Journal of Autism and Developmental Disorders (© 2006)
DOI 10.1007/s10803-006-0094-1

'Autistic' Traits in Non-Autistic Japanese Populations: Relationships with Personality Traits and Cognitive Ability

Yura Kunihira,[1,6] Atsushi Senju,[1,2] Hitoshi Dairoku,[3,4] Akio Wakabayashi,[5] and Toshikazu Hasegawa[1]

We explored the relationships between 'autistic' traits as measured by the AQ (Autism-Spectrum Quotient; Baron-Cohen *et al*., *J. Autism Develop. Disord.* (2001b) **31** 5) and various personality traits or cognitive ability, which usually coincide with autistic symptoms, for general populations. Results showed the AQ was associated with tendencies toward an obsessional personality as defined by the TCI (Temperament and Character Inventory), higher depression and anxiety, and higher frequency of experience of being bullied. These results parallel the patterns in autism and corroborate the validity of the AQ for general populations. Contrary to our prediction, however, there was no relationship between the AQ and cognitive ability, such as theory of mind, executive functioning, and central coherence, suggesting the AQ does not reflect autism-specific cognitive patterns in general populations.

KEY WORDS: Autism-Spectrum Quotient (AQ); general population; personality; depression; anxiety; cognitive ability.

Kanner (1943) first described autism, followed by Asperger (1944), who mentioned a syndrome characterized by traits similar to Kanner's description. Today, ''Asperger's syndrome'' is distinguished from Kanner's autism, and their relationship is still debated (Volkmar, 1999). In their current versions, the Diagnostic and Statistical Manual for Mental Disorders (DSM; American Psychiatric Association [APA], 1994), and the International Classification of Diseases (ICD; World Health Organization [WHO], 1994) international classification systems of disorders classify both autism and Asperger's syndrome as pervasive developmental disorders. The diagnostic criteria for autism are defined as the triad of symptoms consisting of: (a) qualitative impairment in social interactions, (b) qualitative impairment in communication, and (c) restricted, repetitive, and stereotyped patterns of behavior, interests, and activities. By contrast, the diagnostic criteria of Asperger's syndrome are (a) and (c) without clinically significant delays in language (APA, 1994; WHO, 1994).

However, additional traits are often seen in individuals with autism: it is likely to superinduce learning disabilities; it is likely to superinduce other developmental or physical disorders, particularly epilepsy; and its symptoms might be changed with circumstances or education. These characteristics have led to inconsistency in the diagnosis of autism (Wing & Potter, 2002); that is, people with autistic traits that do

[1] Department of Cognitive and Behavioral Sciences, The University of Tokyo, Tokyo 153-8902, Japan.
[2] Centre for Brain and Cognitive Development, Department of Psychology, Birkbeck, University of London, London, UK.
[3] Faculty of Human Studies, Musashino University, Tokyo, Japan.
[4] Institute of Disability Sciences, University of Tsukuba, Ibaraki, Japan.
[5] Faculty of Letters, Chiba University, Chiba, Japan.
[6] Correspondence should be addressed to: Yura Kunihira, Department of Cognitive and Behavioral Sciences, The University of Tokyo, 3-8-1, Komaba, Meguro-ku, Tokyo 153-8902, Japan; E-mail: yurayura@darwin.c.u-tokyo.ac.jp

not fit into Kanner's or Asperger's classification are not properly diagnosed. Moreover, the criteria dividing high-functioning autism and Asperger's syndrome are currently still debated (Cohen & Volkmar, 1997; Wing & Potter, 2002). Against this background, the autism spectrum hypothesis was proposed (Baron-Cohen, 1995; Wing, 1981).

The autism spectrum hypothesis reflects a comparatively broad concept, which includes Kanner's autism and Asperger's syndrome, as well as individuals who do not correspond to either. This hypothesis was based on the assumption of a spectrum according to the degree of 'autistic' traits. In this sense, it differs from the existing view that categorizes autism and Asperger's syndrome independently. This hypothesis also enables the determination of an individual's degree of deficit or pattern of abilities in line with a single autism spectrum. Consequently, the autism spectrum hypothesis has the potential to provide a valuable perspective for clinical and educational applications, in contrast to the categorical concepts that are convenient in medical or psychological studies using diagnostic statistics.

On the other hand, non-autistic members of families with children with autism are more likely to have difficulties with social interaction or communication, or to have repetitive behaviors. These family members are defined as part of a "broader phenotype" of autism (Bailey, Palferman, Heavey, & Le Couteur, 1998), which has been investigated in various fields in family or twin studies (Bailey *et al.*, 1998; Briskman, Happè, & Frith, 2001; Piven, Palmer, Jacobi, Childress, & Arndt, 1997). The broader phenotype has been confirmed in both behavioral research and studies of cognitive ability. For example, Baron-Cohen and Hammer (1997b) pointed out that family members of children with autism tend to be poorer at theory of mind tests and better at the Embedded Figures Test than family members of children without autism. This suggests that the general population may have variable levels of 'autistic' traits regardless of the diagnosis, which is consistent with the autism spectrum hypothesis.

Many studies have examined the autism spectrum hypothesis and the possibility of its extension to general populations. Against this background, Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley (2001b) developed the Autism-Spectrum quotient (AQ) as a short, self-administered scale for identifying the degree to which any individual of normal IQ has 'autistic' traits. This scale is useful because both a clinical group of people with autism and a group from a general population can be tested in the same manner. Indeed, the AQ can distinguish individuals with autism from those in the general population (Baron-Cohen *et al.*, 2001b). Moreover, within a general population, some groups tend to score higher on the AQ; for example, men have higher scores than women, as do students majoring in the sciences, compared with those majoring in the humanities or social sciences (Baron-Cohen *et al.*, 2001b; Wakabayashi, 2003). These results suggest a higher incidence of autism or Asperger's syndrome in men versus women (Happè & Frith, 1996; Wing, 1981), and support the extreme male brain theory of autism (Baron-Cohen, 2002; Baron-Cohen & Hammer, 1997a). And since the AQ was designed to assess 'autistic' traits of both individuals with autism and those in general populations, this suggests the possibility of analogue studies using the AQ. An analogue study can acquire useful data or help construct a solid model, especially in abnormal and clinical psychology, such as in studies on depression or anxiety (Vredenburg, Flett, & Krames, 1993). Since the value of analogue studies has already been established, this approach should also contribute to autism research.

However, since the validity of the autism spectrum hypothesis remains controversial, we conducted an exploratory analogue study to examine the autism spectrum hypothesis, using the AQ with healthy university students. Following the hypothesis, it was expected that even in the general population, higher scores on the AQ would be related to the most prominent characteristics that are commonly seen in people with autism. We chose two characteristics, personality traits and cognitive abilities, which have often been discussed in autism research.

First, it has been noted that autism shows some parallels with other psychiatric disorders. For example, people with high-functioning autism or Asperger's syndrome have some symptoms that are similar to those of other psychiatric disorders, such as schizophrenia, obsessive–compulsive disorder, and mood disorder (Gillott, Furniss, & Walter, 2001; Wing, 1981).

Concerning the relation with schizophrenia, autism has been acknowledged as a form of childhood schizophrenia, and from the late 1960s through the 1970s, the ICD and DSM defined it as a form of schizophrenia or 'childhood schizophrenia'. Findings in the 1970s, then, revealed that autism differed from schizophrenia. Today both the ICD and DSM define autism as a developmental disorder, and this is now gradually being accepted. However, the

precise relationship between autism and schizophrenia still remains a matter for investigation (Cohen & Volkmar, 1997).

The relation between autism and obsessive–compulsive disorder has also been examined, because people with autism often show compulsive, repetitive, ritualistic, and stereotypical behaviors (Gillott *et al*., 2001; Wing, 1981). Based on a family study of autism, Bolton, Pickles, Murphy, and Rutter (1998) suggested that families that had children with autism had a higher incidence of obsessive–compulsive disorder than families that had children with Down's syndrome. This implies a link not only between autism and obsessive–compulsive disorder, but also between the broader phenotype of autism and obsessive–compulsive disorder. In addition, studies have examined the autistic traits of obsessive–compulsive disorder (Bejerot, Nylander, & Lindstom, 2001). However, McDougle *et al*. (1995) reported that the compulsive thought or behavior seen in autism did not resemble that seen in obsessive–compulsive disorder, in terms of content. These discrepancies suggest further investigation is necessary to clarify the relationship between them.

Concerning the relation with mood disorder, research has shown that individuals with autism, especially high-functioning individuals, are more susceptible to suffer mood disorders, such as depression or anxiety, than individuals in the general population (Gillott *et al*., 2001; Wing, 1981). People with autism are generally poor at reading intention, and have difficulties in everyday interpersonal communication. Consequently, it has been reported that in some instances they are likely to be bullied because of their poor communication ability (Wing, 1981). Some researchers think that such maladaptation might lead children with autism to depression or anxiety. By contrast, Gillott *et al*. (2001) suggested that echolalia and repetitive or compulsive ritualistic behaviors are defense mechanisms against anxiety, and this account has been put forward in discussions of obsessive–compulsive disorder. On another front, it was also reported that members of families with children with autism tend to experience mood disorders more frequently than families with typically developing or Down's syndrome children (Bolton *et al*., 1998; DeLong & Dwyer, 1988; Murphy *et al*., 2000). This indicates that mood disorders may be one aspect of a broader phenotype of autism, too.

Another characteristic typical of autism that we examined is related to cognitive ability. Research has indicated that compared with general populations, people with autism show different patterns in some cognitive tasks, such as those that reflect theory of mind [the ability to attribute mental conditions to self and others (Premack & Woodruff, 1978)], executive functions, and central coherence. As for theory of mind, Baron-Cohen, Leslie, and Frith (1985) and Baron-Cohen (1989) showed that children with autism performed poorly on false belief tasks compared with children with other developmental disorders, suggesting that children with autism are limited in developing a theory of mind ability. In recent years, new theory of mind tasks have been developed, such as the "Eyes Test" (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001a) and the "Faux Pas Test" (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999). The Eyes Test requires the ability to attribute a mental condition to pictures of another's eye region, while the Faux Pas Test involves the ability to point out an inappropriate comment caused by a false belief in conversation. In both tests, children with high-functioning autism and Asperger's syndrome scored lower than typically developing children. Moreover, Baron-Cohen and Hammer (1997b) demonstrated that the performance in the Eyes Test of parents of children with autism was poorer than that of parents of children without autism, a finding that suggests that individual differences in the theory of mind ability might somehow reflect the autism spectrum.

Executive functions, such as planning, flexibility, inhibition, or working memory, have also been linked to autism (Ozonoff, Pennington, & Rogers, 1991). In particular, the Wisconsin Card Sorting Test (WCST; Heaton, Chelune, Talley, Key, & Curtiss, 1993) has generally been used to measure flexibility, and it is well established that individuals with autism tend to make more mistakes on the WCST than typically developing individuals or those with other developmental disorders (Liss *et al*., 2001; Ozonoff *et al*., 1991). Furthermore, a family study of autism showed that even the family members of children with autism were not as good at executive functions as those of typically developing or learning disordered children (Hughes, Leboyer, & Bouvard, 1997). However, executive function deficits are not specific to autism, so the nature of the relationship between autism and executive functions remains unclear.

Research on central coherence suggests that autism-specific cognitive tendencies, such as faster, more exact answers on the Embedded Figures Test

(EFT) (Jolliffe & Baron-Cohen, 1997; Ropar & Mitchell, 2001; Shah & Frith, 1983) or faster responses on the block design test of the WAIS (Shah & Frith, 1993), are related to the cognitive style of dealing with figures not as a whole, but as local components (Frith & Happè, 1994). This hypothesis is called weak central coherence in autism, and is often thought to explain other autistic characteristics, such as restricted interests. Baron-Cohen and Hammer (1997b) and Happè, Briskman, and Frith (2001) affirmed the dominance of families having children with autism in the EFT and block design test, supporting a relationship between the broader phenotype of autism and the central coherence hypothesis.

This study investigated the relationship between the AQ (i.e., 'autistic' traits) and other traits mentioned above, such as personality and cognitive ability, which usually coincide with autism symptoms. We used the Japanese version of the AQ (Wakabayashi, Tojo, Baron-Cohen, & Wheelwright, submitted), and targeted healthy university students.

In regards to personality traits, we examined the correlation between the AQ, the Temperament and Character Inventory (TCI) and the depression and anxiety scale. TCI measures temperaments that are assumed to be related to personality disorders, such as obsessional or schizoid personality disorders (Cloninger, 1987), so we predicted that AQ scores would correlate with such personality patterns. As for mood disorders, too, we predicted that high AQ scores would exhibit greater tendencies towards depression or anxiety. We also surveyed experience of bullying, and predicted more frequent experience of being bullied in high AQ scorers. To examine cognitive abilities, we used the Eyes Task to measure the theory of mind ability, the WCST to measure executive functioning, and the EFT to measure central coherence. We predicted that high AQ scorers would show a more autistic answering pattern, that is, low scores on the theory of mind task, many mistakes on the WCST, and high scores for the EFT.

METHOD

Questionnaires

Participants

The participants were 1513 adult students at six universities in Tokyo and its environs (743 men, 762 women, and eight unknown). Their mean age was 19.34 years (SD = 2.51; range: 16–54). We obtained informed consent before asking them to complete the questionnaires, which are described in detail below. Among them, 1364 participants, who completed the whole questionnaires, were asked to participate in the subsequent investigation.

Instruments

Japanese Version of the Autism-Spectrum Quotient (AQ; Wakabayashi et al., submitted): This is the Japanese version of the AQ, which was first developed by Baron-Cohen *et al.* (2001b), and includes 50 questions, 10 items each in the subcategories Social Skill, Attention Switching, Attention to Detail, Communication, and Imagination. Each response has four options, and is scored using 0 or 1 according to Baron-Cohen *et al.* (2001b). Higher scores indicate higher 'autistic' traits.

Japanese Version of the Temperament and Character Inventory (TCI; Kijima et al., 1996): The TCI is a self-report test that evaluates four temperament and three character dimensions based on Cloninger's seven-factor model of temperament and character (Cloninger, 1987; Cloninger, Przybeck, & Svrakic, 1993), which was translated into Japanese (Kijima *et al.*, 1996). The entire TCI has 240 questions, but we used only 60 questions concerning four aspects of temperament that are included in a shortened version of the TCI. The four subcategories were Novelty Seeking (NS; 20 items), Harm Avoidance (HA; 20 items), Reward Dependence (RD; 15 items), and Persistence (P; 5 items). They were assumed to be related to certain major personality disorders, such as obsessional or schizoid personality disorders. Each item had four possible responses, with higher scores indicating a greater tendency for that temperament.

Japanese Version of the Self-Rating Depression Scale (SDS; Fukuda & Kobayashi, 1973): Zung (1969) developed a self-report questionnaire that measures states of depression (SDS). It consists of 20 questions, and the response options and scoring are the same as for the TCI. Higher scores indicate a greater tendency for depression.

Japanese Version of the State-Trait Anxiety Inventory (STAI; Shimizu & Imae, 1981): Spielberger and his colleagues divided anxiety into temporary "State Anxiety" and permanent "Trait Anxiety", and they developed a self-report questionnaire for both (STAI; Spielberger, Gorsuch, & Lushene, 1970). We used the Japanese version of the Trait Anxiety scales of the STAI, which consists of 20 questions. The response options and scoring are the same as for the TCI. Higher scores indicate a greater tendency for anxiety.

Questionnaire About Bullying Experiences (Tanno & Sakamoto, 1994): This questionnaire asks about experience of being bullied once, or bullying someone else once, related to nine kinds of bullying (shutting out someone, stealing someone's personal belongings, pushing too hard, speaking against someone behind one's back, behaving violently, putting someone on the shake, making threats, getting someone's kit off, and smashing someone to the head). While Tanno and Sakamoto (1994) asked only whether subjects had experienced being bullied or bullying once, we asked about and scored responses for frequency of bullying using four options. Higher scores indicated a higher frequency of experience of bullying.

Tests for Individuals

Participants

Of those 1364 participants who completed the questionnaires, 613 (351 men and 262 women) agreed to participate in the subsequent individual investigation. Their mean AQ score was 22.83 (SD = 6.13) for men, and 21.00 (SD = 6.29) for women, and their total AQ score did not differ significantly from the other participants of the questionnaires. Consequently, for the purposes of exploring the relationship among the AQ, gender and cognitive ability, we chose people of 25% percentile rank and below in AQ score (men who scored 18.50 and below and women who scored 16.75 and below), and people of 75% percentile and above in AQ score (men who scored 27.00 and above and women who scored 25.00 and above), then sent an e-mail to ascertain whether they wanted to continue to participate in the individual investigation. Finally 42 men (20 high scorers and 22 low scorers) and 54 women (29 high scorers and 25 low scorers) participated in the investigation. All the subsequent cognitive tests described in detail were given to each of these participants in random order[1].

Tests

Eyes Test (Baron-Cohen et al., 2001a).: This is the revised version of the Eyes Test first developed by Baron-Cohen *et al.* (1997). This test requires participants to guess what another person is thinking or feeling based on observations of the eye region only. We used the Japanese version (Wakabayashi, personal observation, October 15, 2002).

The test included three practice items and 32 test items, which were presented one at a time on a computer screen. The participants were asked to choose which of four words best described what the eye region showed. For each trial, the chosen word and reaction time were recorded. Although Baron-Cohen *et al.* (2001a) scored the number of correct answers, we considered the reaction time following Wakabayashi (personal observation, October 15, 2002). For each of the 32 trials, the average (M) and standard deviation (SD) of all the participants' reaction times were calculated. A score of 0 was given when the answer was incorrect. If the answer was correct, a score of 2 was given when the reaction time exceeded $M + SD$, a score of 3 was given when the reaction time was between $M-SD$ and $M + SD$, and a score of 4 was given when the reaction time was below $M–SD$.

Wisconsin Card Sorting Test (WCST; Heaton et al., 1993; Kashima & Kato, 1995): The WCST is generally used to measure the flexibility of executive functions (Liss *et al.*, 2001; Ozonoff *et al.*, 1991). The task involves categorizing cards following an unknown rule; how the individual categorizes the cards indicates his/her flexibility of thinking. We used the Keio

[1] The response rate in the subsequent individual investigation (= 613/1364 = about 45%) seems quite low. But probably it is because of cultural problem specific to Japan, because Japanese people are reportedly less willing to volunteer such an individual investigation (For example, Takuma, Amaha, Ando (2001) reported that the usual level of involvement in Japanese population was only 15%). So in the response rate in our study was actually higher than those of usual Japanese survey. Moreover, we couldn't get contact with all the candidates because some of them had changed their e-mail address or telephone number. This is also a reason why the number of participants in second investigation was so small.

version of the WCST (Kashima & Kato, 1995), which is slightly different from the original version (Heaton *et al*., 1993).

The test uses 48 cards, each of which is one of four colors, one of four figures, and one of four numbers. The participants are asked to categorize the cards using the colors, figures, or numbers. Participants' actions were reinforced using feedback as to whether they were correct, and they were asked to modify incorrect strategies. We recorded which category the participants chose, and whether it was correct. In scoring, the categories achieved (C), perseverative errors of Nelson (P), and difficulty in maintaining a set (D) were counted. C is defined as the number of sets of six continuous correct answers, which is an indicator of the ability to change concepts. P is the number of incorrect answers regardless of being incorrect just before, and indicates flexibility of thinking. D is the number of incorrect answers after 2–5 continuous correct answers, and indicates interruptions in maintaining a set caused by a memory or attention disorder. Autism studies often focus on P (Liss *et al*., 2001; Ozonoff *et al*., 1991).

Embedded Figures Test (EFT; Witkin, Oltman, Raskin, & Karp, 1971): This is a perceptual test of the ability to discriminate figures embedded in more complicated figures. It requires the ability to detect target figures in the context of a whole image, sometimes referred to as the "field-dependent-independent" ability. Witkin *et al*. (1971) suggested that men were better at this test than women.

This test involved 12 cards with complicated figures and eight cards with target figures. The participants were asked to detect the target figures embedded in the complicated figures as quickly as possible, and to trace the outline of the target. The reaction time for detecting the target figure was recorded. The maximum allowable time was 3 min. The mean reaction time was calculated.

RESULT

Results of the Questionnaire

Differences in Gender and Area of Study

Of all the 1513 participants', the data from the 1364 participants who completed the questionnaires, were included in the following analyses. Table I shows the mean total and subcategory AQ according to gender and area of study. Area of study consisted of two categories, Arts or Sciences, unlike Baron-Cohen *et al*. (2001b) and Wakabayashi (2003) who used Sciences, Humanities, and Social Sciences,

Table I. Mean and Standard Deviations of the Total AQ, TCI, SDS, STAI-Trait, and Experience of Being Bullied and Bullying

	Men		Women	
	Arts	Sciences	Arts	Sciences
n	257	407	568	123
AQ				
Social Skill[a]	4.37 (2.55)	4.56 (2.68)	3.93 (2.48)	4.33 (2.63)
Attention Switching[a]	5.87 (1.68)	6.00 (1.74)	5.55 (1.86)	5.81 (1.80)
Attention to Detail[b]	4.86 (2.17)	4.38 (2.14)	5.02 (2.08)	4.52 (2.00)
Communication[ab]	4.10 (2.25)	4.30 (2.08)	3.60 (2.07)	3.99 (2.10)
Imagination[ab]	3.70 (1.71)	4.05 (1.86)	3.21 (1.75)	3.34 (1.66)
Total AQ[a]	22.90 (6.18)	23.29 (6.17)	21.32 (6.03)	21.99 (6.11)
TCI				
Novelty Seeking	49.79 (7.06)	50.40 (7.26)	50.77 (7.77)	49.10 (7.40)
Harm Avoidance	55.98 (9.79)	56.62 (9.27)	57.08 (9.49)	56.46 (8.75)
Reward Dependence	39.60 (5.83)	40.08 (6.01)	42.93 (5.90)	42.00 (5.71)
Persistence	14.30 (2.75)	14.20 (2.74)	13.69 (2.45)	14.42 (2.71)
SDS (Depression)	40.69 (8.37)	41.02 (7.60)	43.19 (7.92)	40.26 (6.49)
STAI-trait (Anxiety)	46.30 (11.40)	47.19 (10.05)	49.03 (10.65)	46.17 (9.19)
Bullied Experience	10.97 (2.48)	10.87 (2.79)	10.75 (2.55)	10.05 (1.59)
Bullying Experience	11.37 (2.78)	11.06 (2.63)	10.26 (1.97)	10.04 (1.50)

[a]A significant main effect of gender ($p < .05$).
[b]A significant main effect of area of study ($p < .05$).

because the Arts and Sciences is the typical classification in Japan; Arts encompasses both the Humanities and the Social Sciences.

An analysis of variance (ANOVA) performed on the total AQ, including gender and area of study as independent variables, yielded a main effect of gender (F (1, 1354) = 13.60, $p < .01$), indicating that men scored significantly higher than women. There were no significant differences for area of study and no interactions. For the subcategories, ANOVAs revealed main effects of gender for Social Skill (F (1, 1354) = 4.23, $p < .05$), Attention Switching (F (1, 1354) = 4.85, $p < .05$), Communication (F (1, 1354) = 8.94, $p < .01$), and Imagination (F (1, 1354) = 28.36, $p < .01$). Men tended to score higher on all four measures. There were also main effects of area of study on Attention to Detail (F (1, 1354) = 13.57, $p < .01$), Communication (F (1, 1354) = 4.73, $p < .05$), and Imagination (F (1, 1354) = 4.70, $p < .05$), suggesting that students who majored in the Arts scored higher on Attention to Detail, and students who majored in the Sciences scored higher on Communication and Imagination. There were no statistically significant interactions. These results indicated that men tended to have higher AQ scores than women, and that for Communication and Imagination, students majoring in the Sciences tended to score higher than those majoring in the Arts. These findings are consistent with those of Baron-Cohen *et al.* (2001b) and Wakabayashi (2003), since the Arts correspond to the Humanities and Social Sciences in Baron-Cohen *et al.* (2001b) and Wakabayashi (2003).

Relationship between AQ and Other Personality Traits

Table II shows the correlations between the total AQ score and the subcategories of the Temperament and Character Inventory (TCI), Self-Rating Depression Scale (SDS), State-Trait Anxiety Inventory (STAI), and the frequency of experiences of being bullied or bullying. As for the TCI, the AQ was negatively correlated with Novelty Seeking (NS) and Reward Dependence (RD), and positively correlated with Harm Avoidance (HA) (NS: $r = -.27$; HA: $r = .56$; RD: $r = -.28$, all $p < .01$). There was no correlation between the AQ and Persistence (P) ($r = -.01$, ns.). The pattern low NS, high HA, and low RD, seen in our results, has been defined as an obsessional personality trait (Cloninger, 1987; Kijima *et al.*, 1996). Therefore, higher AQ scores show a higher tendency toward an obsessional personality within non-autistic university students. There was no correlation between the AQ and a schizoid personality tendency (i.e., NS, HA, and RD are all low). When divided by gender, the results for the correlations reveal similar patterns (men: NS: $r = -.29$, $p < .01$; HA: $r = .58$, $p < .01$; RD: $r = .28$, $p < .01$; P: $r = -.03$, ns.; women: NS: $r = -.25$, $p < .01$; HA: $r = .56$, $p < .01$; RD: $r = -.23$, $p < .01$; P: $r = -.16$, ns.), which indicate that gender has no effect on the pattern of correlation between the AQ and temperament.

Table II. Correlations between AQ and TCI, SDS, STAI-Trait, and Experience of Being Bullied and Bullying

Scales	Correlations with AQ
TCI: Novelty Seeking	−0.27*
Harm Avoidance	0.56*
Reward Dependence	−0.28*
Persistence	−0.01
SDS (Depression)	0.43*
STAI-trait (Anxiety)	0.49*
Bullied Experience	0.21*
Bullying Experience	0.08*

*$p < .01$.

As for the SDS, STAI-trait, and the experiences of being bullied or bullying, the AQ was positively correlated with all three (SDS: $r = .43$; STAI-trait: $r = .49$; frequency of once being bullied: $r = .21$; frequency of once bullying others: $r = .08$, all $p < .01$). In addition, because there was a strong positive correlation between the frequency of being bullied and that of bullying others ($r = .40$, $p < .01$), partial correlations with the AQ were calculated after controlling for each. The correlation between the AQ and the frequency of bullying others was not significant, although the correlation between the AQ and the frequency of being bullied remained significant (frequency of being bullied: $r = .20$, $p < .01$; frequency of bullying others: $r = -.11$, ns.).

Moreover, AQ, SDS, STAI-trait, and the frequency of being bullied all had strong, positive correlations with Harm Avoidance (HA) of the TCI; therefore, partial correlations between the AQ, SDS, STAI-trait, and the frequency of being bullied were calculated after controlling for the effect of HA. The AQ was positively correlated with all of these scales (SDS: $r = .16$; STAI-trait: $r = .17$; frequency of being bullied: $r = .16$, all $p < .01$), implying that the AQ is related to depression, anxiety, and the frequency of once being bullied, independent of the effect of temperament.

When groups divided by gender were analyzed, similar relationships were confirmed, except that for men the AQ and frequency of bullying others were not significantly correlated (men: SDS: $r = .46$, $p < .01$; STAI-trait: $r = .53$, $p < .01$; frequency of being bullied: $r = .17$, $p < .01$; frequency of bullying others: $r = -.001$, ns.; women: SDS: $r = .43$; STAI-trait: $r = .47$; frequency of being bullied: $r = .25$; frequency of bullying others: $r = .14$, all $p < .01$). Even when excluding HA, the AQ was significantly correlated with the SDS, STAI-trait, and frequency of being bullied (men: SDS: $r = .18$; STAI-trait: $r = .21$; frequency of being bullied: $r = .10$, all $p < .01$; women: SDS: $r = .19$; STAI-trait: $r = .16$; frequency of being bullied: $r = .20$, all $p < .01$), which implies that the AQ relates to the scales of mood disorders in a similar pattern, regardless of gender.

Structural Equation Model

Figure 1 depicts a model of the relations among the AQ and other personality traits. Based on the correlation analysis above, every factor for personality (the subcategories of the TCI, depression, anxiety, and experience of being bullied or bullying) is assumed to be associated with the AQ. Using structural equation modeling, we examined the validity of this model and assessed the contribution of the AQ to the other variables, especially, the causal relationship between the AQ and personality. Calculations were carried out using Amos 5.0. The goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), the Akaike Information Criterion fit index (AIC) were used to assess the fit of the model[2].

First, the model was directly implemented within the framework of SEM. Since there were gender differences for every scale, the model was analyzed with multiple groups of men and women. However there were no significant differences between men and women for any regression weights except that from the AQ to experience of bullying, so the analysis was implemented without the distinction of gender. Figure 2 depicts the final model with standardized path coefficients. The pathway of errors between NS and RD was eliminated because it was not allowed. In this model, the goodness of fit measures indicated that the proposed model fitted the data well: $\chi^2(13) = 137.57$, $p < .01$; GFI = 0.98; AGFI = 0.94; AIC = 183.57. As for the causal association between the AQ and the subcategories of the TCI (NS, HA, and RD), the model with the opposite pathway was also implemented, but the AIC of this model was not as small as that of the model ultimately adopted ($\chi^2(15) = 319.14$, $p < .01$; GFI = 0.95; AGFI = 0.88; AIC = 316.14), so this model was not adopted. This suggests the existence of a causal association between the AQ and personality traits. The standardized regression weights between the variables are shown in Table III. All were statistically significant.

To summarize, this model indicates that the AQ has some effects on all the measures of personality traits; further, it specifically indicates that HA, a subcategory of the TCI, and bullying experience are related to tendencies to depression and anxiety.

Results of the Tests for Cognition

Table IV shows the mean scores of the Eyes Test, WCST (C, P, and D), and EFT for the subjects according to gender and AQ (high or low). ANOVAs were performed on the test scores, with gender and AQ as independent variables. For the Eyes Test, there was a marginal two-way interaction between gender and AQ ($F(1, 94) = 3.69$, $p = .06$), but no main effects of gender or AQ. The absence of main effects is contrary to the findings of Baron-Cohen *et al.* (2001a). For the WCST, there was a marginal main effect of gender for C ($F(1, 94) = 3.60$, $p = .06$), indicating that men tended to achieve more sets of categories than women. Contrary to our predictions, however, there were no main effects of the AQ on C, P, or D. There were also no statistically significant two-way interactions. For the EFT, the ANOVA yielded a main effect of gender ($F(1, 94) = 7.39$, $p < .01$), with no significant main effect of the AQ and no significant two-way interaction. These findings suggest that men are faster in detecting the embedded figures than women, as Witkin *et al.* (1971) mentioned. Contrary to our predictions, however, we found no significant differences between high-AQ-scorers and low-AQ-scorers.

Table V shows the correlations among the tests (Eyes Test, WCST, and EFT). The Eyes Test was not correlated with either the WCST or the EFT. Both C and D of the WCST were significantly correlated with the EFT (C: $r = -.32$, $p < .01$; D: $r = .22$, $p < .05$).

[2] GFI (the Goodness of Fit Index) varies from 0 to 1. By convention, GFI should by equal to or greater than .90 to accept the model. AGFI (the Adjusted Goodness of Fit Index) takes into account the degrees of freedom available for testing the model. It also varies from 0 to 1, and should be at least .90. AIC (the Akaike information criterion) is used for comparing models to each other. Smaller value is good, but it does not judge the merit of a single model.

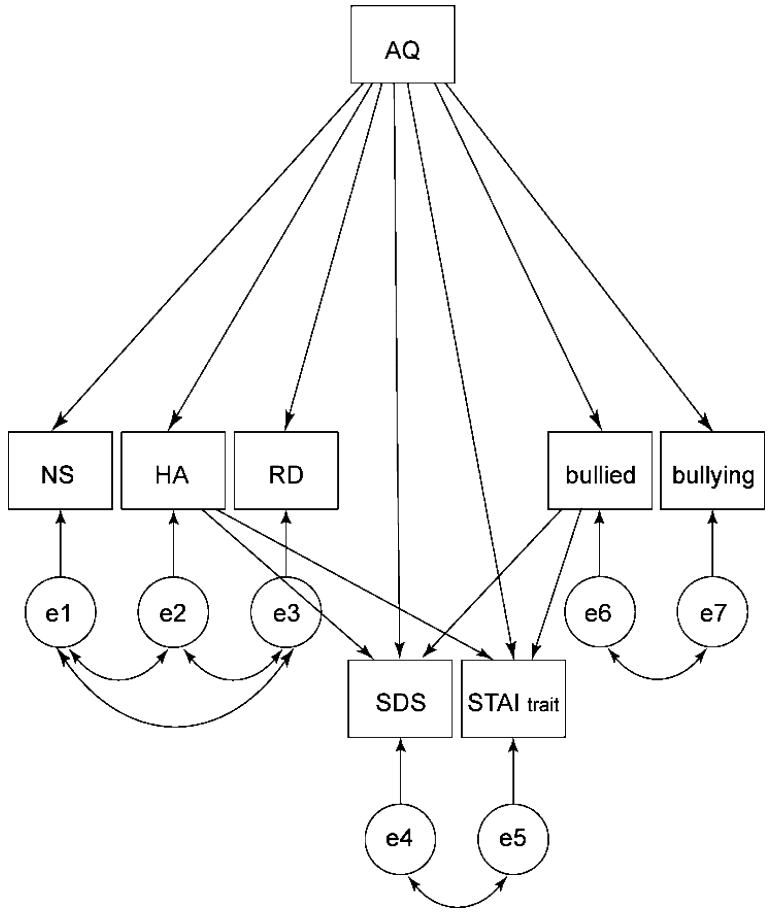

Fig. 1. The model for the relationships between the AQ, personality, and psychological adaptation based on correlation analysis. (AQ: total AQ; NS: Novelty Seeking; HA: Harm Avoidance; RD: Reward Dependence; SDS: Depression; STAI trait: Anxiety; Bullied: Experience of being bellied; Bullying: Experience of bullying others).

For the WCST, the correlations between C and P ($r = -.66$, $p < .01$) and C and D ($r = -.67$, $p < .01$) were statistically significant. These findings do not indicate a relationship between the theory-of-mind test and the executive function test, but suggest a relationship between the executive function test and the Embedded Figures Test.

DISCUSSION

This exploratory study of healthy university students investigated the relationship between the AQ and other traits that usually coincide with autistic symptoms, such as personality and cognitive abilities. Overall, men tended to score higher than women on the AQ, consistent with the findings of Baron-Cohen *et al.* (2001b) and Wakabayashi (2003). We suggest that this reflects the overrepresentation of autism and Asperger's syndrome in men (Happè & Frith, 1996; Wing, 1981), or the extreme male brain hypothesis of autism (Baron-Cohen & Hammer, 1997a; Baron-Cohen, 2002). Even within general populations, the degree of autism may be sexually dimorphic.

For personality, higher AQ scores were related to low NS, high HA, and low RD on the TCI, a pattern Cloninger (1987) and Kijima *et al.* (1996) defined as a tendency toward an obsessional personality. This is similar to the results of Soderstorm, Rastam, and Gillberg (2002), who administered the TCI to individuals with Asperger's syndrome. These results support the link between autism and obsessive-compulsive disorder reported by Gillott *et al.* (2001) and Wing

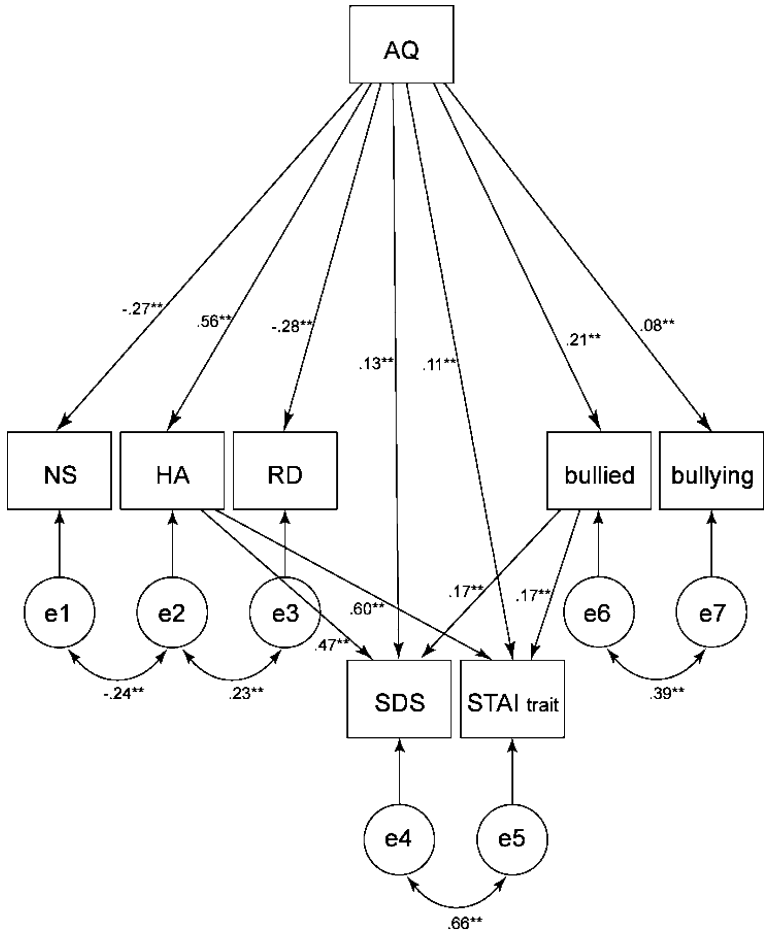

Fig. 2. The structural equation model that was finally adopted for the relationships among AQ, personality, and psychological adaptation. (AQ: total AQ; NS: Novelty Seeking; HA: Harm Avoidance; RD: Reward Dependence; SDS: Depression; STAI trait: Anxiety; Bullied: Experience of being bellied; Bullying: Experience of bullying others).

(1981). Interestingly, the schizoid personality tendency, which has also been observed in individuals with autism, was not related to the AQ. This is consistent with the report of Soderstorm *et al.* (2002), who found an association between Asperger's syndrome and the schizoid personality tendency on the TCI for a few individuals, and suggested that the AQ, or 'autistic' traits, was associated with the obsessional personality rather than the schizoid personality tendency. In our study, even when gender was included as a variable, the same patterns were observed, suggesting that there were no gender differences in the personality traits reflected by the AQ.

But it is important to note that in our study, participants were assessed only using questionnaires. The tendency toward an obsessional personality is usually described as a behavioral trait (DSM-IV; APA, 1994); consequently, it is difficult to assess it solely through a questionnaire, such as the AQ or TCI. Future research will require a behavioral viewpoint to clarify the extent to which the AQ actually reflects an obsessional personality.

As for another characteristic of individuals, we considered the relationship with depression, anxiety, and the experiences of bullying. We found that higher AQ scores were related to a greater tendency to depression and anxiety, as well as to more frequent experience of bullying. Even after eliminating the effect of HA of the TCI (which also had strong positive correlations with the AQ, SDS, STAI-trait, and frequency of being bullied), the AQ was still correlated positively with these scales. We suggest

Table III. Standardized Regression Weights between the Observed Variables by Gender

Scales	Standardized regression weights
NS—AQ	−0.27*
HA—AQ	0.56*
RD—AQ	−0.28*
SDS—AQ	0.13*
STAI-trait—AQ	0.12*
Bullied—AQ	0.21*
Bullying—AQ	0.08*
SDS—HA	0.47*
STAI-trait—HA	0.60*
SDS—Bullied	0.17*
STAI-trait—Bullied	0.17*

*$p < .01$.
Note. AQ: total AQ; NS: Novelty Seeking; HA: Harm Avoidance; RD: Reward Dependence; SDS: Depression; STAI trait: Anxiety; Bullied: Experience of being bellied; Bullying: Experience of bullying others.

that the relationships between the AQ and the psychological adaptation scales are partly independent of temperament (especially HA). Moreover, these results are consistent with clinical reports that people with autism are likely to develop depression or anxiety (Wing, 1981; Gillott *et al*., 2001), and that children with Asperger's syndrome are often bullied because of their poor communication skills. These results appear to support a continuum from autism to the general population, and even in the general population, a higher AQ or a higher degree of 'autistic' traits may prevent individuals from getting on well in their daily life. This points to the importance of considering the notion of an autism spectrum in clinical and educational fields.

When we analyzed these effects by gender, the correlation between the AQ and experience of bullying was slightly different; that is, for women, the AQ was positively correlated with both the frequency of being bullied and the frequency of bullying others, while for men the AQ was positively correlated only with the frequency of being bullied. This implies a gender difference in the relationship between the AQ and experience of bullying.

Structural equation models implemented based on the correlations among AQ and the personality traits suggested that highly 'autistic' traits have a causal effect on a specific personality (i.e., a tendency toward an obsessional personality, a greater tendency to depression and anxiety, and maladaptation in school life), even in general populations. This is supported by clinical findings of similar relationships between autism and other specific problems. In addition, the model confirmed the relationships among the personality traits, particularly the pathway from HA and experience of being bullied to depression and anxiety. We suggest that the depression and anxiety observed in general populations is partly caused by temperament or experience of being bullied. But it is possible that the obsessional personality might also contribute to depression and anxiety (Masi *et al*., 2004), possibility which requires further investigation.

As a whole, the results in our study, too, indicate that the AQ may reflect 'autistic' traits within general populations, as advocated by Baron-Cohen *et al*. (2001b) and Wakabayashi *et al*. (submitted). Our findings also confirm that students majoring in the Sciences scored higher than those majoring in the Arts on the Communication and Imagination subcategories of the AQ, suggesting an analogue study be used to examine the autism spectrum in the future.

Nevertheless, as Baron-Cohen *et al*. (2001b) mentioned, a diagnosis of autism or Asperger's syndrome cannot be based solely on a high AQ

Table IV. Mean Total and Standard Deviations of the Scores for the Eyes Test, WCST, and EFT

	Men		Women	
	Low AQ	High AQ	Low AQ	High AQ
N	22	20	25	28
Eyes Test	41.59 (8.62)	39.35 (8.49)	39.20 (8.05)	43.52 (8.09)
WCST: C	5.27 (1.16)	5.25 (1.37)	4.36 (2.02)	4.82 (1.96)
P	1.64 (2.92)	1.05 (1.88)	2.40 (3.49)	4.50 (10.40)
D	0.55 (0.86)	0.65 (1.18)	1.36 (2.53)	0.50 (0.92)
EFT[a]	19.45 (10.27)	21.30 (16.90)	29.89 (15.89)	27.45 (15.20)

[a]A significant main effect of gender ($p < .05$).
Note. WCST: Wisconsin Card Sorting Test; C: categories achieved; P: perseverative errors of Nelson; D: difficulty in maintaining a set; EFT: Embedded Figures Test.

Table V. Correlations between Eyes Test, WCST, and EFT

Scales	Eyes Test	WCST: C	P	D	EFT
Eyes Test					
WCST: C	–				
P	–	−0.66**			
D	–	−0.67**	–		
EFT	–	−0.32**	–	0.22*	

**$p < .01$, *$p < .05$.
Note. WCST: Wisconsin Card Sorting Test; C: categories achieved; P: perseverative errors of Nelson; D: difficulty in maintaining a set; EFT: Embedded Figures Test.

score. It is possible that the individuals with high AQ scores in our study would meet the diagnostic criteria of the DSM or ICD for Asperger's syndrome, although it was impossible for us to know that without a clinical diagnosis. Such a diagnosis should be made only when an individual is suffering from serious maladaptation in daily life because of highly 'autistic' traits.

On the other hand, although we expected that the 'autistic' traits measured with the AQ would also be related to cognitive ability, there were no relationships between the AQ and the tasks reflecting the theory of mind ability, executive functioning, or central coherence. These results are inconsistent with the autism spectrum hypothesis; however, they confirmed the relationship between the AQ and personality or psychological adaptation. Although this suggests that there is no relationship between 'autistic' traits and cognitive functioning, individuals with autism do show specific cognitive patterns, leading to the view that the autism spectrum may include cognitive aspects. One possible explanation for our results is that the autism spectrum approach cannot embrace general populations. However, our findings confirm a link between personality and psychological adaptation and the autism-specific condition for a general population, suggesting the potential for a relationship between 'autistic' traits and cognitive functions. It is possible that the AQ is not a reliable measure reflecting cognitive functions. Alternatively, the tasks that we used to measure cognitive functions might not be sensitive enough to reveal individual cognitive differences within a general population. In our study, there might have been little variability in the cognitive abilities across participants, so the chosen tasks may not have been sensitive enough to reflect these individual differences.

But our results did show a gender difference, as we predicted, for the EFT, suggesting superior performance for men. This result confirms Witkin *et al.* (1971) and suggests that men have weaker central coherence than women. However, there were no other main effects of gender for other tasks, contrary to our prediction. We did find positive correlations between the WCST, especially C and P, and the EFT. This suggests that executive functions are somehow associated with central coherence independently of the AQ. Nevertheless, because we did not control for IQ, it is possible that IQ affected the effects for these two tasks. But in our study all participants were university students, so it is thought that the variance of IQ in our study might not fully represent those of general populations. Further investigation is necessary to examine the relationship between these cognitive tasks and IQ, even from a clinical viewpoint that includes individuals with autism.

In consequent, the correlations among AQ and the personality traits do support the 'autism spectrum' hypothesis within a general population. They also suggest that analogue studies of 'autistic' traits are useful; that is, the AQ might enable us to discuss the subtle psychological problems that are sometimes observed in general populations, as well as in people with autism. Importantly, the questionnaire method is appropriate for quantifying objectively that which is difficult to measure directly, and as such, the AQ can quantify the degree of such psychological conditions. In the future, an analogue study using the AQ might become important for investigations of social interactions or the psychological problems associated with 'autistic' traits. To ascertain whether cognitive abilities, such as theory of mind, executive functions, and central coherence, are related to the AQ, additional research with more sensitive tasks may be necessary to expose individual differences in cognitive abilities.

In general, our study suggests the potential value of the AQ for analogue studies of autism. In the future, the knowledge produced in such studies might contribute to our fundamental understanding of autism or the autism spectrum. This would make it possible to discuss autism not only from a clinical viewpoint, but also based on educational applications. However, we cannot generalize our current findings since this study only included university students. So, further broad-scale investigations including the family members of children with autism or the people with other developmental disorders, such as ADHD, are needed in the future. The investigation for the people of various IQ levels is also needed to our further understanding about 'autistic' traits.

ACKNOWLEDGEMENTS

We thank all the participants for their kind cooperation. We also thank Nobuhiko Kijima for allowing us to use the Japanese version of the TCI, Simon Baron-Cohen for helpful comments on an earlier version of our paper, and Mariko Hasegawa, Toshiaki Tanaka, Harumi Eguchi, Hitomi Shimazaki, Yuki Takeuchi, and Yoshimi Hosaka for their help with data acquisition.

REFERENCES

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders, (4th ed.)* (DSM-IV). Washington, DC: APA.

Asperger, H. (1944). Die "Autistischen Psychopathen" im Kindesalter. *Archiv fur Psychiatrie und Nervenkrankheiten*, *117*, 76–136.

Bailey, A., Palferman, S., Heavey, L., & Le Couteur, A. (1998). Autism: The phenotype in relatives. *Journal of Autism and Developmental Disorders*, *28*, 369–340.

Baron-Cohen, S. (1989). The autistic child's theory of mind: A case of specific developmental delay. *Journal of Child Psychology and Psychiatry*, *30*, 285–297.

Baron-Cohen, S. (1995). *Mindblindness: An Essay on Autism and Theory of Mind*. Cambridge, MA: MIT Press/Bradford Books.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Sciences*, *6*, 248–254.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind?" *Cognition*, *21*, 37–46.

Baron-Cohen, S., & Hammer, J. (1997a). Is autism an extreme form of the male brain? *Advances in Infancy Research*, *11*, 193–217.

Baron-Cohen, S., & Hammer, J. (1997b). Parents of children with Asperger syndrome: What is the cognitive phenotype? *Journal of Cognitive Neurosciences*, *9*, 548–554.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high-functioning adults with autism or asperger syndrome. *Journal of Child Psychology and Psychiatry*, *38*, 813–822.

Baron-Cohen, S., O'Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children and children with asperger syndrome or high-functioning autism. *Journal of Autism and Developmental Disorders*, *29*, 407–418.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001a). The "reading the mind in the eyes" test revised version: A study with normal adults, and adults with asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, *42*, 241–251.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001b). The autism-spectrum quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of autism and Developmental Disorders*, *31*, 5–17.

Bejerot, S., Nylander, L., & Lindstom, E. (2001). Autistic traits in obsessive–compulsive disorder. *Nordic Journal of Psychiatry*, *55*, 169–176.

Bolton, P. F., Pickles, A., Murphy, M., & Rutter, M. (1998). Autism, affective and other psychiatric disorders: Patterns of familial aggregation. *Psychological Medicine*, *28*, 385–395.

Briskman, J., Happè, F., & Frith, U. (2001). Exploring the cognitive phenotype of autism: Weak "central coherence" in parents and siblings of children with autism: II. Real-life skills and preferences. *Journal of Child Psychology and Psychiatry*, *42*, 309–316.

Cloninger, C. R. (1987). A Systematic method for clinical description and classification of personality variants. *Archives of General Psychology*, *44*, 573–588.

Cloninger, C. R., Przybeck, T. R., & Svrakic, D. M. (1993). A psychological model of temperament and character. *Archives of General Psychology*, *50*, 975–990.

Cohen, D., & Volkmar, F. R. (Eds.) (1997). *Handbook of autism and pervasive developmental disorders* (2nd ed.). New York: John Wiley & Sons, Inc.

DeLong, G. R., & Dwyer, J. T. (1988). Correlation of family history with specific autistic subgroups: Asperger's syndrome and bipolat affective disease. *Journal of Autism and Developmental Disorders*, *18*, 593–600.

Frith, U., & Happè, F. (1994). Autism: Beyond "theory of mind". *Cognition*, *50*, 115–132.

Fukuda, K., & Kobayashi, S. (1973). A study on a Self-Rating Depression Scale. *Psychiatria et Neurologia Japonica*, *75*, 673–679.

Gillott, A., Furniss, F., & Walter, A. (2001). Anxiety and high-functioning children with autism. *Autism*, *5*, 277–286.

Happè, F., & Frith, U. (1996). The neuropsychology of autism. *Brain*, *119*, 1377–1400.

Happè, F., Briskman, J., & Frith, U. (2001). Exploring the cognitive phenotype of autism: Weak "central coherence" in parents and siblings of children with autism: I. Experimental tests. *Journal of Child Psychology and Psychiatry*, *42*, 299–307.

Heaton, R. K., Chelune, G. J., Talley, J. L., Key, G. G., & Curtiss, G. (1993). *Wisconsin Card Sorting Test Manual – Revised and Expanded*. Odessa, Florida: Psychological Assessment Resources, Inc.

Hughes, C., Leboyer, M., & Bouvard, M. (1997). Executive function in parents of children with autism. *Psychological Medicine*, *27*, 209–220.

Jolliffe, T., & Baron-Cohen, S. (1997). Are people with autism and Asperger syndrome faster than normal on the embedded figures test? *Journal of Child Psychology and Psychiatry*, *38*, 527–534.

Kanner, L. (1943). 'Autistic disturbances of affective contact'. *Nervous Child*, *2*, 217–250.

Kashima, H., & Kato, G. (1995). Wisconsin Card Sorting Test (Keio Version) (KWCST). *Brain science and mental disorders*, *6*, 209–216.

Kijima, N., Saito, R., Takeuchi, M., Yoshino, S., Ono, Y., Kato, G., & Kitamura, T. (1996). Cloninger's seven-factor model of temperament and character and Japanese version of Temperament and Character Inventory (TCI). *Archives of psychiatric diagnostics and clinical evaluation*, *7*, 379–399.

Liss, M., Fein, D., Allen, D., Dunn, M., Feinstein, C., Morris, R., Waterhouse, L., & Rapin, I. (2001). Executive functioning in high-functioning children with autism. *Journal of Child Psychology and Psychiatry*, *42*, 261–270.

Masi, G., Perugi, G., Toni, C., Millepiedi, S., Mucci, M., Bertini, N., & Akiskal, H. S. (2004). Obsessive–compulsive bipolar comorbidity: focus on children and adolescents. *Journal of Affective Disorders*, *78*, 175–183.

McDougle, C. J., Kresch, L. E., Goodman, W. K., Naylor, S. T., Volkmar, F. R., Cohen, D. J., & Price, L. H. (1995). A case-controlled study of repetitive thoughts and behavior in adults with autistic disorder and obsessive–compulsive disorder. *American Journal of Psychiatry*, *152*, 772–777.

Murphy, M., Bolton, P. F., Pickles, A., Fombonne, E., Piven, J., & Rutter, M. (2000). Personality traits of the relatives of autistic probands. *Psychological Medicine*, *30*, 1411–1424.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals:

Relationship to theory of mind. *Journal of Child Psychology and Psychiatry*, *32*, 1081–1105.

Piven, J., Palmer, P., Jacobi, D., Childress, D., & Arndt, S. (1997). Broader autism phenotype: Evidence from a family history study of multiple-incidence autism families. *American Journal of Psychiatry*, *154*, 185–190.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a "theory of mind"? *Behaviour and Brain Sciences*, *4*, 515–526.

Ropar, D., & Mitchell, P. (2001). Susceptibility to illusions and performances on visuospatial tasks in individuals with autism. *Journal of Child Psychology and Psychiatry*, *42*, 539–549.

Shah, A., & Frith, U. (1983). An islet of ability in autistic children: A research note. *Journal of Child Psychology and Psychiatry*, *24*, 613–620.

Shah, A., & Frith, U. (1993). Why do autistic individuals show superior performance on the block design task? *Journal of Child Psychology and Psychiatry*, *34*, 1351–1364.

Shimizu, H., & Imae, K. (1981). Japanese version of STATE-TRAIT ANXIETY INVENTORY. *The Japanese Journal of Educational Psychology*, *29*, 348–353.

Soderstorm, H., Rastam, M., & Gillberg, C. (2002). Temperament and character in adults with Asperger syndrome. *Autism*, *6*, 287–297.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *Manual for the State-Trait Anxiety Inventory (Self-Evaluation Questionnaire)*. Palo Alto, California: Consulting Psychologists Press.

Takuma, T., Amaha, S., & Ando, J. (2001). *Futago no kenkyu* [*Twin research*.]. Tokyo, Japan: Brain Shuppan.

Tanno, Y., & Sakamoto, S. (1994). Research about the bulled and bullying experiences within university students. Unpublished document.

Vredenburg, K., Flett, G. L., & Krames, L. (1993). Analogue versus clinical depression: A critical reappraisal. *Psychological Bulletin*, *113*, 327–344.

Volkmar, F. (1999). Can you explain the difference between autism and Asperger syndrome? My 6-year-old son has had both diagnoses and I wonder if it makes any difference at all in terms of his intervention program. *Journal of Autism and Developmental Disorders*, *29*, 185–186.

Wakabayashi, A. (2003). Validity of Autism-Spectrum Hypothesis in normal adults: Evidence from the relation between types of Sciences and AQ scores in university students. *The Japanese Journal of Autistic Spectrum*, *2*, 11–20.

Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., & Tojo, Y. (submitted). The Autism-Spectrum Quotient (AQ) in Japan: A cross-cultural comparison.

Wing, L. (1981). Asperger syndrome: A clinical account. *Psychological Medicine*, *11*, 115–130.

Wing, L., & Potter, D. (2002). The epidemiology of autism spectrum disorders: is the prevalence rising? *Mental Retardation and Developmental Disabilities Research Reviews*, *8*, 151–161.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). *A manual for embedded figures test*. Consulting Psychologists Press, Inc: Palo Alto, CA.

World Health Organization (1994). *International classification of diseases* (10th ed.). Geneva, Switzerland: Author.

Zung, W. W. K. (1969). A self-rating depression scale. *Archives of General Psychiatry*, *12*, 63–70.