Table 5. Comparison between two ASD subgroups by demographic characteristics, medical conditions past history, and current family support (N = 154)

	Psychological health domain QoL			Social relationships domain QoL		
	Mean score		*t*	Mean score		*t*
Demographic characteristics						
Gender (male/female)	2.83	2.56	2.35*	2.73	2.60	2.68**
Age (18–24/25+)	2.76	2.79	0.34	2.80	2.64	0.77
Residential status (living with family/independent living)	2.78	2.73	0.49	2.74	2.27	1.73
Marital status (unmarried/married or partnered)	2.78	2.74	0.37	2.72	2.46	1.37
Education (≤ high school/further higher education)	2.69	2.90	−1.51	2.64	2.80	−1.14
Employment (unemployed/employed)	2.76	2.85	−0.48	2.69	2.80	−0.40
Medical conditions						
Comorbid psychiatric conditions (absent/present)	2.91	2.58	2.76**	2.85	2.43	3.14**
Comorbid physical conditions (absent/present)	2.76	2.89	−0.38	2.71	2.60	0.42
Self-injurious behaviors (absent/present)	2.81	2.50	1.68	2.74	2.52	1.30
Aggressive behaviors (absent/present)	2.85	2.44	2.58*	2.80	2.36	2.38*
Past history						
Sentence level at 6 years (word or two-word phrases/ sentence with more than three words)	3.05	2.71	2.32*	2.93	2.65	1.64
Early diagnoses before 4 years (not diagnosed/diagnosed)	2.71	3.04	−2.02*	2.69	2.86	−1.18
Service utilization (no use at any time/continuous use through all life stages)	2.77	3.04	−1.63	2.71	2.73	−0.13
Current family support						
Father (not helpful/helpful)	2.73	2.81	−0.73	2.66	2.85	−1.25
Mother (not helpful/helpful)	2.14	2.84	−4.01***	1.91	2.84	−4.50***
Sibling (not helpful/helpful)	2.71	2.72	0.00	2.61	2.83	−0.92

**$p<.05$, **$p<.01$, ***$p<.001$.

Table 6. Summary of a stepwise multiple regression analysis investigating the predictive variables of demographic characteristics, medical conditions, past history, and current family support on QoL 'psychological health' domain scores of the ASD participants (N = 154)

Variables entered	Standardized coefficients (β)	*t*	*p*-value
Early diagnosis before 4 years	0.22	2.22	.05
Mother's support being helpful	0.32	3.24	.01

Adjusted $R^2=0.16$. Excluded variables by a stepwise procedure were gender, age, residential status, marital status, education, employment, comorbid psychiatric conditions, aggressive behaviors, speech level at 6 years.

from comorbid psychiatric conditions ($p < .01$ for both psychological and social domains), behaving aggressively ($p < .01$ for psychological domain, $p < .05$ for social domain), and having spoken sentences at 6 years of age ($p < .05$ for psychological domain).

The results of multiple regression analysis are summarized in Tables 6 and 7. Mother's support being helpful emerged as significantly predictive of higher QoL for both the psychological and social domains ($\beta = 0.32$, $p < .01$; $\beta = 0.32$, $p < .001$, respectively). In addition, having received early diagnosis before 4 years of age was also significantly associated with higher psychological

Table 7. Summary of a stepwise multiple regression analysis investigating the predictive variables of demographic characteristics, medical conditions, past history, and current family support on QOL 'social relationships' domain scores of the ASD participants (N = 154)

Variables entered	Standardized coefficients (β)	*t*	*p*-value
Aggressive behaviors: absent	0.18	2.15	.05
Mother's support being helpful	0.32	3.69	.001

Adjusted R^2=0.14. Excluded variables by a stepwise procedure were gender, age, residential status, marital status, education, employment, comorbid psychiatric conditions.

QoL ($\beta = 0.22$, $p < .05$), and not having aggressive behaviors was significantly associated with higher social QoL ($\beta = 0.18$, $p < .05$).

Discussion

The present study investigated long-term outcomes for adults with HFASD living in the community in Japan, focusing on subjective aspects such as QoL, and also identified past and current environmental factors that had (pseudo) predictive value. Our major findings are the following.

First, as expected, the self-reported QoL in the psychosocial domain of our sample with HFASD over 18 years of age was found to be significantly lower than the gender- and age-matched healthy Japanese population. The QoL was not found to be related to parent-reported performance level, age, or conventionally used outcome indicators such as residential, marital, educational, and employment status. Although these conventional indicators are certainly important to consider as long-term outcomes, psychosocial QoL in our adults with HFASD appeared not to be related to them. Thus, our findings suggest that the QoL reported by adults with HFASD might be measuring an additional independent aspect that should be considered in judging long-term outcomes in populations with HFASD, which is in line with Renty and Roeyers (2006) and Ruble and Dalrymple (1996).

Second, receiving diagnosis before 4 years of age and mother's support that met current needs were determined to be factors associated with better psychological QoL for adults with HFASD. This finding supports our prediction and is partially consistent with Renty and Roeyers (2006) in that support variables had significant impact on long-term outcomes in HFASD. In Renty and Roeyers (2006), perceived informal support indicative of availability, but not received formal or informal support indicative of actual transfer of advice, aid, and affect, was found to have predictive value; both support characteristics were measured using validated scales. On the other hand, family support characteristics in the current study were not measured using such standard scales, and were instead judged by the facility staff who knew the person well and therefore knew to what degree the family support was actually helpful to the person. This is different from subjectively perceived availability or objectively measured actual transfer of family support. The question was intended to ask how family support met the participant's actual needs from an objective viewpoint. However, validation of this is required.

To our knowledge, the present study is the first to associate early diagnosis with better psychological QoL in adults with HFASD. Only 29 cases out of our sample (18.8%) were diagnosed before 4 years of age, and 22 cases among them used some services during childhood. On the other hand, parental concerns about development were reported for a majority of the sample (66.9%). Why parental concerns did not lead to early diagnosis may be explained by a lack of healthcare or educational professionals with accurate knowledge and wide experience with HFASD at that time in Japan. Moreover, socioeconomic status (SES) could be associated with age of diagnosis: according to birth cohort data from individuals with autism born in California between 1992 and 2001, children

of high SES parents were diagnosed earlier (Fountain et al., 2011). The role of SES in our Japanese participants with HFASD is unknown and this remains a topic for future study.

The finding that mother's support was the best predictor of psychosocial QoL of individuals with HFASD has to be interpreted with caution, because it suggests a bidirectional but not causal association. However, the obvious significance of mother's support but not father's in our study may be related to the Japanese socio-cultural environment in relation to child rearing. For example, Japanese mothers have traditionally been viewed as overprotective and overindulgent toward their children (Doi, 1973). Although it is not clear how such a cultural bias in childrearing practices influences familial attitudes toward a child with HFASD, future intervention must target parenting behavior and assist mothers with formal and informal social support after an early diagnosis of ASD.

Third, our results suggest that adults with aggressive behaviors might experience lower psychosocial QoL. This could be attributable to satisfactory social relationships being disrupted by violent behavior toward others or anger being reflected on others or self, although the causal relationship is not clear.

Study limitations. There are several methodological limitations in the present study. First, our sample (N = 154) who returned a complete set of self-, parent-, and facility staff-report questionnaires were not representative of all persons with HFASD, although the male:female ratio was 4:1, which is similar to the epidemiological data in Japan (Honda et al., 2005). In regard to the 48 individuals not included in the analyses because of incomplete data, although they were older and more educated than our sample of 154, we confirmed, based on the information that was available, that they did not differ from our sample in psychological and social QoL scores. Moreover, being male, absence of comorbid psychiatric conditions, and mother's support being helpful were significantly associated with higher QoLs, as in our sample. However, whether early diagnosis before 4 years or having aggressive behaviors was similarly predictive of QoL in the 48 individuals not included could not be confirmed. Second, diagnostic status and IQ level of our sample was based on reports by parents and facility staff and was not confirmed using standard procedures. Third, we chose to focus on the domains of 'social relationships' and 'psychological health' because we considered that they best reflected psychosocial QoL, although the 'physical health' and 'environment' domains also reflect psychosocial functioning in everyday life to some degree. We based this decision on the findings of previous studies. Health-related QoL studies on ASD found that individuals with ASD scored lower in most domains than healthy populations (Jennes-Coussens et al., 2006; Kamp-Becker et al., 2010; Kuhlthau et al., 2010), but children with ASD had significantly lower scores for psychosocial health but not physical health than other clinical populations with chronic conditions (Kuhlthau et al., 2010), and adolescents and young adults with HFASD had higher scores than patients with schizophrenia-spectrum disorders except for the 'social relationship' domain (Kamp-Becker et al., 2010). Future research should aim to clarify the relationships between the various QoL domains in ASD. Fourth, past history was retrospectively obtained only from parents and was not based on a review of the clinical records, so there is a chance that the history has been influenced by parents' recall or memory bias.

Clinical implications. Despite these methodological limitations, this study points to some important clinical issues. First, clinicians can help children maximize their chances for high long-term QoL by changing environmental factors and treating comorbid psychiatric conditions related to aggressive behaviors, both of which may affect psychosocial well-being and QoL, even if the autistic core symptoms are largely not changeable. Bastiaansen et al. (2005) demonstrated that the QoL of a subgroup of child psychiatric patients improved although the level of psychopathology remained high during a 1-year follow-up period. Therefore, improving QoL should be included as one of the goals in treating individuals with HFASD.

Second, the present study provides evidence for the long-term significance of early detection and intervention for children with HFASD. Although there has been controversy about the positive and negative effects of early diagnosis for parents (Johnson et al., 2007), it may be important for clinicians to convey to parents – and empower them – that prognosis is not deterministic and may be changed by appropriate treatment and family support (Tantam, 2000).

Conclusions

This study demonstrated that self-reported QoL by adults with HFASD can be an important subjective aspect of long-term outcomes. Environmental factors, such as mother's support being helpful and early diagnosis, were associated with better QoL, and aggressive behaviors were associated with poorer QoL in adulthood, whereas expressive language level in preschool years, a conventional outcome indicator, did not predict QoL levels. To improve long-term QoL, professionals need to detect autistic symptoms in the early years, evaluate the needs of the child and family, provide consistent support, and comprehensively monitor all aspects of mental health. Future outcome studies should be conducted prospectively to determine predictive factors at each developmental stage and at the same time try to determine the mediators and moderators that modify the developmental trajectories for children with ASD.

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Quantitative autistic traits ascertained in a national survey of 22 529 Japanese schoolchildren

Kamio Y, Inada N, Moriwaki A, Kuroda M, Koyama T, Tsujii H, Kawakubo Y, Kuwabara H, Tsuchiya KJ, Uno Y, Constantino JN. Quantitative autistic traits ascertained in a national survey of 22 529 Japanese schoolchildren.

Objective: Recent epidemiologic studies worldwide have documented a rise in prevalence rates for autism spectrum disorders (ASD). Broadening of diagnostic criteria for ASD may be a major contributor to the rise in prevalence, particularly if superimposed on an underlying continuous distribution of autistic traits. This study sought to determine the nature of the population distribution of autistic traits using a quantitative trait measure in a large national population sample of children.
Method: The Japanese version of the Social Responsiveness Scale (SRS) was completed by parents on a nationally representative sample of 22 529 children, age 6–15.
Results: Social Responsiveness Scale scores exhibited a skewed normal distribution in the Japanese population with a single-factor structure and no significant relation to IQ within the normal intellectual range. There was no evidence of a natural 'cutoff' that would differentiate populations of categorically affected children from unaffected children.
Conclusion: This study provides evidence of the continuous nature of autistic symptoms measured by the SRS, a validated quantitative trait measure. The findings reveal how paradigms for diagnosis that rest on arbitrarily imposed categorical cutoffs can result in substantial variation in prevalence estimation, especially when measurements used for case assignment are not standardized for a given population.

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Key words: autism; questionnaire; prevalence; classification; diagnosis

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Significant outcomes

- In a large Japanese child population, behaviorally measured autistic traits are continuously distributed without any apparent deflection in the distribution plot that would signal a natural cutoff for categorical diagnoses. This is similar to the distribution pattern in US and European samples.
- Autistic traits measured quantitatively by parents differ slightly by culture, suggesting the need to interpret autism spectrum disorder (ASD) severity ratings with the use of culturally calibrated norms.
- Many children who do not meet the diagnosis of ASD exhibit elevations in autistic traits measured quantitatively, suggesting the need to reconsider current diagnostic systems that assume discontinuity between affected and unaffected populations.

Limitations

- The response rate of this nationwide survey was 29%.
- There is a possibility of bias that would differentiate respondents vs. non-respondents.
- High-scoring children in the sample as a whole were not confirmed using diagnostic instruments, although quantitatively measured autistic traits were extensively clinically confirmed for a separate smaller sample.

Introduction

Although to date the designation of pervasive developmental disorders in children – and the services to which affected children are entitled – rest on categorical case definitions, the concept of an autistic *spectrum*, along which the number and intensity of autistic features vary continuously from mild to severe, dates back to early epidemiological research by Wing and Gould (1). Wing (2) subsequently developed the concept of the autistic continuum, broadening the case designation beyond classic autism to encompass the mildest (but most prevalent) of the autism spectrum disorders (ASDs), pervasive developmental disorder not otherwise specified (PDD-NOS) assigned by diagnostic and statistical manual of mental disorders: text revision (DSM-IV-TR) (3). Several lines of subsequent research (4–7) now strongly suggest that the autism spectrum extends beyond this PDD-NOS subcategory to include subclinical levels of symptomatology, which are known to aggregate in the undiagnosed members of families with multiple-incidence autism. Very recently, Lord et al. (8) observed that diagnostic assignments of autistic disorder, Asperger's disorder, and PDD-NOS made by expert clinicians varied considerably across sites, despite the fact that distributions of scores on validated measures were similar. They concluded that current taxonomies should be revised to place priority on characterizing the dimensions of ASD while controlling for IQ and language level.

Clarifying the nature of the population distribution of autistic traits and symptoms across cultures has substantial implications for understanding a rise in prevalence over time (9) and for establishing the 'boundaries' of clinical affectation. A recent Korean study (10) suggested the highest ever reported prevalence for categorically defined ASD in a total population sample; in that study, symptom counts were found to be continuously distributed in the population.

Aims of the study

This study determined whether autistic traits would be continuously distributed in a population-based sample to establish the appropriate epidemiologic framework for interpreting the rise in estimated autism spectrum disorders prevalence over time.

Material and methods

Participants

The participants comprised a normative sample (n = 22 529) of schoolchildren, a child psychiatric clinical sample (n = 417), and typically developing (TD) children (n = 61). The normative sample was exclusively assessed using the Japanese version of the Social Responsiveness Scale (SRS) (11). The latter two samples were more extensively assessed using standard diagnostic batteries for the purpose of validation and calibration of the Japanese version of the SRS.

In regard to the normative sample, questionnaires were distributed by mail to the caregivers of all students attending mainstream classes at primary or secondary schools in the 10 geographical areas making up Japan in 2010 (n = 87 548 caregivers). One hundred and forty-eight primary schools and 71 secondary schools participated in this study. All of them were community schools where >93% of children living in the community attend, according to the annual report of Japan's Ministry of Education, Culture, Sports, Science and Technology, 2010 (12). Questionnaires were returned for 25 779 children aged 6–15 years (response rate 29.4%). Questionnaires with missing answers were excluded so that all analysis was based on a complete data set, leaving a final normative sample of 22 529 participants (11 455 boys) with SRS data provided by their mothers (n = 20 430), fathers (n = 1728), both parents (n = 166), other caregivers (n = 119) or unspecified (n = 86). Each of the 9 grade levels comprised a minimum of 754 participants of each sex, and both sexes were proportionally represented (Table 1).

The clinical sample consisted of 257 children diagnosed with ASD (ASD group) and 157 children with psychiatric diagnoses other than ASD (non-ASD group) (Table 2). They were patients who visited one of 10 child psychiatric clinics dur-

Table 1. Social Responiveness Scale total raw score distributions in the normative sample by sex and age (grade)

	Sex						
	Males		Females				
Grade	N	Mean (SD)	N	Mean (SD)	t	P	d
1	1655	37.3 (18.2)	1473	33.0 (16.7)	44.3	0.000	0.25
2	1521	36.2 (18.2)	1394	32.1 (16.3)	37.8	0.000	0.24
3	1384	35.4 (19.2)	1432	31.2 (16.4)	39.0	0.000	0.24
4	1375	33.7 (18.4)	1386	30.2 (16.3)	26.2	0.000	0.20
5	1449	33.0 (18.5)	1287	31.0 (17.5)	8.6	0.003	0.11
6	1203	31.9 (19.6)	1229	29.9 (17.8)	6.9	0.009	0.11
7	1072	32.3 (19.1)	1070	30.3 (17.8)	6.7	0.010	0.11
8	1007	32.7 (20.2)	1049	29.8 (18.2)	12.7	0.000	0.15
9	789	31.7 (20.7)	754	28.9 (18.6)	9.2	0.002	0.14
Total	11 455	34.1 (19.1)	11 074	30.9 (17.2)	13.4	0.000	0.18
Total children	22 529		32.5 (18.3)				

Grade 1 children are usually 6–7 years old. Most grade 1 participants were 7 years old at the time of the survey.

ing 2008–2010 and whose caregivers gave informed consent to participate in this study. Their existing clinical diagnoses were confirmed according to DSM-IV-TR criteria (3) based on all of the clinical information available to our research team, which included experienced child psychiatrists and licensed clinical psychologists. Among the 257 children of the ASD group, 229 were subcategorized with 100% diagnostic agreement: 96 with autistic disorder, 65 with Asperger's disorder, 68 with PDD-NOS, and 28 were unspecified. Children in the non-ASD group were diagnosed with adjustment disorder, attention deficit hyperactivity disorder, anxiety disorder, eating disorder, schizophrenia, somatoform disorder, conduct disorder, mood disorder, or mental retardation. Moreover, 61 children recruited from local communities comprised a TD group and were confirmed in diagnostic interviews with the children and their parents to have no history of neuropsychiatric conditions.

The intellectual levels of the children in the clinical sample ranged from normal intelligence to severe mental retardation based on cognitive testing carried out at clinics [various versions of the Wechsler Intelligence Scale and the Revised Kyoto Scale of Psychological Development (13)] or educational/administrative records. The proportions of children with normal intelligence in the ASD and non-ASD groups were not significantly different ($\chi^2 = 1.42$, n.s.).

Measures

The social responsiveness scale. The SRS (11) is a 65-item questionnaire of autistic traits for use with 4- to 18-year-olds that can be completed in 15 min by any adult who has observed the child over time in naturalistic social settings. The SRS was developed to assess autistic symptoms or quantitative traits and has subsequently undergone extensive validation in US samples for use in subclinical and clinical child populations(4, 14–17) as well as in general child populations for behavioral genetic research (18–20). It also demonstrated satisfactory internal consistency (Cronbach's $\alpha > 0.95$), inter-rater reliability between parents and teachers ($r = 0.78$, $P < 0.01$), and concurrent validity with an interview-based instrument(21) ($r = 0.86$, $P < 0.05$ for preschoolers; $r = 0.48$, $P < 0.05$ for children aged 7–12; $r = 0.77$, $P < 0.001$ for adolescents aged 13–18) for Japanese children(22, 23) and also for German children(24). The Japanese version was used in this study. Higher scores on the SRS indicate higher degrees of social impairment. The 65 SRS items were further categorized into five treatment subscales (social awareness, social cognition, social communication, social motivation, autistic mannerisms) (11). The SRS total scores are generally unrelated to IQ in the normal range and distinguish children with ASD from those with other types of psychopathology (16).

Table 2. Comparison of Social Responsiveness Scale total raw score between the United States and Japan

	Country						
	Japan		US				
Grade	N	Mean (SD)	N	Mean (SD)	*t*	*P*	*d*
1	3102	35.3 (17.6)	71	29.6 (25.6)	1.87	0.06	0.318
2	2891	34.2 (17.4)	92	34.9 (26.9)	0.25	0.80	0.041
3	2786	33.2 (18.0)	109	35.7 (26.8)	0.97	0.33	0.136
4	2739	31.9 (17.5)	227	35.3 (24.9)	2.02	0.04	0.188
5	2703	32.0 (18.0)	214	34.5 (25.3)	1.42	0.16	0.134
6	2408	30.8 (18.7)	211	31.7 (21.5)	0.59	0.56	0.049
7	2123	31.3 (18.4)	161	31.1 (20.6)	0.12	0.90	0.008
8	2040	31.1 (19.1)	137	31.9 (23.7)	0.39	0.70	0.040
9	1532	30.2 (19.7)	124	38.9 (29.2)	3.26	0.00	0.422
Total	22 344	32.5 (18.2)	1626*	33.6 (24.7)	1.76	0.08	0.051

Grade 1 children are usually 6–7 years old. Most grade 1 participants were 7 years old at the time of the survey.
*US data were cited from the SRS manual (p. 28) (11).

The autism diagnostic interview-revised. The Autism Diagnostic Interview-Revised (ADI-R) (25) is a parent-report interview and is a research standard for establishing a diagnosis of autism. To meet the ADI-R criteria for autism, the cutoff must be reached in each domain of reciprocal social interaction, communication, and restricted, repetitive, and stereotyped patterns of behavior. The Japanese version of the ADI-R was used in this study, which has demonstrated good reliability and validity for Japanese children (26).

Ethical issues

The study protocol was approved by the Ethics Committee of the National Center of Neurology and Psychiatry, Japan. Written informed consent to participate was obtained from the caregivers of each child participant.

Data analysis

Following examination of the SRS distribution as a function of age and sex, a cross-cultural comparison of SRS total scores provided by parents was performed between previously reported US norms (the SRS manual, p. 28) (11) and the obtained Japanese scores using *t*-tests. Factor analysis was performed using principal components analysis

(PCA) on children in the ASD, non-ASD, and TD groups, and the most parsimonious model was subsequently examined by confirmatory factor analysis (CFA) in the normative sample. To address discriminant validity, comparisons of the SRS scores across diagnostic groups were made using analysis of variance (ANOVA) methods with Bonferroni correction whenever appropriate. Intraclass correlation coefficient (ICC) was computed for associations between SRS scores, full scale IQ, and ADI-R algorithm scores. In addition, a receiver operating characteristics (ROC) analysis was conducted to determine the cutoff points for primary and secondary screening; for the former, the cutoff point was where the sum of sensitivity and specificity was the largest, and for the latter, it was where the likelihood was the largest for children in the ASD, non-ASD, and TD groups, for boys and girls separately. Analysis was performed using SPSS 18.0J for Windows (SPSS Japan Inc., Tokyo, Japan), with AMOS 17.0J for Windows (SPSS Japan Inc., Tokyo, Japan) used for the confirmatory factor analysis.

Results

Population distribution

Social Responsiveness Scale score distribution among 6- to 15-year-old children in the Japanese general population is shown in Fig. 1, and mean SRS total raw scores by age group are presented for boy and girl subsamples in Table 1. To investigate the effects of age (grade) and sex on SRS scores, a 2-way ANOVA (grade × sex) was conducted on the total raw scores. The interaction was significant ($F_{8,180,224} = 2.00$, $P < 0.05$, $\eta^2 = 0.00$), and the main effects of grade ($F_{8,180,224} = 20.03$, $P < 0.001$, $\eta^2 = 0.01$) and sex ($F_{8,180,224} = 157.37$, $P < 0.001$, $\eta^2 = 0.01$) were significant, although the effect size indicates that the differences in the SRS scores by grade and sex were modest.

Mean SRS score of each age group was within 0.2 standard deviations of the entire sample means for boys and girls respectively (boys 30.3–37.9, girls 27.5–34.3). Boys scored higher than girls across the entire age range, with the maximum sex difference seen for the youngest subgroup at grade 1 ($t = 44.24$, $P < 0.001$, $d = 0.25$). Therefore, we standardized the Japanese version of the SRS on each of the boy and girl subsamples across the age range (27).

Table 2 shows our Japanese normative data together with the original US parent and teacher rating data (the SRS manual, p. 28) (11) derived from five different studies. Japanese children scored similarly to their US counterparts, except those in grades 4 and 9; here, Japanese children had significantly lower mean SRS scores than their US counterparts.

Factor structure. PCA suggested a one-factor solution for the 475 children comprising the clinical and TD groups (Table 3). Seven items (items 24, 29, 35, 37, 44, 49, 51) with factor loadings >0.600 represented all three of the DSM-IV-TR criterion domains for autism. When 22 items with factor loadings <0.400 were excluded, the first factor explained 34.8% of variance in SRS scores in this sample, consistent with the original US and German data for child psychiatric patients. When performed with the mean scores of the five treatment subscales, rather than the mean scores of 65 items, PCA gave a one-factor solution accounting for 77.2% in this sample.

Next, the single-factor model suggested by PCA and by extensive prior research on the SRS (20, 24) was subjected to CFA using data from the normative sample. The comparative fit index, the goodness of fit index, the adjusted goodness of fit index, and root mean square error of approximation were 0.677, 0.739, 0.722, and 0.055 for all 65 items, 0.811, 0.854, 0.840, and 0.055 for 43 items with factor loadings >0.400 derived from PCA on the exploratory set, and 0.989, 0.987, 0.962, and 0.083 for the five treatment subscales. These findings lend support to the notion of a unitary factor influencing the multiple aspects of dysfunction that characterize autistic symptomatology in children in the general population.

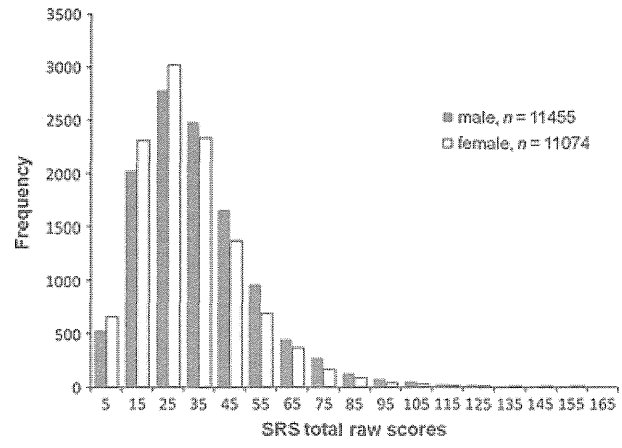

Fig. 1. Distribution of Social Responsiveness Scale (SRS) total raw scores rated by caregivers in the general sample of 6- to 15-year-old children.

Table 3. Principal components analysis of social responsiveness scale data

	ASD, non-ASD, and TD groups (n = 475)		
Component	Total	% of variance	Cumulative%
1	18.928	29.120	29.120
2	3.851	5.925	35.045
3	3.152	4.850	39.895
4	1.926	2.963	42.858
5	1.701	2.616	45.474

ASD, autism spectrum disorders; TD, typical development.
The clinical sample consisted of participants with ASD (n = 257) and non-ASD (n = 157).

Other psychometric properties

Table 4 indicated that the mean SRS total score of the ASD group was significantly higher than that of the clinical non-ASD (boys t = 4.87, P < 0.001, d = 0.65, girls t = 4.68, P < 0.001, d = 0.83) and TD (boys t = 11.73, P < 0.001, d = 2.29, girls t = 11.80, P < 0.001, d = 2.66) groups. The differences in SRS score were not pronounced among the ASD subcategories: the score did not discriminate between Asperger's disorder and PDD-NOS for either sex, as previously reported (23). As shown in Fig. 2, the SRS scores of both ASD and non-ASD groups were distributed widely and with significant overlap with the general population distribution. Table 5 shows the raw score cutoffs for the 99th, 97.5th, 95th, and 90th percentile values by sex for our normative sample and the proportion of boys and girls with diagnosed ASD who fell within the respective percentile cutoffs. In general, a higher proportion of diagnosed females were at the more extreme percentile rankings in comparison with males.

Social Responsiveness Scale score did not correlate with IQ (ICC = −0.23, n.s.) for 118 participants with IQs > 70 for whom formal test data were available (ASD 46, non-ASD 11, TD 61), although the subgroup with mental retardation tended to score higher. With regard to autistic symptoms, SRS score was significantly correlated with ADI-R total score (ICC = 0.66, P < 0.001; Fig. 3), as well as scores for the social interaction domain (ICC = 0.68, P < 0.001), communication domain (ICC = 0.58, P < 0.001), and restricted and repetitive behavior domain (ICC = 0.50, P < 0.001) for a subsample for whom data from both the SRS and ADI-R were available (n = 36; ASD 20, non-ASD 10, TD 6; mean age 8.0 years, range 4–18 years).

Receiver operating characteristics analysis informed two sets of cutoff points depending on the purpose of use. When used for primary screening of the general child population such as at school entrance, an optimal cutoff point was 53.5 for boys (sensitivity 0.91, specificity 0.48) and 52.5 for girls (sensitivity 0.89, specificity 0.41). For secondary screening of children referred to clinical settings, where a much higher rate of ASD is expected, the cutoff point of 109.5 for boys (sensitivity 0.23, specificity 0.96, likelihood ratio 6.14) and 102.5 for girls (sensitivity 0.32, specificity 0.95, likelihood ratio 5.73) increases the positive predictive value for ASD diagnosis up to 80.4% for boys and 79.2% for girls, given that the prevalence in Japanese child psychiatric clinics is 40%. Primary and secondary screening cutoffs correspond to a SRS T-score of 60 and 90 for boys and 62 and 92 for girls respectively.

Discussion

We conclude from these data involving a nationwide representative sample of schoolchildren that autistic traits measured by the Japanese version of the SRS are distributed continuously in the population; that the clinical validity of the measurements (in essence, their relevance to autism) appeared strong; and that the findings of this cross-cultural study recapitulate and extend what has been observed in smaller epidemiologic studies of autistic traits in other countries.

The results of this study of quantitative autistic traits – the largest of its kind – add substantial evidence in support of the continuous nature of autistic traits in the general population. This does not mean that individual cases of autism are never discretely or categorically determined. It has long been known, for example, that there exist categorical, relatively rare causes of autistic syndromes (e.g., fragile X syndrome, Rett syndrome, and tuberous sclerosis) caused by single gene abnormalities. The notion of an autistic continuum remains consistent with the existence of such discrete entities. The same is true for mild to moderate intellectual disability, which constitutes the extreme end of a normal distribution (the so-called 'bell curve') but comprises a number of discrete syndromes (including but not limited to Down syndrome, Fragile X syndrome, etc.) in the severe end of the symptom distribution. Similarly, segments of the autistic continuum may be comprised of small clusters of discrete disorders (e.g., SHANK 1 mutations, 15q duplications, 16p11.2 deletions) that contribute to intervals at the pathological end of the distribution (for example 75–85, 90–110), but overlap in severity with other cases that represent quantitative accumulations of inherited liability transmitted by polygenic mechanisms or by gene–environment interactions. The causes of cases

Table 4. Social Responsiveness Scale total raw score means of the ASD, non-ASD, and TD groups

				ASD subcategory			
	ASD	nonASD	TD	Autism	Asperger's disorder	PDD-NOS	Unspecified
N (Male/Female)	257 (203 : 54)	157 (78 : 79)	61 (30: 31)	96 (77 : 19)	65 (48 : 17)	68 (54 : 14)	28 (24 : 4)
Age (years)							
Mean (SD) Range	10.0 (3.9) 4–18	12.1 (3.7) 4–18	9.61 (2.5) 6–18	9.0 (4.2) 4–18	10.7 (3.1) 4–17	10.0 (4.1) 4–18	11.68 (3.67) 6–17
Intellecual level (N)							
Normal	181	118	57	57	64	59	1
Borderline	14	9	4	8	1	3	2
Mild MR	10	12	0	5	0	3	2
Moderate MR	7	3	0	2	0	1	4
Severe MR	12	8	0	2	0	0	10
MR (unknown level)	33	7	0	22	0	2	9
SRS Mean (SD) Range							
Males	87.6 (27.4) 15–158†	69.7 (27.9) 13–141†	27.4 (16.6) 6–72†	89.5 (24.0) 48–139‡	82.4 (26.8) 15–132	78.4 (26.5) 24–144‡	
Females	86.1 (27.9) 21–153§	62.1 (29.9) 12–134§	21.4 (16.2) 2–65§	91.4 (27.2) 21–133	91.0 (31.4) 38–153	74.7 (25.3) 40–114	
Total	87.3 (27.4) 15–158¶	65.9 (29.1) 12–141¶	24.3 (16.5) 2–72¶	89.8 (24.5) 21–139**	84.6 (28.1) 15–153	77.7 (26.1) 24–144**	

SRS, Social Responsiveness Scale; ASD, autism spectrum disorders; TD, typical development; PDD-NOS, pervasive developmental disorder not otherwise specified; MR, mental retardation.

†ASD > non-ASD, TD ($t = 4.87$, $P < 0.001$, $d = 0.65$; $t = 11.73$, $P < 0.001$, $d = 2.29$, respectively), non-ASD > TD ($t = 7.79$, $P < 0.001$, $d = 1.67$).

‡Autism > PDD-NOS ($t = 2.48$, $P < 0.05$, $d = 0.44$).

§ASD > non-ASD, TD ($t = 4.68$, $P < 0.001$, $d = 0.83$; $t = 11.80$, $P < 0.001$, $d = 2.66$, respectively), non-ASD > TD ($t = 7.17$, $P < 0.001$, $d = 1.52$).

¶ASD > non-ASD, TD ($t = 7.53$, $P < 0.001$, $d = 0.76$; $t = 17.19$, $P < 0.001$, $d = 2.45$, respectively), non-ASD > TD ($t = 10.51$, $P < 0.001$, $d = 1.59$).

**Autism > PDD-NOS ($t = 3.05$, $P < 0.05$, $d = 0.48$).

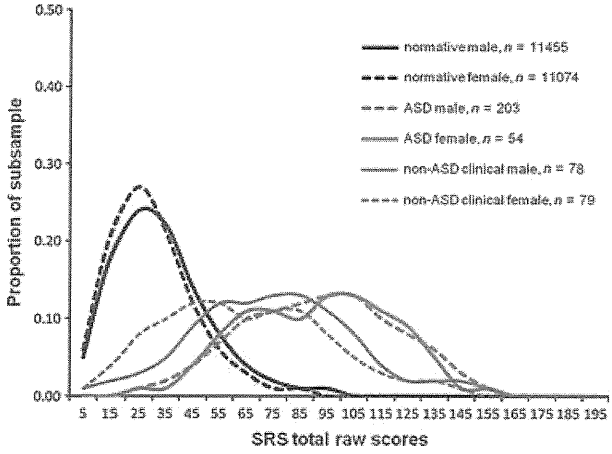

Fig. 2. Distribution of Social Responsiveness Scale (SRS) total raw scores in child psychiatric patients with and without autistic spectrum disorders (ASD).

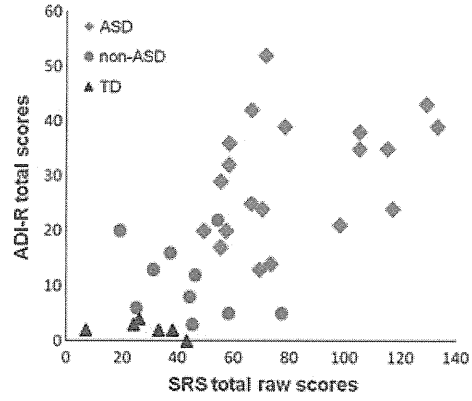

Fig. 3. Social Responsiveness Scale (SRS) total raw scores as a function of Autism Diagnostic Interview-Revised (ADI-R) total scores for children with autism spectrum disorders (ASD), non-ASD, and typical development (TD).

Table 5. Proportion of children with autism spectrum disorders (ASD) corresponding to the 99th, 97.5th, 95th, and 90th percentile values among the ASD group of the Japanese clinical sample

Normative sample (n = 22 529)			ASD group (n = 257)			
	Raw score cutoff		N (%)			
Percentile value	Males	Females	Males (n = 203)		Females (n = 54)	
≥ 99	98	87	70	34.5%	28	51.9%
≥ 97.5	81	73	117	57.6%	36	66.7%
≥ 95	70	63	147	72.4%	42	77.8%
≥ 90	58	53	173	85.2%	44	81.5%

represented by any given score in the distribution may be independent, partially overlapping, or fully overlapping with the underlying causes of other cases at the same level of severity. The result is a continuous distribution encompassing both discrete and quantitative pathways to affectation across a wide range of severity (28–32). We note that in a recent large general population twin study, Robinson et al. (33) demonstrated overlap in causal influence on autistic symptomatology at each of the first, second, and fifth percentiles of severity in the population.

In our study, there was no evidence of a natural cutoff that differentiated children categorically affected from those unaffected by ASD. The parent-report Japanese SRS cutoff scores for secondary screening derived from our ROC analysis, 109.5 for boys and 102.5 for girls, would comprise approximately 0.5% of our normative sample. On the other hand, the ASD primary screening cutoff with the highest sensitivity, 53.5 for boys and 52.5 for girls, encompassing 10.9% of our normative sample, identifies subthreshold conditions in children that might warrant clinical attention (11). Taken together, these findings complement a recent Korean study (10), in which categorical screening and diagnostic confirmation revealed (and validated) what a continuous distribution of symptom counts. In our normative sample, a parent-report Japanese SRS raw score of 74 for boys and 80 for girls would cut off approximately 3.74%, 1.47% of each gender-specific population distribution, which is very near the prevalence for ASD reported in the Korean study (2.64%) (10).

Our observation of higher quantitative autistic trait scores in males than in females confirms across cultures a subtle but statistically robust gender difference (11, 18, 24). The sex distribution pattern has potentially profound implications for sex disparities universally observed at the extreme end of the distribution (i.e., in clinical ASD cases), where such disparities would be expected to be accentuated, as is true for any normally distributed trait such as height. The magnitude of the sex difference in our sample (d = 0.18) was smaller than that in the US data set (11) (d = 0.37) but similar to the German normative sample (24) (d = 0.16). Accentuation of the gender difference in the US data set could potentially relate to its being derived from a twin sample, given that male twins score higher than non-twins (34). Japanese children diagnosed with ASD were rated as having somewhat lower quantitative trait scores than their US and German counterparts. Such cross-cultural differences could be partly explained by cultural differences in responding to Likert-type rating, on which Japanese informants have a higher tendency to use the midpoint on the scales and US informants a higher tendency to use the extreme values (35).

The results of the exploratory factor analysis for the clinical sample replicate those of previous

studies (17, 18), and the results of the confirmatory factor analysis for a very large general population underscore the presence of a primary underlying factor that influences the symptoms representing all three DSM-IV-TR criterion domains of autism. Factor structure has important implications for understanding the core neuropsychological mechanisms underlying autistic traits and symptoms, which are relevant to not only the pursuit of biomarkers and genetic susceptibility factors related to ASD but also diagnostic paradigms (20, 31).

There are two major limitations in this study. First, the response rate was low (29%), although it is keeping with what is expected from population-based surveys. Second, high-scoring children in 22 529 Japanese schoolchildren were not confirmed using any diagnostic instruments, although quantitatively measured autistic traits were extensively clinically confirmed for the separate smaller sample.

In the present study, although the instrument capably distinguished children diagnosed with ASD from children diagnosed with other psychiatric conditions, the score distribution for both clinical groups overlapped. A possible interpretation of this observation, given that autistic traits exhibit considerable independence in causation from many forms of psychopathology in genetic epidemiologic research (15, 36), is that autistic traits, when present, exacerbate other types of psychopathology when they cooccur with autistic traits as comorbid conditions. For some neurodevelopmental conditions, however, it has also become increasingly clear that there are elements of genetic causation that genuinely overlap with the genetic cause of autism; these include ADHD, tic disorders, and developmental coordination disorders, among others (37).

In conclusion, our study provides strong evidence of the continuous nature of autistic symptomatology in the general population, as has been reported in previous studies (1, 18, 19, 37). The findings underscore the notion that paradigms for categorical case assignment are superimposed on a continuous distribution, which can result in substantial variation in prevalence estimation, especially when the measurements used in case assignment are not standardized for a given population (i.e. by gender, informant, culture, etc.). In other words, these data illustrate that when imposing an arbitrary, non-standardized cutoff for diagnosis, small, clinically insignificant changes in the cutoff value can result in significant changes in prevalence, especially when operating at the steeper slopes of the distribution. Our results support the importance, validity, and feasibility of determining standardized quantitative ratings of autistic traits and symptoms across cultures, the implementation of which has the potential to advance international collaborative research on autism and related conditions. Finally, these results call for a rational approach to revising systems of diagnosis and service delivery that currently perpetuate the notion of discontinuity between ASD-affected and unaffected populations.

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Declaration of interest

Dr. Constantino receives royalties for commercial distribution of the SRS, which is published by Western Psychological Services. No royalties were generated from use of the scale for this research study, and the study was exclusively designed to address scientific questions in the domains of epidemiology and public health.

The authors have no conflict of interests to declare with respect to this article.

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Neuropsychiatric comorbidities in autism spectrum disorders without intellectual disability

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Abstract

Epilepsy and autism spectrum disorder tend to co-occur in the population with intellectual disability. However, in the autistic population without intellectual disability, the prevalence of epilepsy is also much greater than in the general population. The special health needs in children having autism spectrum disorder without intellectual disability, namely those with high-functioning autism spectrum disorder have become recognized in recent years, yet comorbid neuropsychiatric symptoms such as anxiety, attention-deficit/hyperactivity disorder, and epilepsy still sometimes remain undiagnosed and untreated. Heightened awareness of such comorbidities will help these children to access appropriate treatment. Whether the epilepsy associated with high-functioning autism spectrum disorder is the same or different from that associated with intellectual disability, and whether the autistic profile associated with epilepsy in high-functioning autism spectrum disorder is the same or different from that without epilepsy, should be answered by future studies.

INTRODUCTION

Evidence from a community-based study[1] and numerous clinical reports indicate that a high proportion of individuals with autism spectrum disorder (ASD) suffer from one or more comorbid neuropsychiatric disorders. An association between epilepsy and ASD is well recognized, and comorbidity tends to be accompanied by intellectual disability. According to a meta-analysis of 23 studies[2], the pooled prevalence rates of epilepsy are 21.4% for individuals with ASD (defined as autism and/or pervasive developmental disorder) and intellectual disability, and 8% for those without intellectual disability, both of which are notably higher than the rate of 0.5% for the general population. In addition, sex seems to be another factor influencing the prevalence rate of epilepsy in the autistic population; epilepsy is more prevalent in autistic females than in autistic males, suggesting a close association between epilepsy and a female-predominant subgroup with ASD.[2]

Recently, heightened awareness of milder autistic conditions without intellectual disability has led to a higher overall prevalence rate of ASD of 2.6%[3], and has highlighted the clinical needs of children with ASD who have been undiagnosed until school age. In fact, a recent U.S. study found that most children with ASD were first identified as having ASD after age 5.[4] Further, it is reported that being older at first diagnosis of ASD is one of associated factors to reduce quality of life (QOL) for adults with high-functioning ASD, together with having a comorbid psychiatric disorder and being female by a nationwide survey conducted in Japan.[5] Taken together, it is clear that the early identification and treatment of ameliorable comorbid neuropsychiatric disorders such as depression and epilepsy is important to improving the QOL for autistic individuals with or without accompanying intellectual disability.

PREVALENCE OF EPILEPSY IN AUTISM SPECTRUM DISORDER WITHOUT INTELLECTUAL DISABILITY

Previous studies have reported a relatively lower prevalence of epilepsy in high-functioning ASD compared to that in ASD with intellectual disability, but the prevalence is still greater than that found in the general population. A large cohort study in the U.K. identified epilepsy in 8.7% (2/23) of children with Asperger syndrome compared to 16.7% (5/30) of children with childhood autism.[6] A large population-based survey in Finland found epilepsy, defined according to the International League Against Epilepsy (ILAE), in 18.2% (34/187) of children with autistic disorder and 12.1% (11/91) of those with IQ >70.[7] However, no firm statistical conclusion can be drawn about the type of epilepsy from these data. A clinical

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study of 100 boys with Asperger syndrome made a conservative comorbidy estimate of epilepsy in 4 patients.[8] Another clinical study comparing 26 patients with Asperger syndrome and 16 patients with high-functioning autism found no significant differences between the groups in electroencephalogram abnormalities (8.7% vs 13.3%), epilepsy (7.7% vs 6.3%) or clinical variables.[9]

Recently, we conducted a small-scale study in the west of Tokyo to determine the comorbid neuropsychiatric disorders associated with high-functioning ASD (HFASD).[10] The target population was primary school children aged 6-12 years in mainstream classes (n=1,374), of which 775 participants were screened using teacher-report autism questionnaires. Following semi-structured diagnostic interviews with all screen-positives and randomly selected screen negatives, 7 children were identified as having definite ASD and 3 as having broader ASD. None had intellectual disability. One or more diagnoses according to the Text revision of the Diagnostic and Statistical Manual of Mental Disorders, the fourth edition (DSM-IV-TR) was found in 72% of children with definite HFASD and 100% of children with broader ASD, findings consistent with those of the UK study.[1] The distribution pattern of comorbid disorders is also similar; anxiety or phobic disorders and oppositional or conduct disorders being the most common, with a prevalence of up to 40%. Most of these children were undiagnosed and had received no professional health interventions in terms of these comorbid disorders. Epilepsy was found in one boy in the HFASD sample (1/7, 14.3%). He was diagnosed as having complex partial seizure upon his first seizure at age 4 and has been treated using valproic acid. He is currently seizure free but has attention problems. In addition, two girls in our sample (one with Asperger syndrome, one with broader ASD) had repeated generalized seizures over the last 1-3 years, although they were not diagnosed with epilepsy. Since some individuals with ASD are still at a risk of developing epilepsy after puberty, the rate of 14.3% should not be overestimated. Our sample was small, however, the results emphasize that there does seem to be a high rate of children who develop epilepsy in autistic population without intellectual disability.

Many issues regarding the association between epilepsy and HFASD remain unanswered. Pediatric neurologists may want to know whether the epilepsy associated with HFASD is the same as that associated with ASD plus intellectual disability; or from another viewpoint, child psychiatrists may want to know how the autistic profile associated with epilepsy in HFASD is different from that without epilepsy.

CONCUSIONS

Recently, the special health needs of children with HFASD have been recognized. The prevalence of epilepsy is much higher in children with HFASD than it is in the general population. Children with HFASD are likely to have additional psychiatric symptoms such as anxiety and attention-deficit/hyperactivity disorder, but such health problems are often undiagnosed and untreated. Comprehensive neuropsychiatric evaluations of children with HFASD or children with epilepsy will lead to early identification of treatable health problems and the provision of appropriate treatment. Some behavioral problems in ASD can be improved with antiepileptic drugs.

Given that there are approximately 2-3% of children having ASD, and 10% of children with subthreshold autistic traits[11], an approach using quantitatively measured autistic traits may be also helpful to explore the association between epilepsy and autism.

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Validation of an interview-based rating scale developed in Japan for pervasive developmental disorders

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ABSTRACT

The pervasive developmental disorders (PDDs) Autism Society Japan Rating Scale (PARS), an interview-based instrument for evaluating PDDs, has been developed in Japan with the aim of providing a method that (1) can be used to evaluate PDD symptoms and related support needs and (2) is simpler and easier than the currently used "gold standard" instruments such as the Autism Diagnostic Interview-Revised (ADI-R). We examined the reliability and validity of PARS on the basis of data from 572 participants (277 PDD patients and 295 nonclinical controls). Inter-rater reliability was sufficient at both the item and scale level. Factor analysis extracted four subscales, for which internal consistency was found to be high. The sub and total scores of PARS showed correlations with the domain and total scores of ADI-R, in line with theoretical prediction, indicating the convergent validity of PARS. A receiver operating characteristic analysis showed that PARS has good discriminative validity in differentiating between PDD patients and nonclinical controls, regardless of intellectual capacity. Considering that PARS can be easily implemented by professionals with appropriate knowledge regarding PDDs, PARS may be superior to the existing instruments in terms of cost performance.

1. Introduction

Over the course of many years, several instruments have been developed for the diagnosis, evaluation, and screening of pervasive development disorders (PDD). In recent years, the Autism Diagnostic Interview-Revised (ADI-R; Le Couteur et al., 1989; Lord, Rutter, & Le Couteur, 1994) has been broadly accepted as a standardized interview-based diagnostic instrument

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for PDD. The Autism Diagnostic Observational Schedule (ADOS; Lord et al., 2000, 1989) is also widely used as an observation-based diagnostic instrument. These instruments have a high level of discriminative validity with respect to the differentiation of PDD from non-PDD and are useful in reaching a definitive diagnosis; however, their implementation requires special training and significant time, leading to the development of numerous simpler evaluation scales in recent years.

The Modified Checklist for Autism in Toddlers (M-CHAT; Robins, Fein, Barton, & Green, 2001), which has been broadly accepted as a screening instrument, is a unique tool that comprises a combination of questionnaires, telephone interviews, and structured follow-up interviews. Although it is a highly useful tool, its use is limited to toddlers because it was developed with the aim of early identification of PDD. In countries such as Japan and other Asian countries lacking the medical and governmental services for PDD that exist in the United States and Europe, it is believed that many people with undiagnosed PDD exist in a broad age group. In fact, Kawamura, Takahashi, and Ishii (2008) reported that in Toyota City, Japan, where a new systematic PDD screening system has been implemented, there were 11 times more detections of PDD compared with that observed in a survey done 20 years ago. However, few regions in the world have an adequate PDD detection system of this kind. Considering this, the development of a simple and practical evaluation scale that can be applied to a wide age group is an important and pressing issue.

The Autism Spectrum Screening Questionnaire (ASSQ; Ehlers, Gillberg, & Wing, 1999), Autism Screening Questionnaire (ASQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999), and Social Responsiveness Scale (Constantino et al., 2003) have been developed as PDD evaluation scales that can be applied to a relatively broad age group. As all of these evaluation tools are in the format of a questionnaire that can be evaluated by parents or teachers, they have the advantage of being fairly easy to implement. However, in most cases, parents lack the specialized knowledge needed to understand PDD, so the standards for rating individual items can vary greatly depending on the individual conducting the evaluation, possibly leading to a deterioration of the reliability of evaluation results. Furthermore, though teachers generally have more PDD-related knowledge than do parents, they have less specific knowledge of each individual child; hence, their evaluations tend to be less reliable than those of parents. In practice, the sensitivity (true positive rate) and specificity (one minus false positive rate) of the ASSQ in distinguishing PDD and non-PDD was .91 and .77, respectively, for the parent evaluation and .90 and .58, respectively, for the teacher evaluation (Ehlers et al., 1999). Considering that the sensitivity and specificity of the ADI-R were 1.00 and .90, respectively (Lord et al., 1997), the level of accuracy of the ASSQ in distinguishing PDD from non-PDD was insufficient in the hands of both parents and teachers. Furthermore, in a simultaneous comparison conducted by Charman et al. (2007), sensitivity and specificity in identifying autistic spectrum disorders was .86 and .78, respectively, for the ASQ and .78 and .67, respectively, for the SRS, thereby indicating its insufficient precision in practical use.

To resolve this dilemma between accuracy and simplicity, the PDDs Autism Society Japan Rating Scale (PARS) has been developed in Japan as an instrument for evaluating PDDs (Adachi et al., 2006; Kamio et al., 2006; Tsujii et al., 2006). This scale was developed with the aim of providing an instrument that is simpler to use than the ADI-R and ADOS; is applicable to any age group, unlike the M-CHAT; and has better reliability and validity than questionnaire scales such as the ASSQ and ASQ. While PARS uses an interview format similar to ADI-R, the procedures, which are briefly summarized in the manual, can be implemented after simple training. Furthermore, because the criteria for rating each item is clearly defined in PARS, a more reliable and valid evaluation is possible than with questionnaire scales. In order to ease the rating process and shorten the evaluation time, the evaluator assigns values at three levels—none (0 points), somewhat apparent (1 point), and apparent (2 points)—for the 34 items listed as typical behavioral symptoms of PDD. This innovation ensures that the time required to implement PARS is kept to 30–90 min, depending on the interviewer's proficiency and the target's age and symptoms.

There is no international literature on the psychometric properties of PARS, although PARS is now widely used in Japan. This study examined the reliability and validity of PARS and involved a study population of 628 test subjects that included 302 people with PDD and 326 people without PDD. Specifically, we evaluated the inter-rater reliability, factor structure, internal consistency, correlation with the ADI-R, and the ability to distinguish subjects with PDD from a nonclinical sample.

2. Methods

2.1. PARS

The PARS instrument has been developed (Adachi et al., 2006; Kamio et al., 2006; Tsujii et al., 2006) and published (PARS Committee, 2008) in Japan. It involves the evaluation of PDD symptoms through a semi-structured interview conducted with a parent or family member of the subject as the target. This tool can be used to assess not only the risk of PDD but also the need for support pertaining to administrative and medical services. PARS comprises both an evaluation of symptoms when they were most pronounced during infancy (named the peak symptoms scale) and an evaluation of current symptoms (named the current symptoms scale). The former is used mainly to an assessment of PDD risk, and the latter is mainly used in assessment of actual support needs. The peak symptoms scale, which comprises 34 items, is the same for subjects of all age groups, whereas the current symptoms scale, which comprises 57 items, has 3 versions targeting different age groups: preschoolers, primary schoolers, and adolescents/adults. This study reports on data obtained from the peak symptoms scale.

The PARS peak symptoms scale comprises 34 items that describe the characteristic behavioral symptoms of PDDs during the preschooler phase. The items were selected by a panel of eight child psychiatrists and a developmental clinical psychotherapist who were specialized in autism research and clinical practice with more than 10 years of expertise. They compiled behavioral characteristics shown by children with PDD and classified them into eight categories—Interpersonal

Relationship, Communication, Restricted Interests, Stereotyped Behavior, Resistance, Hypersensitivity, Clumsiness, and other complications. From these, 34 items relating to symptoms that are specific to PDD, as well as items relating to nonspecific symptoms with high need for either clinical or administrative support, were selected. Twenty-two out of the 34 items corresponded to diagnostic features for PDD in the *Diagnostic and Statistical Manual 4th Edition, Text Revision* (DSM-IV-TR; American Psychiatric Association, 2000), and 8 corresponded to associated features. Symptoms described in the remaining four items (items 15, 27, 28, and 32) were not listed in the DSM-IV-TR, but since they are often present in PDD children seen in everyday clinical experience, they were included in the scales.

The evaluation of each item in PARS is based on a 30-page manual (PARS Committee, 2008). This manual includes detailed explanations of the questioning and rating standards for each item. For example, for item 1 of the peak symptoms scale (not making eye contact), a sample question "has the child ever had difficulty making eye contact?" is presented, and the rating standards are listed in detail: "0: made eye contact always," "1: had some difficulty making eye contact (made eye contact when requesting or showing interest in something but not otherwise; sometimes made eye contact and sometimes did not; made eye contact only with the parents but not with others)," and "2: rarely made eye contact (did not make eye contact with parents; avoided eye contact)." In this way, evaluation based on subjective criteria of the interviewer is avoided, and a more objective evaluation is possible.

2.2. Sample

The 572 subjects of the main sample comprised two broad groups: a PDD group made up of 277 subjects and a nonclinical control group made up of 295 subjects (Table 1).

Participants in the PDD group were diagnosed as having PDD or subordinate disorders based on the DSM-IV by experienced psychiatrists of medical and educational facilities in 28 areas throughout Japan. The diagnoses were made by integrating data from parental interviews; developmental and medical information; records provided by parents, other caregivers, and teachers; and direct observations of and interactions with the children. Subjects were referred to the facilities due to developmental concerns and randomly recruited for the study by examiners belonging to the facilities. Among these, 175 subjects underwent full-scale IQ tests using intelligence scales such as the Wechsler (Japanese WISC-III Publication Committee, 1998; Shinagawa, Kobayashi, Fujita, & Maekawa, 1990), Binet (Tanaka Institute for Educational Research, 2003), and K-ABC scales (Kaufman, Nadeen, & Kaufman, 1993). Of the 175 subjects, 51 were considered mentally retarded (IQ < 70), while 118 were not (IQ ≥ 70). To evaluate the correlation between PARS and the ADI-R, an ADI-R interview was additionally administered to 74 subjects (mean age = 14.0 years; SD = 3.6; range = 7–24 years; mean IQ = 86.2; SD = 24.7; range = 40–135) from the PDD group.

Table 1
Characteristics of the main sample.

	Age			IQ			Gender		
	M[a]	*SD*[b]	Range	*M*	*SD*	Range	Male	Female	Total
All age groups									
PDD[c] group	12.5	5.8	3–39	81.6	29.2	19–142	233	44	277
Without MR[d] (IQ[e] ≥ 70)	12.7	5.5	4–39	97.2	16.8	70–142	105	13	118
With MR (IQ < 70)	12.3	4.9	5–31	43.6	15.7	18–69	44	13	57
IQ unknown	12.4	6.3	3–32	–	–	–	84	18	102
Nonclinical control group	10.8	7.6	3–38	–	–	–	153	142	295
Preschoolers (age, 3–6 years)									
PDD group	5.1	1.0	3–6	74.1	24.5	22–121	27	12	39
Without MR (IQ ≥ 70)	5.4	0.8	4–6	87.7	13.6	70–121	9	5	14
With MR (IQ < 70)	5.9	0.4	5–6	47.0	17.8	22–68	3	3	6
IQ unknown	4.5	1.0	3–6	–	–	–	15	4	19
Nonclinical control group	4.8	1.0	3–6	–	–	–	69	63	132
Primary schoolers (age, 6–12 years)									
PDD group	9.9	1.8	6–12	80.9	31.9	18–140	94	15	109
Without MR (IQ ≥ 70)	10.2	1.7	7–12	99.6	16.2	71–140	46	5	51
With MR (IQ < 70)	9.2	2.0	6–12	40.5	13.5	18–65	16	5	21
IQ unknown	10.0	1.7	7–12	–	–	–	32	5	37
Nonclinical control group	9.2	1.8	6–12	–	–	–	34	33	67
Adolescents and adults (age, 12–39 years)									
PDD group	17.3	5.2	12–39	77.4	31.2	19–142	112	17	129
Without MR (IQ ≥ 70)	17.1	5.5	12–39	97.9	16.9	70–142	50	3	53
With MR (IQ < 70)	15.9	3.7	12–31	44.9	16.7	19–69	25	5	30
IQ unknown	17.8	5.0	12–32	–	–	–	37	9	46
Nonclinical control group	20.1	6.0	13–38	–	–	–	50	46	96

[a] Mean.
[b] Standard deviation.
[c] Pervasive development disorders.
[d] Mental retardation.
[e] Intelligence quotient.