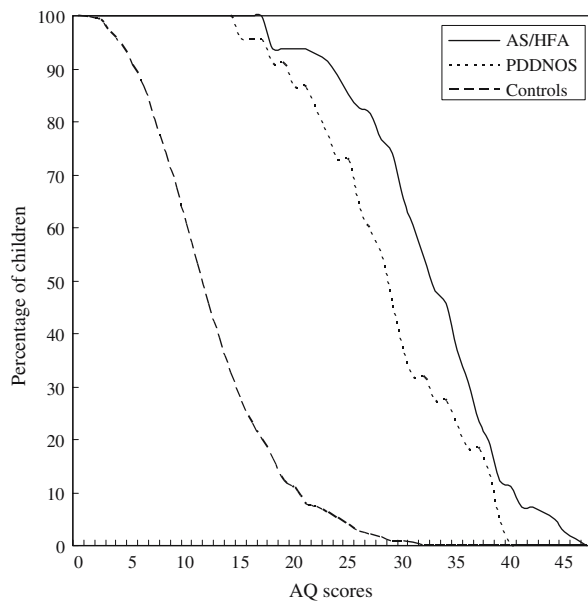


Fig. 2 Percent of children scoring more than or equal to each AQ score

effects of age on AQ score in the normal control group. Additionally, in this study three results were found which were not examined in the UK study: (4) Children with PDD-NOS did not differ from children with AS/HFA in the AQ, although there was a tendency that they showed slightly lower AQ score than AS/HFA group. (5) The AQ score was independent of intelligence level in the clinical groups. (6) The AQ score was not affected by children's age in both the clinical group and control group either.

In both countries, children with Asperger Syndrome (AS) or high functioning autism (HFA) scored distinctly higher on the AQ than matched controls. This demonstrates that, like the UK version, the Japanese version of the child AQ has reasonable face validity, since the questionnaire purports to measure autistic spectrum traits and people with a diagnosis involving these traits score highly on it. The Japanese version of the child AQ can also be said to have reasonable construct validity, in that items purporting to measure total AQ score show a high Cronbach's alpha coefficient.

Each of the 5 domains of interest (social skill, communication, imagination, attention to details, and attention switching) also shows relatively high alpha coefficients. Cronbach's alpha coefficient is one of the representative index of the reliability of questionnaire scales. Nunnally (1978) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature. The Cronbach's alpha coefficient obtained in the Japanese version of the child AQ met this level (0.84), and those in each sub-scales were around 0.7–0.8, which is adequate for scales with such small number of items (10 items each). The scores of the AQ in the control group had a normal distribution. This result suggests that the AQ measures the degree of autistic traits in accordance with the autism-spectrum hypothesis.

These results suggest that the children's version of the AQ can be applied to Japanese children adequately, and that autism spectrum conditions are expressed in a very similar way across widely differing cultures. The results also demonstrate the reliability of the child AQ in terms of generating very similar patterns of results in two very different samples.

In the Japanese data, the mean scores for the total child AQ and almost all of the subscales were slightly lower than the British data. However, this does not necessarily imply that AS/HFA is less common or less severe in Japan. Epidemiological research does not report any differences in the prevalence of autism spectrum disorders between western countries and Japan. The lower score in Japan may partly reflect that we added the option 'Don't know' to the Japanese version of the child AQ, which could have reduced the score. If a respondent chose 'Don't know' for more than 5 items in total, or more than 2 items in one sub-scale, then this data was omitted from our sample, but this might still have influenced results.

This modification from the original study might cause some problems in when making comparisons with the UK study. However this could not affect the score difference among groups, because this modification was common to all groups. The results suggested that this assumption was correct, since the score difference

Table 5 The differences of the child AQ scores (means and SDs) between the UK and Japan

Group	Total AQ	Social Skill	Att. Switch	Local detail	Communi.	Imagination
AS/HFA, Japan	31.9 (6.69)	6.9 (2.16)	6.2 (1.81)	5.1 (2.19)	7.2 (2.17)	6.5 (2.01)
The UK	37.3 (5.8)	7.8 (1.8)	8.5 (1.7)	6.1 (2.4)	8.2 (1.6)	6.7 (2.2)
Significant difference	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$	<i>n.s.</i>
Controls, Japan	11.7 (5.94)	2.2 (1.94)	2.3 (1.73)	3.6 (1.85)	1.3 (1.55)	2.4 (1.72)
The UK	17.7 (5.7)	2.0 (1.9)	4.5 (2.0)	5.3 (2.4)	2.7 (1.7)	3.2 (2.3)
Significant difference	$p < 0.01$	<i>n.s.</i>	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$

between AS/HFA and controls were almost identical in the two countries.

Alternatively, it might reflect cultural differences between the UK and Japan. For example, parents in Japan do not notice social problems in their children's behaviour as readily as parents in western countries because, as many cross-cultural studies have suggested, Japanese people are more introverted than westerners (Kitayama, Markus, & Matsumoto, 1995). This means that autistic traits would be more inconspicuous in Japan as compared with western countries, because autistic traits relate to introversion to some extent (Wakabayashi, Baron-Cohen, & Wheelwright, in press).

However, the differences in the scores between the clinical group and the control group were almost identical in both countries, as was true for the adult AQ. Although in the cross-cultural study of the adult AQ, the scores on the AQ were slightly different in the UK and Japan, the *difference* in the scores between the clinical and control groups was almost *identical* in the two countries.

It is of interest if children with PDD-NOS showed differences from children with AS/HFA on the AQ. However, it is not clear that the two clinical groups differ in important ways from each other, and this result deserves to be tested further, as it could throw doubt on the clinical distinction between these subgroups on the autistic spectrum, or on the reliability of diagnosis of PDD-NOS.

The child AQ assumes that the number of autistic traits and intelligence level are independent. The results of correlation analyses supported this assumption. The correlations between AQ score and the three IQ scores were extremely low, and a regression analysis showed that IQs predicted only 0.5% of the variability on the AQ. These results suggest that the extent of autistic traits is not influenced by intelligence level in high-functioning PDD children.

Interestingly, in both countries, there were no significant effects of age on child AQ score. These results suggest that what is being measured by the AQ does not change with age, and that the items are not biased towards one particular age group in children (at least among 7–15 yrs old).

Do autistic traits in the general population have the same meaning as those in autism spectrum conditions? We think the AQ may well measure autistic traits similarly in children with or without autistic spectrum conditions, based on the continuum view of the autism-spectrum. It seems that the boundary between autistic condition and *quasi*-autistic condition are indistinct and permeable.

Within the control group, males scored slightly but significantly higher than females. This is consistent with the extreme male brain theory of autism (Asperger, 1944; Baron-Cohen, 2002; Baron-Cohen & Hammer, 1997): sex differences in autistic traits may be universal characteristics. However, in the Japanese sample, just as in the original UK sample, males and females in both clinical groups did not differ significantly on the AQ. This suggests that both males and females with autism spectrum conditions have been hyper-masculinized in terms of the neurocognitive profile.

We wish to underline that the child AQ is not diagnostic, but may serve as a useful instrument in identifying the number of autistic traits shown by a child of normal intelligence. Currently, this should be used for research purposes primarily, as the child AQ has not been tested as a screening instrument in the general population. Further research is needed to apply the AQ as a screening instrument in the general population.

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