Journal of Autism and Developmental Disorders (2022) 52:4750–4762
https://doi.org/10.1007/s10803-021-05342-9

ORIGINAL PAPER

Exploring Cultural Differences in Autistic Traits: A Factor Analytic Study of Children with Autism in China and the Netherlands

Fangyuan Liu[1] · Anke M. Scheeren[1] · Rachel Grove[2] · Rosa A. Hoekstra[3] · Ke Wang[4] · Dehua Guo[5] · Chongying Wang[4] · Sander Begeer[1]

Accepted: 24 October 2021 / Published online: 6 November 2021

Abstract

Autism spectrum disorders are diagnosed globally, but recognition, interpretation and reporting may vary across cultures. To compare autism across cultures it is important to investigate whether the tools used are conceptually equivalent across cultures. This study evaluated the factor structure of the parent-reported Autism Spectrum Quotient Short Form in autistic children from China (n = 327; 3 to 17 years) and the Netherlands (n = 694; 6 to 16 years). Confirmatory factor analysis did not support the two-factor hierarchical model previously identified. Exploratory factor analysis indicated culturally variant factor structures between China and the Netherlands, which may hamper cross-cultural comparisons. Several items loaded onto different factors in the two samples, indicating substantial variation in parent-reported autistic traits between China and the Netherlands.

Keywords Culture · Autistic traits · Children · Autism spectrum disorder · Autism spectrum quotient

Autism spectrum disorders (ASD) are characterized by deficits in social interaction and communication, and unusually repetitive and restricted behaviors and interests (American Psychiatric Association, 2013). Reliable instruments are needed to quantify autistic traits and screen for high-risk children, thereby improving early detection of autism and promoting better emotional and behavioral outcomes (de Leeuw et al., 2020; Saito et al., 2017). However, the majority of screening tools for autistic traits have been developed in Western high-income countries, typically in Western Europe and North America (Durkin et al., 2015; West et al., 2016). Our knowledge of measurements of autistic traits may thus be culturally and contextually biased (Durkin et al., 2015). In this study, we compare a popular parent-report screening tool for ASD between children with ASD from Eastern (Chinese) and Western (The Netherlands) cultures.

If the recognition, interpretation and reporting of children's autistic traits are not consistent across cultures, as suggested by a recent review (de Leeuw et al., 2020), this restricts the usability of autism screening tools developed in Western cultures in other countries (Norbury & Sparks, 2013). Even though there is a growing number of studies attempting to develop or adapt screening instruments for use in Eastern cultures, outcomes are not always optimal. For instance, translated screening instruments showed low sensitivity (0.48) in identifying children with ASD in Japan (Kamio et al., 2014), and had low to moderate internal consistencies in China (0.21–0.69) (Zhang et al., 2018). There is preliminary evidence suggesting subtle differences in autistic traits across Eastern and Western countries (de Leeuw et al., 2020; Freeth et al., 2014; Norbury & Sparks, 2013). For example, disinterest toward other children, which is an important indicator of autism in the original screening tools developed in the United States (Robins et al., 2001), is not reported by Japanese caregivers as an autism symptom

✉ Chongying Wang
chongyingwang@nankai.edu.cn

1 Department of Clinical, Neuro and Developmental Psychology, Vrije Universiteit Amsterdam, Amsterdam, The Netherlands

2 Faculty of Health, University of Technology Sydney, Sydney, Australia

3 Institute of Psychiatry, Psychology and Neuroscience, King's College London, London, UK

4 Department of Social Psychology, Zhou Enlai School of Government, Nankai University, 38 Tongyan Road, Tianjin, China

5 Department of Special Education, Guangxi College for Preschool Education, Nanjing, China

of their children with ASD (Inada et al., 2011). As Japanese people generally are more introverted than westerners (Wakabayashi et al., 2006a, 2006b), Japanese caregivers may interpret a lack of interest in other children as modesty or shyness rather than an autistic trait. Therefore, assessment tools that have been developed and standardized in the West may not be reliable or valid if applied in other non-Western cultures (Henrich et al., 2010). In line with this, a lack of culturally adapted screening tools may further contribute to the discrepancies in prevalence estimates (Pang et al., 2018). China, with a population of almost 1.4 billion and an increasing prevalence of ASD, represents an enormously growing population of individuals with ASD. Yet, the prevalence rate of autism in Chinese children is reported to be 0.7% (Zhou et al., 2020), which is lower than the 1–2% prevalence rates among Western children (Baron-Cohen et al., 2009; Xu et al., 2018). Thus, further research is needed to evaluate whether autism screening tools are culturally appropriate and whether they are valid across different countries and cultures. So far, there have been no systematic comparisons of children's autistic traits from Chinese and Western samples.

Besides the role of culture, socioeconomic status (SES) and demographic (sex and age) information may also impact on the recognition, interpretation and reporting of autistic traits. Parents from low SES families (e.g., lower maternal education) within the United States tend to over-report symptoms associated with ASD (Khowaja et al., 2014; Scarpa et al., 2013) and exhibit lower consistency in screening outcomes when compared to families with higher maternal education levels (Khowaja et al., 2014). This high false-positive rate might be due to the limited awareness of early childhood development and behaviors in families with low SES (Bishop-Fitzpatrick & Kind, 2017; Colbert et al., 2017; Ratto et al., 2016) or lack of internal consistency and accuracy in screening tools across low SES groups (Scarpa et al., 2013). Whether the effects of SES on parental report of children's autistic traits is the same in different cultural contexts is still unknown. Within ASD, males outnumber females with a sex ratio of 4.3:1 (Maenner, 2020). Previous studies found that boys with ASD are prone to isolation and thus less social (Hiller et al., 2015) and have more stereotyped and repetitive behaviors than girls (Hiller et al., 2015; Sun et al., 2019; Szatmari et al., 2012). Moreover, although ASD is generally considered a 'life-long' condition, the severity of core symptoms seems to increase or decrease as children grow older (Fountain et al., 2012; Louwerse et al., 2015; Scheeren et al., 2019). Increased insight into the effects of SES, sex and age on autistic traits in children with ASD will promote screening and diagnostic accuracy.

Worldwide, the most frequently used questionnaire for autism is the Autism-spectrum Quotient (AQ; Baron-Cohen et al., 2001), which is a 50-item self-report or parent-report measure. The parent-report children's version of the AQ (AQ-Child) aims to quantify autistic traits in children 4–11 years old across five theoretical domains (Social skills, Attention to detail, Attention switching, Communication and Imagination) (Auyeung et al., 2007; Baron-Cohen et al., 2001). The factor structure of the parent-report AQ-Child varies according to different studies (Auyeung et al., 2007; Gomez et al., 2018; Sun et al., 2019). Auyeung et al. (2007) found a 4-factor model (Mind-reading, Attention to detail, Social Skills and Imagination), with 47 items based on 1225 typically developing UK children. A Chinese study reported a 5-factor model (Socialness, Social communicative competence, Imagination, Patterns and Attention Switching), with 30 items in a sample of 1020 typically developing children (Sun et al., 2019). However, they reported a low alpha coefficient (0.588) for the Attention Switching domain, suggesting weak internal consistency of this subscale. Finally, Gomez et al. (2018) found a 4-factor model with 32 items reflecting Mind-reading, Social Skills, Attention to details and Imagination in 404 Australian children with a diagnosis of Attention Deficit/Hyperactivity Disorder (ADHD). These inconsistent factor structures raise the concern that the construct validity and latent structure of the AQ-Child may differ across samples, countries and cultures. These studies have all been conducted in samples that are typically developing or had additional diagnoses such as ADHD. Therefore, there is a need for evaluating the structure of this parent report measure within a sample of children with ASD.

A popular, shortened version, the Autism Spectrum Quotient-Short Form (AQ-Short, Hoekstra et al., 2011), includes 28 items targeting the core dimensions of autism and is suitable for quick assessment of autistic traits in large samples (Murray et al., 2013; Rentergem et al., 2019). Previous research has supported a two-factor structure, including a social behavior factor and a numbers and patterns factor, of the self-report AQ-Short in adults with ASD (Grove et al., 2016; Kuenssberg et al., 2014; Murray et al., 2013). While these results indicate that the AQ-Short is a valid and useful autism screening instrument in adults with ASD, the AQ-Short has not been tested as a parent report measure of autistic traits in children with ASD. As mentioned above, previous research evaluating the factor structure of the AQ-Child suggests a large degree of variability across samples and cultures. The reliability and validity of the parent-report AQ in samples of children with ASD needs more investigation. Moreover, underlying differences in the interpretation and reporting of autistic traits in different countries may affect the generalizability of Western screening tools in Eastern cultures. Clearly, there remains a need for structural validation studies to investigate whether the AQ-Short can be adapted as a parent report measure for use across cultures.

The current study's objectives are threefold: (a) examine the factor structure of the parent-report version of the

AQ-Short for children with ASD in China and the Netherlands; (b) compare autistic traits between children with ASD in China and the Netherlands; (c) explore the role of SES, children's gender and age on parent-reported autistic traits in China and the Netherlands. As specified in our preregistered analysis plan (authors blinded), we expect that (1) the underlying factor structures of the AQ-Short for each population are similar; (2) more autistic traits will be reported for the Chinese compared to the Dutch participants; and (3) boys will be reported to score higher than girls on autistic traits in both countries.

Method

Study Sample

The current study included parent-reported data on children with ASD from China (n = 327, 85% boys, 3 to 17 years) and the Netherlands (n = 694, 78% boys, 6 to 16 years). The Chinese sample (n = 327) was recruited through the China Association of Persons with Psychiatric Disability and their Relatives (CAPPDR), the national autism organization in charge of providing services for ASD in China. Members of the CAPPDR service centers from all over China invited their patients and families to participate in our study. This data collection was conducted online in late 2018. Children diagnosed with ASD or receiving an ASD subsidy from the government were included in the final sample. Data of Dutch children with ASD (n = 694) were collected via the Netherlands Autism Register (NAR, https://www.nederlandsautismeregister.nl/english/), an online database that collects information from individuals with ASD and their families. The NAR data have been collected in annual waves since 2013 and cover various domains including general demographics, clinical diagnosis, co-occurring conditions, and autistic traits. All participants had a formal ASD diagnosis, the sample did not include control participants.

Measurements

Background information of the children and the parents was collected using structured questions on demographics (age, sex) and socioeconomic status (parents' employment status and family income). Parents reported their employment status in three categories: employed, unemployed and other. Income data were available for 309 Chinese and 143 Dutch parents. Chinese parents reported their monthly income, whereas Dutch parents selected one of eight predefined yearly income levels. Since the two countries differ in absolute income, the categorization of income levels was based on country-specific percentiles (low: below 30th percentile; middle: 30–70th percentile; high: above 70th percentile) of the data from the National Bureau of Statistics of China (2019) and Statistic Netherlands (National CBS, 2019) separately. We categorized family income into low (China: 0–¥3590 a month, €0–€5532 a year; Netherlands: €0–€30,000), middle (China: ¥3590–¥9118 a month, €5532–€14,052 a year; Netherlands: €30,000–€70,000), and high income (China: above ¥9118, above €14,052 a year; Netherlands: > €70,000).

The Autism Spectrum Quotient-Short

The parent-report version of the Autism Spectrum Quotient Short Form (AQ-Short) is based on the adult self-report version (Hoekstra et al., 2011), which includes 28 items comprising two higher-order factors assessing 'social behavior difficulties' and 'a fascination for numbers/patterns'. The higher order social behavior factor consists of Social Skills, Routine, Switching and Imagination. Each statement can be answered on a 4-point Likert scale (1 = definitely agree; 2 = slightly agree; 3 = slightly disagree; 4 = definitely disagree). The scoring is reversed for items in which an "agree" response is characteristic for autism (13 out of 28 items). Scores on the AQ-Short range from 28 to 112, with higher scores indicating greater endorsement of autistic traits. The AQ-Short has good sensitivity and specificity in distinguishing individuals with ASD from controls and has been shown to correlate highly with the original 50-item version of the measure (Hoekstra et al., 2011). The AQ-Short has previously been translated into Dutch (Hoekstra et al., 2008). The translation of the Chinese version of the AQ-Short was done by three experts, which followed the forward and backward procedure (Hall et al., 2017). For the parent-report version of the AQ-Short, the first-person perspective ("I") of the items was changed into a third-person perspective ("He/She").

Community Involvement

This study was not designed with community involvement, but the content and formulation of the NAR (Dutch) survey was developed together with a panel of individuals with ASD and their parents. The NAR also has several team members with ASD.

Statistical Analysis

Confirmatory Factor Analysis

Before conducting group comparisons, we first needed to make sure the factor structure of the parent-report AQ-Short was comparable between China and the Netherlands. The data was first cleaned, coded, and analyzed using SPSS version 22.0 for Windows (SPSS Inc., Chicago, IL). Following

the factor structure identified in adult samples in Hoekstra et al. (2011), a two-factor hierarchical model was implemented in which the social skills, routine, switching, and imagination factors were predicted to load on a higher-order social behavior factor. The numbers and patterns items were predicted to load on a separate factor. This model was estimated both within the total sample and in China and the Netherlands separately. Confirmatory factor analyses (CFAs) on the parent-report AQ-Short were conducted using M*Plus* version 7 (Muthén & Muthén, 2012). To compare the relative fit of the models, approximation fit indices including the comparative fit index (CFI; Hu & Bentler, 1998) and Tucker-Lewis index (TLI; Tucker & Lewis, 1973) and the root mean square error of approximation (RMSEA; Steiger & Lind, 1980) were calculated. For CFI and TLI, values above 0.90 indicate a reasonable model fit, with values above 0.95 indicating a good fit to the data (Hu & Bentler, 1999; Marsh et al., 2004). For RMSEA, values below 0.06 indicate a good fit to the data (Browne and Cudeck, 1993).

Exploratory Factor Analysis

EFA analyses were conducted to further explore the underlying relationships among the items. For these analyses, WLSMV estimation with promax (i.e., oblique) rotation was applied. Norris and Lecavalier (2010) suggest that a scree plot, model fit indices, content and interpretability of the factors, salience of item loadings, items with cross-loadings, and the number of salient items in the factors should be used to ascertain the number of factors to be retained. Items with a factor loading of less than 0.32 and/or items with strong cross-loadings (loaded ≥ 0.40 on more than one factor) were dropped (Tabachnick & Fidell, 2007). Only factors with three or more strongly loading items were considered solid and justifiable factors (Costello & Osborne, 2005).

Internal Consistency and Relationships Between Factors

Cronbach's alpha and correlations among the latent factors were estimated to measure the internal consistency and the correlations between the identified factors of the EFA model for the Chinese and the Dutch samples separately.

Group Comparison

Differences in demographics and SES characteristics across countries were evaluated using χ^2 tests (for categorical variables) and t-tests (for continuous variables). The impact of demographic variables (age and sex) and SES were evaluated per country. All statistical tests were two-tailed with an alpha of 0.05. Where appropriate, these were corrected for multiple testing using the false discovery rate (FDR) procedure (Benjamini & Hohberg, 1995). Where applicable, effect sizes were calculated (Cohen, 2013). Preregistration of this study can be found at Open Science Framework (authors blinded).

Results

Table 1 presents the primary participant demographic characteristics in the Chinese and Dutch samples. The Dutch sample had a less skewed girl to boy ratio (1:3.5 compared to 1:5.5), was significantly older ($t = -16.95$, $p < 0.001$, $d = -1.17$). A smaller proportion of the Netherlands ample reported having a low-income (17.5%) compared to the Chinese sample (40.5%). In both countries, most fathers were employed, but more Dutch mothers (65.4%) were employed compared to Chinese mothers (56.9%).

Factor Analysis of the AQ-Short in China and the Netherlands

Confirmatory factor analyses were performed for the Chinese and Dutch samples separately. The fit indices for the Chinese AQ-Short model were: $\chi^2 = 1378.68$, $df = 345$, $p < 0.001$; RMSEA = 0.096; CFI = 0.770; TLI = 0.748. The fit indices for the Dutch CFA model were: $\chi^2 = 1327.69$, $df = 345$, $p < 0.001$; RMSEA = 0.064; CFI = 0.876; TLI = 0.864. Only the RMSEA value in the Dutch sample indicated a good model fit. The CFI, TLI values indicated moderate to poor model fit for both the Chinese and Dutch samples. Thus, there was little support for the two-factor model previously identified for the self-report adult AQ-Short. We therefore used exploratory factor analysis (EFA) to ascertain an alternate better fitting model separately for the AQ-Short in China and the Netherlands, using the same sample.

Chinese EFA Results

The scree plot for the Chinese sample suggested three or four factors. Both 3- and 4-factor models showed good fit, as indicated by RMSEA, CFI, and TLI values (see fit indices in supplementary Table 1). However, the second factor of the 4-factor model only contained one item. Taken together, the scree plot, fit values, and the number of salient items supported a 3-factor model. Item 6 "When s/he reads a story, s/he can easily imagine what the characters might look like" and item 11 "S/he finds making up stories easy" were dropped due to high cross-loadings on two factors (> 0.40). Item 17 "It does not upset him/her if his/her daily routine is disturbed" was dropped based on a low factor loading (< 0.32). Corresponding to the original AQ-Short factor model, we labeled factors 1, 2, 3 as Numbers and Patterns, Social Skills, and Mind-Reading, respectively. Final factor

Table 1 The demographic variables between China and the Netherlands

Variables	China		The Netherlands		Statistics
	N	%/SD	n	%/SD	
Total N	327	100.0	694	100.0	
Sex					χ^2=6.87, p < .01
Male	277	84.7	539	77.7	
Female	50	15.3	155	22.3	
Mean age	8.59	2.97	11.81	2.54	t = − 16.95, p < .001
Father's employment status					χ^2=2.02, p > .05
Employed	292	89.3	600	86.5	
Unemployed	33	10.1	91	13.1	
Not reported	2	0.6	3	0.4	
Mother's employment status					χ^2=79.21, p < .001
Employed	137	41.9	454	65.4	
Unemployed	186	56.9	199	28.7	
Not reported	4	1.2	41	5.9	
Family income level					
Low income	125	40.5	25	17.5	
Middle income	132	42.7	83	58.0	
High income	52	16.8	35	24.5	

loadings of the 3-factor model (25 items) for the Chinese sample are presented in Table 2. Correlations among the latent factors for the Chinese sample are shown in Table 3.

Dutch EFA Results

The scree plot for the Dutch sample suggested four or five factors. Only the 4- and 5-factor models showed a good fit in the RMSEA value and the CFI and TLI values (see fit indices in Supplementary Table 2). The fourth factor "Attention Switching" and the fifth factor "Imagination" in the 5-factor model together made up the third factor in the 4-factor model. Even though in the 4-factor model, an "Attention Switching" factor and an "Imagination" factor were effectively combined into one factor, this combined factor was neither conceptually congruent with the theme of their designated factor, nor resembled any factors in the original AQ-Short models (Hoekstra et al., 2011). The five-factor Dutch model was conceptually comparable to the original AQ-Short, although the original two-factor hierarchical model previously identified in adult self-report samples was not replicated in this sample. Thus, the five-factor model was deemed the optimal model. Item 8 "In a social group, s/he can easily keep track of several different people's conversations" was eliminated based on a low factor loading (< 0.32) and item 19 "S/he enjoys doing things spontaneously" was eliminated based on high cross-loadings on two factors (> 0.40). Corresponding to the AQ-Short, we labeled factors 1, 2, 3, 4, and 5 as Imagination, Numbers and Patterns, Social Skills, Attention Switching, and Mind-reading. Final factor loadings of the 5-factor model (26 items) for the Dutch sample are presented in Table 4. Correlations among the latent factors measuring the internal relatedness of the EFA model for the Dutch sample are shown in Table 5.

Internal Consistency and Relationship Between Factors in the EFA Models

Cronbach's alpha scores > 0.70 indicate good internal consistency (Streiner, 2003). However, when dealing with subscales derived from a single questionnaire, values around 0.60 are considered acceptable (Nunnally, 1975). In the Chinese sample, Cronbach's α for the total AQ-Short, Numbers and Patterns, Social Skills and Mind-reading subscales were 0.77, 0.78, 0.84, and 0.65, respectively. For the Dutch sample, Cronbach's α for total AQ-Short, Imagination, Numbers and Patterns, Social Skills, Attention Switching and Mind-reading were 0.82, 0.71, 0.76, 0.75, 0.64, and 0.62, respectively.

Overall, the relations between factors in the Chinese and Dutch EFA models ranged from very weak to moderate (0.05 to 0.43). Against expectation, a negative modest correlation (− 0.19) was found between the Social Skills and Numbers and Patterns factors in the Chinese sample, indicating that increased attention to numbers and patterns was associated with better social skills.

Impact of Age, Sex, and Socioeconomic Status (SES) Based on Country-Dependent Analysis

Due to different factor structures in the Chinese and Dutch sample, it was not possible to compare the AQ-Short total

Table 2 Chinese AQ-short fit indices: RMSEA = 0.051 CFI = 0.952 TLI = 0.937

Item	Content	Factor loadings			Original subscale
Factor 1 Number/Patterns		1	2	3	
5	S/he usually notices car numbers or similar strings of information	0.906*	0.150*	− 0.024	Number/Patterns
7	S/he is fascinated by dates	0.825*	− 0.001	− 0.002	Number/Patterns
10	S/he would rather go to a library than a birthday party	0.471*	− 0.141*	0.239*	Social Skills
13	S/he is fascinated by numbers	0.872*	0.017	0.042	Number/Patterns
16	S/he notices patterns in things all the time	0.424*	− 0.175*	0.173*	Number/Patterns
22	S/he likes to collect information about categories of things (e.g., types of care, types of bird, types of train)	0.476*	− 0.114*	0.241*	Number/Patterns
Factor 2 Social skills					
1	S/he prefers to do things with others rather than on her/his own	− 0.105	0.445*	− 0.041	Social skills
2	S/he prefers to do thing the same way over and over again	0.187*	0.437*	0.312*	Routine
3	If s/he tries to imagine something, s/he finds it very easy to create a picture in her/his mind	− 0.296*	0.402*	0.063	Imagination
4	S/he frequently gets so strongly absorbed in one thing that s/he loses sight of other things	0.325*	0.467*	0.262*	Switching
8	In a social group, s/he can easily keep track of several different people's conversations	− 0.136*	0.557*	0.086	Switching
9	S/he finds social situations easy	0.013	0.744*	− 0.084	Social skills
12	S/he is drawn more strongly to people than to things	0.046	0.670*	0.032	Social skills
18	S/he finds it easy to go back and forth between different activities	− 0.138*	0.679*	0.008	Switching
19	S/he enjoys doing things spontaneously	− 0.045	0.688*	− 0.075	Routine
20	S/he find it easy to work out what someone is thinking or feeling just by looking at their face	− 0.062	0.594*	− 0.001	Imagination
21	If there is an interruption, s/he can switch back to what s/he was doing very quickly	− 0.04	0.544*	− 0.153*	Switching
24	S/he enjoys social occasions	0.125*	0.837*	− 0.125*	Social skills
26	New situations make him/her anxious	0.066	0.327*	0.144*	Routine
27	S/he enjoys meeting new people	− 0.001	0.746*	− 0.051	Social skills
28	S/he finds it very easy to play games with children that involve pretending	− 0.136*	0.691*	0.025	Imagination
Factor 3 Mind reading					
14	When s/he is read a story, s/he finds it difficult to work out the characters' intentions or feelings	0.002	0.101	0.687*	Imagination
15	S/he finds it hard to make new friends	− 0.037	0.344*	0.692*	Social skills
23	S/he finds it difficult to imagine what it would be like to be someone else	0.210*	0.001	0.504*	Imagination
25	S/he finds it difficult to work out people's intentions	0.01	0.299*	0.551*	Imagination
Items omitted from the Chinese AQ-short					
6 When s/he is read a story, s/he can easily imagine what the characters might look like					
11 S/he finds making up stories easy					
17 It does not upset him/her if his/her daily routine is disturbed					
*Significant at 5 % level in geomin factor loading					

Table 3 Chinese geomin factor correlations

	1	2	3
1. Number/Patterns	1		
2. Social skills	− 0.194*	1	
3. Mind reading	0.049	0.193*	1

*Significant at 5% level

and factor scores between countries. However, we were able to examine the impact of demographic variables *within* both countries.

There were no significant sex differences in total AQ-Short scores within both the Chinese and Dutch samples. Dutch boys were reported to score significantly higher than girls on the Numbers and patterns factor

Table 4 Dutch AQ-short fit indices: RMSEA = 0.043; CFI = 0.963 TLI = 0.941

Item	Content	Factor loadings					Original subscale
Factor 1 Imagination		1	2	3	4	5	
3	If s/he tries to imagine something, s/he finds it very easy to create a picture in her/his mind	0.682*	0.004	0.044	0.052	− 0.075	Imagination
6	When s/he is read a story, s/he can easily imagine what the characters might look like	0.834*	0.014	− 0.038	0.027	0.084	Imagination
11	S/he finds making up stories easy	0.615*	0.021	0.123*	− 0.205*	0.044	Imagination
28	S/he finds it very easy to play games with children that involve pretending	0.418*	− 0.017	0.206*	0.056	0.024	Imagination
Factor 2 Number/Patterns							
5	S/he usually notices car numbers or similar strings of information	0.066	0.649*	− 0.073	0.183*	0.029	Number/Patterns
7	S/he is fascinated by dates	0.001	0.905*	− 0.007	− 0.026	− 0.041	Number/Patterns
13	S/he is fascinated by numbers	0.103*	0.880*	0.018	− 0.094	− 0.006	Number/Patterns
16	S/he notices patterns in things all the time	− 0.072	0.505*	0.051	0.289*	-0.093	Number/Patterns
22	S/he likes to collect information about categories of things (e.g., types of care, types of bird, types of train)	− 0.198*	0.482*	0.053	0.202*	0.077	Number/Patterns
Factor 3 Social skills							
1	S/he prefers to do things with others rather than on her/his own	0.029	0.024	0.426*	− 0.116*	0.037	Social skills
9	S/he finds social situations easy	0.023	− 0.065	0.591*	0.066	0.184*	Social skills
10	S/he would rather go to a library than a birthday party	− 0.136*	0.092*	0.591*	0.014	− 0.006	Social skills
12	S/he is drawn more strongly to people than to things	0.083	0.121*	0.456*	0.041	0.099	Social skills
15	S/he finds it hard to make new friends	0.006	0.107*	0.534*	− 0.128*	0.191*	Social skills
24	S/he enjoys social occasions	− 0.037	− 0.042	0.797*	0.048	− 0.077	Social skills
27	S/he enjoys meeting new people	0.073	− 0.035	0.743*	0.013	− 0.06	Social skills
Factor 4 Attention switching							
2	S/he prefers to do thing the same way over and over again	0.015	0.189*	0.016	0.414*	0.123*	Routine
4	S/he frequently gets so strongly absorbed in one thing that s/he loses sight of other things	− 0.248*	0.136*	− 0.025	0.424*	0.175*	Switching
17	It does not upset him/her if his/her daily routine is disturbed	0.064	0.034	0.01	0.539*	0.06	Routine
18	S/he finds it easy to go back and forth between different activities	0.05	− 0.064	0.044	0.708*	− 0.051	Switching
21	If there is an interruption, s/he can switch back to what s/he was doing very quickly	0.089	− 0.053	0.024	0.580*	0.019	Switching
26	New situations make him/her anxious	− 0.011	0.081	0.248*	0.373*	0.067	Routine
Factor 5 Mind reading							
14	When s/he is read a story, s/he finds it difficult to work out the characters' intentions or feelings	0.297*	0.107*	− 0.103*	0.083	0.439*	Imagination
20	S/he find it easy to work out what someone is thinking or feeling just by looking at their face	0.097	− 0.175*	0.066	0.263*	0.392*	Imagination
23	S/he finds it difficult to imagine what it would be like to be someone else	0.074	0.019	0.046	0.032	0.544*	Imagination

Table 4 (continued)

Item	Content	Factor loadings					Original subscale
25	S/he finds it difficult to work out people's intentions	− 0.057	− 0.05	0.028	− 0.024	0.866*	Imagination
Items omitted from the Dutch AQ-short							
8 In a social group, s/he can easily keep track of several different people's conversations							
19 S/he enjoys doing things spontaneously							

Table 5 Dutch geomin factor correlations

	1	2	3	4	5
1. Imagination	1				
2. Number/Patterns	0.084*	1			
3. Social skills	0.244*	0.108*	1		
4. Attention switching	0.302*	0.118*	0.401*	1	
5. Mind reading	0.350*	0.171*	0.274*	0.430*	1

*Significant at 5% level

($t = 4.60$, $p < 0.001$, $d = 0.430$; males = 11.40 [SD = 3.63], females = 9.90 [SD = 3.34]). No other sex differences across the AQ-Short subscale scores were found within the Dutch sample. There were no significant sex differences found in any of the subscales within the Chinese sample.

In the Chinese sample, older children had lower total AQ-Short scores and lower Numbers and Patterns scores than young children ($r = -0.16$, $p = 0.04$; $r = -0.14$, $p = 0.043$). Similarly, older Dutch children had lower total AQ-Short scores ($r = -0.10$, $p = 0.042$), Attention switching scores ($r = -0.13$, $p = 0.01$) and Numbers and patterns scores ($r = -0.20$, $p < 0.001$). The specific results of sex and age differences in both countries are shown in supplementary Table 3.

Within the Chinese sample, parents who were unemployed reported fewer autistic traits (AQ-Short total) and better social-skills for their child compared with employed Chinese mothers ($F = 4.82$, $p = 0.04$, $\eta^2 = 0.029$; $F = 6.668$, $p = 0.01$, $\eta^2 = 0.040$). Chinese parents in the low income bracket also reported fewer autistic traits and better mind-reading skills in their children with ASD ($F = 4.41$, $p = 0.04$, $\eta^2 = 0.028$; $F = 9.58$, $p < 0.001$, $\eta^2 = 0.059$) than children of parents with middle and high income levels (see supplementary Table 4). In the Dutch sample, parents who were unemployed reported worse mind-reading skills for their child compared with those who were employed ($F = 5.59$, $p = 0.03$, $\eta^2 = 0.016$). There was no relationship between AQ-Short subscale scores and income level in the Dutch sample (see supplementary Table 5).

Item Comparison Between China and the Netherlands

To get a deeper understanding of potential cross-cultural differences on the AQ-Short in children with ASD, the nonparametric Mann–Whitney U test ($p < 0.05$) was used to test for cross-cultural differences at an item level (see supplementary Table 6). Out of the 23 'Social behaviors' items based on the original AQ-Short factor structure, there was a higher endorsement on nine items (39%), lower endorsement on seven items (30%) and no significant difference on the other seven items (30%) for the Chinese sample compared with Dutch participants. Out of five 'Numbers and patterns' items based on the original AQ-Short factor structure, the Chinese sample showed a higher endorsement of one item (20%), lower endorsement on three items (60%) and no significant difference on the other one items (20%). We also checked potential sex differences on item level across countries. Out of the 28 items, boys showed higher endorsement on four numbers and patterns items (80%, out of five items) and three social behaviors items (13%, out of 23 items), lower endorsement on five social behaviors items (22%, out of 23 items) and no significant differences on the other 16 items compared with girls. No cross-cultural sex differences on the AQ-Short item scores were found.

Discussion

This study examined and compared the factor structure of the parent-reported AQ-Short for children with ASD from China and the Netherlands. Initial CFA models showed that the AQ-Short child version did not map onto the two-factor hierarchical model previously identified in typically developing adults (Hoekstra et al., 2011) and adults with ASD (Grove et al., 2016). Subsequent exploratory factor analyses supported a three-factor model in the Chinese sample (Numbers and Patterns, Social Skills, and Mind-reading) and a five-factor model in the Dutch sample

(Imagination, Numbers and Patterns, Attention Switching, Social Skills, and Mind-reading). SES, sex and age influences on AQ-Short scores were observed. Older children tended to receive lower AQ-Short scores in both countries. Chinese children from low SES families also tended to receive lower AQ scores.

Even though the EFA results showed a different factor structure for the Chinese and Dutch parent-reported AQ-Short, the Social Skills factor, Numbers and Patterns factor, and Mindreading factor emerged in both models, suggesting that the same types of behaviors tended to group together in different cultures. Consistent with the original adult AQ-Short (Hoekstra et al., 2011), a Social Skills factor and a Number and Patterns factor was found. However, the items loading on the Social Skills factor in the Chinese model included a combination of items loading on separate factors in the Dutch model (Social Skills, Attention Switching, and Imagination), indicating that certain behaviors group together differently across cultures. Specifically, Social Skills, Attention Switching and Imagination factors appear more closely linked in children with ASD in China than in the Netherlands.

How parents interpret and report on their child's behavior is likely influenced by culture (de Leeuw et al., 2020; Norbury & Sparks, 2013). Certain AQ-Short items may therefore be interpreted differently in Eastern and Western cultures. For example, item 18 "S/he finds it easy to go back and forth between different activities", is part of attention switching in the Netherlands, but loaded on the social skills factor in China. Possibly, in China, social skills depend more strongly on the ability to switch between activities and contexts, so as to preserve group harmony. There is also a special term, Ren Qing (人情), for social favors exchanged in the form of money, information, or affection. Item 20 "S/he finds it difficult to work out other's thinking and feeling by looking at their face" loaded onto the Social Skills factor in the Chinese sample, but in the Dutch sample, it loaded onto the Mind-reading factor. The concept of Mind-reading, describing difficulty in perspective-taking (Baron-Cohen et al., 1985), emerged as Communication/Mindreading in Austin (2005)'s 3-factor model (Social skills, Attention to details/patterns and Mindreading/Communication). Perspective taking may depend less on the ability to decipher someone's facial expression in China, but more so on the understanding and incorporation of the entire social context. This would be in line with earlier study findings that Asian participants attended to the whole social context when interpreting facial expressions, while American participants focused exclusively on faces (e.g., Masuda et al., 2008). Moreover, Chinese parents tended to endorse social behavior items slightly more compared to Dutch parents based on the original AQ-Short factor structure. Dutch parents more likely endorsed number and pattern items compared to Chinese parents. In sum, there may be subtle cross-cultural differences in how parents reflect on their children's social behaviors.

Of further note is the modest negative correlation between Numbers and Patterns and Social Skills in the Chinese sample. This negative correlation has also been reported in previous studies using the AQ (Kloosterman et al., 2011; Lau et al., 2013; Ward et al., 2021). The items assessing interests in numbers and patterns may not be a good measure of autistic traits in Chinese children, as also indicated by the large proportion of Chinese parents that reported to "strongly disagree" on all of the Numbers and Patterns items (see supplementary Fig. 1). Thus, a large number of Chinese parents in this sample disagreed that their child with ASD showed a particular interest in numbers and patterns. In the Dutch sample, items 5, 7 and 13 of the Numbers and patterns factor also showed an inverse distribution. An alternative explanation of these seemingly counterintuitive results is to conceive autism as a multi-dimensional spectrum rather than a linear one. Consistent with a two-dimensional spectrum, Kitazoe et al. (2017) performed a cluster analysis of the AQ on a Japanese sample and found that participants scoring high on total AQ could be divided into two groups: one with low scores on the Attention to detail subscale but high scores on the other four subscales and the other with high scores on all five subscales. Thus, it is conceivable that some individuals with ASD may have less interest in details.

Parent-reported AQ-Short factor scores generally were the same for boys and girls in the present study, conflicting with some previous findings on sex differences in the social behavior factor of the self-report AQ-Short in adults with ASD (Hoekstra et al., 2011; Grove et al., 2016). The discrepancy between these findings and other previous adult AQ-Short studies may be (a) because women with ASD may experience more problems or are more aware of their autistic traits than men with ASD (Lai et al., 2011), or (b) parents may not recognize all autistic traits of their daughters, perhaps because girls are better at camouflaging (Jorgenson et al., 2020; Lai et al., 2016). The compensatory camouflaging may help girls receive a more similar levels of parent-reported autistic traits compared to boys. However, boys were reported to have more interest in numbers and patterns than girls in the Dutch sample, which is consistent with previous research (Grove et al., 2016; Hattier et al., 2011). The comparison between boys and girls at the item level across countries also indicated subtle biases. Boys with ASD showed a higher endorsement of the Numbers and patterns items. In both samples, parents reported fewer autistic traits and less interest in numbers and patterns for older children, suggesting that autistic symptoms and special interests may decrease with age (Waizbard-Bartov et al., 2020). However, parents of older children may also be more used to their child's difficulties and thus underreport, despite their child

potentially experiencing the same level of autistic traits as younger children. It should be noted that the reported correlations are very small. However, Bujang and Baharum (2016) found that the correlation coefficient of 0.1 can be considered important when the lowest minimum sample size is 782. The findings from these groups should be interpreted with care.

SES was associated with parent-reported autistic traits. Unemployed Chinese mothers reported fewer autistic traits and better social skills for their child than employed Chinese mothers. Unemployed Dutch mothers reported worse mind-reading skills for their child than employed Dutch mothers. Furthermore, low-income Chinese families reported fewer autistic traits than middle and high-income families, which is inconsistent with previous research in Western countries showing that low SES families were more likely to endorse autistic traits (Khowaja et al., 2014; Scarpa et al., 2013). This inconsistency might be because low-income families in China are less willing to report autistic traits due to stigma and misconceptions of autism (Su et al., 2019; Sun et al., 2013). Alternatively, low-income families in China may have lower awareness and may not recognize these autistic traits in their children (de Leeuw et al., 2020). No association with family income level was found in the Dutch sample. Larger income inequality differences (using the World Bank's Gini coefficient) and higher poverty levels in China may have resulted in more pronounced effects of SES in China compared to the Netherlands. In addition, the relatively low number of low-income families in the Dutch sample resulted in poor statistical power to detect an effect. More studies are needed to investigate the effects of SES on parent reported autistic traits. This is particularly important as autism may be underdiagnosed in low-income families in some cultural contexts (Durkin et al., 2015) and previous studies have suggested screening accuracy may be lower in low-income families (Gurthie et al., 2019).

Limitations

The current findings should be interpreted with caution. First, as participants' intellectual ability was not formally assessed, any between-country differences may also be due to differences in cognitive ability levels. Second, the AQ-Child includes items related to children's subjective, internal states, including imagination and mindreading, which parents may find difficult to report on. While previous studies showed adequate concurrent validity, good internal consistency and good test–retest reliability of the Mind-reading and/or Imagination subscales (Sun et al., 2019; Gomez et al., 2018), it would be worthwhile for future studies to examine differences in validity of the imagination/mindreading subscales and the social behavior subscales. Furthermore, study recruitment was not the same in both countries. Chinese participants were recruited via various services for children with ASD around China and most of these participants were identified at a younger age. In contrast, Dutch data were collected through an online volunteer register, including children with ASD who were not necessarily under treatment or assessment in clinics. Behavior of children receiving services may be rated differently than those who are not under treatment in clinics. Moreover, as only children with autism were examined, it is uncertain whether the factor structure differences are specific to Chinese children with autism or reflect more general cross-cultural differences. For a better understanding of cross-cultural differences, it would be worthwhile to examine which items of the AQ-Short best discriminate between clinical and non-clinical groups across cultures. As such, this study's outcome should be taken into consideration as preliminary.

Conclusion

In summary, the factor structure of the parent-reported AQ-Short was substantially different between China and the Netherlands, suggesting that interpretation and reporting of autism symptoms may be culture-dependent. Differences in item-factor loadings indicate variation in the reporting of autistic traits between parents from China and the Netherlands, and this may hamper cross-cultural comparisons. This indicates that the Chinese version of the AQ-Short may assess slightly different autistic traits than the Western version. It would be worthwhile for future research to interview Chinese parents of children with ASD from low-income families to better explore how they recognize, interpret and report their child's autistic traits. This study is the first to test the factor structure of the parent-report AQ-Short across cultures. While our findings require replication in wider samples, including children without ASD, we were able to show that the items of the AQ-Short generally detect autistic traits equivalently in boys and girls with ASD. Autistic traits and special interests may decrease with age, and this decrease may be similar across countries. However, longitudinal studies are needed to further examine the trajectories of autism severity change during childhood. Furthermore, low SES Chinese families reported fewer autistic traits, making them vulnerable for under-detection, which was not the case in our Dutch participants. The under-reporting of autistic traits in low SES families deserves further research to address culture-specific disparities in autism diagnoses and service access.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s10803-021-05342-9.

Acknowledgments The author is grateful to all the participants and their families, service centers for their participation in this study.

Author Contributions FL, AMS, SB and CW developed the research questions. SB, AMS, KW, DG and CW were responsible for the data collection. FL analyzed the data. AMS, RG, RAH, CW and SB were involved in interpreting the results. FL was responsible for writing with all authors contributing to edits. All authors read and approved the final manuscript.

Funding FL is funded by China Scholarship Council for the study at Vrije Universiteit Amsterdam. AMS is funded by Aut.17.006, The Netherlands Organization for Scientific Research (NWO). RAH receives support from the National Institute of Health Research (NIHR200842) using UK aid from the UK Government. The views expressed in this publication are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care. CW is funded by the grants from the Humanities and Social Sciences Youth Foundation of the Ministry of Education of China (13YJCZH167). The funding bodies did not have a role in the design of the study, data collection, analysis or interpretation of data, or the drafting of the manuscript.

Declarations

Conflict of interest The authors declared no potential conflicts of interest with respect of the research, authorship, and/or publication of this article.

Ethical Approval Ethical requirements were in accordance with Nankai University Department of Social Psychology and the NAR. The Ethical Committee of the Vrije Universiteit Amsterdam approved this research (E1321MW, VCWE-2020-041).

Informed Consent All parents provided informed consent before joining the study.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders*. American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425596

Austin, E. J. (2005). Personality correlates of the broader autism phenotype as assessed by the autism spectrum quotient (AQ). *Personality and Individual Differences, 38*(2), 451–460. https://doi.org/10.1016/j.paid.2004.04.022

Auyeung, B., Baron-Cohen, S., Wheelwright, S., & Allison, C. (2007). The autism spectrum quotient: Children's version (AQ-Child). *Journal of Autism and Developmental Disorders, 38*(7), 1230–1240. https://doi.org/10.1007/s10803-007-0504-z

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "Theory of Mind"? *Cognition, 21*(1), 37–46. https://doi.org/10.1016/0010-0277(85)90022-8

Baron-Cohen, S., Scott, F. J., Allison, C., Williams, J., Bolton, P., Matthews, F. E., & Brayne, C. (2009). Prevalence of autism-spectrum conditions: UK school-based population study. *British Journal of Psychiatry, 194*(6), 500–509. https://doi.org/10.1192/bjp.bp.108.059345

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). 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*(1), 5–17. https://doi.org/10.1023/a:1005653411471

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (methodological), 57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Bishop-Fitzpatrick, L., & Kind, A. J. H. (2017). A scoping review of health disparities in autism spectrum disorder. *Journal of Autism and Developmental Disorders, 47*(11), 3380–3391. https://doi.org/10.1007/s10803-017-3251-9

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Newbury Park, CA: Sage.

Bujang, M. A., & Baharum, N. (2016). Sample size guideline for correlation analysis. *World Journal of Social Science Research, 3*(1), 37. https://doi.org/10.22158/wjssr.v3n1p37

Cohen, J. (2013). Statistical power analysis for the behavioral sciences. *Routledge*. https://doi.org/10.4324/9780203771587

Colbert, A. M., Webber, J., & Graham, R. (2017). Factors that influence autism knowledge in Hispanic cultures: A pilot study. *Journal of Racial and Ethnic Health Disparities, 4*(2), 156–164. https://doi.org/10.1007/s40615-016-0213-4

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research and Evaluation, 10*(7), 1–9.

de Leeuw, A., Happé, F., & Hoekstra, R. A. (2020). A conceptual framework for understanding the cultural and contextual factors on autism across the globe. *Autism Research*. https://doi.org/10.1002/aur.2276

Durkin, M. S., Elsabbagh, M., Barbaro, J., Gladstone, M., Happe, F., Hoekstra, R. A., Lee, L.-C., Rattazzi, A., Stapel-Wax, J., Stone, W. L., Tager-Flusberg, H., Thurm, A., Tomlinson, M., & Shih, A. (2015). Autism screening and diagnosis in low resource settings: Challenges and opportunities to enhance research and services worldwide. *Autism Research, 8*(5), 473–476. https://doi.org/10.1002/aur.1575

Fountain, C., Winter, A. S., & Bearman, P. S. (2012). Six developmental trajectories characterize children with autism. *Pediatrics, 129*(5), e1112–e1120. https://doi.org/10.1542/peds.2011-1601

Freeth, M., Milne, E., Sheppard, E., & Ramachandran, R. (2014). Autism across cultures: perspectives from non-western cultures and implications for research. *Handbook of Autism and Pervasive Developmental Disorders, Fourth Edition*. https://doi.org/10.1002/9781118911389.hautc43

Gomez, R., Stavropoulos, V., & Vance, A. (2018). Psychometric properties of the autism spectrum quotient: Children's version (AQ-Child). *Journal of Autism and Developmental Disorders, 49*(2), 468–480. https://doi.org/10.1007/s10803-018-3713-8

Grove, R., Hoekstra, R. A., Wierda, M., & Begeer, S. (2016). Exploring sex differences in autistic traits: A factor analytic study of adults with autism. *Autism, 21*(6), 760–768. https://doi.org/10.1177/1362361316667283

Guthrie, W., Wallis, K., Bennett, A., Brooks, E., Dudley, J., Gerdes, M., Pandey, J., Levy, S. E., Schultz, R. T., & Miller, J. S. (2019). Accuracy of autism screening in a large pediatric network. *Pediatrics*. https://doi.org/10.1542/peds.2018-3963

Hall, D. A., Zaragoza Domingo, S., Hamdache, L. Z., Manchaiah, V., Thammaiah, S., Evans, C., & Wong, L. L. N. (2017). A good practice guide for translating and adapting hearing-related questionnaires for different languages and cultures. *International Journal of Audiology, 57*(3), 161–175. https://doi.org/10.1080/14992027.2017.1393565

Hattier, M. A., Matson, J. L., Tureck, K., & Horovitz, M. (2011). The effects of gender and age on repetitive and/or restricted behaviors and interests in adults with autism spectrum disorders and intellectual disability. *Research in Developmental Disabilities, 32*(6), 2346–2351. https://doi.org/10.1016/j.ridd.2011.07.028

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature, 466*(7302), 29–29. https://doi.org/10.1038/466029a

Hiller, R. M., Young, R. L., & Weber, N. (2015). Sex differences in pre-diagnosis concerns for children later diagnosed with autism spectrum disorder. *Autism, 20*(1), 75–84. https://doi.org/10.1177/1362361314568899

Hoekstra, R. A., Bartels, M., Cath, D. C., & Boomsma, D. I. (2008). Factor structure, reliability and criterion validity of the Autism-Spectrum Quotient (AQ): a study in Dutch population and patient groups. *Journal of Autism and Developmental Disorders, 38*(8), 1555–1566. https://doi.org/10.1007/s10803-008-0538-x

Hoekstra, R. A., Vinkhuyzen, A. A. E., Wheelwright, S., Bartels, M., Boomsma, D. I., Baron-Cohen, S., Posthuma, D., & van der Sluis, S. (2011). The construction and validation of an abridged version of the autism-spectrum quotient (AQ-Short). *Journal of Autism and Developmental Disorders, 41*(5), 589–596. https://doi.org/10.1007/s10803-010-1073-0

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*(4), 424–453. https://doi.org/10.1037/1082-989x.3.4.424

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Inada, N., Koyama, T., Inokuchi, E., Kuroda, M., & Kamio, Y. (2011). Reliability and validity of the Japanese version of the modified checklist for autism in toddlers (M-CHAT). *Research in Autism Spectrum Disorders, 5*(1), 330–336. https://doi.org/10.1016/j.rasd.2010.04.016

Jorgenson, C., Lewis, T., Rose, C., & Kanne, S. (2020). Social camouflaging in autistic and neurotypical adolescents: A pilot study of differences by sex and diagnosis. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04491-7

Kamio, Y., Inada, N., Koyama, T., Inokuchi, E., Tsuchiya, K., & Kuroda, M. (2014). Effectiveness of using the modified checklist for autism in toddlers in two-stage screening of autism spectrum disorder at the 18-month health check-up in Japan. *Journal of Autism and Developmental Disorders, 44*(1), 194–203. https://doi.org/10.1007/s10803-013-1864-1

Khowaja, M. K., Hazzard, A. P., & Robins, D. L. (2014). Sociodemographic barriers to early detection of autism: Screening and evaluation using the M-CHAT, M-CHAT-R, and follow-up. *Journal of Autism and Developmental Disorders, 45*(6), 1797–1808. https://doi.org/10.1007/s10803-014-2339-8

Kitazoe, N., Fujita, N., Izumoto, Y., Terada, S., & Hatakenaka, Y. (2017). Whether the autism spectrum quotient consists of two different subgroups? Cluster analysis of the autism spectrum quotient in general population. *Autism, 21*(3), 323–332. https://doi.org/10.1177/1362361316638787

Kloosterman, P. H., Keefer, K. V., Kelley, E. A., Summerfeldt, L. J., & Parker, J. D. A. (2011). Evaluation of the factor structure of the autism-spectrum quotient. *Personality and Individual Differences, 50*(2), 310–314. https://doi.org/10.1016/j.paid.2010.10.015

Kuenssberg, R., Murray, A. L., Booth, T., & McKenzie, K. (2014). Structural validation of the abridged autism spectrum quotient-short form in a clinical sample of people with autism spectrum disorders. *Autism, 18*(2), 69–75. https://doi.org/10.1177/1362361312467708

Lai, M.-C., Lombardo, M. V., Pasco, G., Ruigrok, A. N. V., Wheelwright, S. J., Sadek, S. A., Chakrabarti, B., & Baron-Cohen, S. (2011). A behavioral comparison of male and female adults with high functioning autism spectrum conditions. *PLoS ONE, 6*(6), e20835. https://doi.org/10.1371/journal.pone.0020835

Lai, M.-C., Lombardo, M. V., Ruigrok, A. N., Chakrabarti, B., Auyeung, B., Szatmari, P., Happé, F., & Baron-Cohen, S. (2016). Quantifying and exploring camouflaging in men and women with autism. *Autism, 21*(6), 690–702. https://doi.org/10.1177/1362361316671012

Lau, W.Y.-P., Gau, S.S.-F., Chiu, Y.-N., Wu, Y.-Y., Chou, W.-J., Liu, S.-K., & Chou, M.-C. (2013). Psychometric properties of the Chinese version of the autism spectrum quotient (AQ). *Research in Developmental Disabilities, 34*(1), 294–305. https://doi.org/10.1016/j.ridd.2012.08.005

Louwerse, A., Eussen, M. L. J. M., Van der Ende, J., de Nijs, P. F. A., Van Gool, A. R., Dekker, L. P., Verheij, C., Verheij, F., Verhulst, F. C., & Greaves-Lord, K. (2015). ASD symptom severity in adolescence of individuals diagnosed with PDD-NOS in childhood: Stability and the relation with psychiatric comorbidity and societal participation. *Journal of Autism and Developmental Disorders, 45*(12), 3908–3918. https://doi.org/10.1007/s10803-015-2595-2

Maenner, M. J., Shaw, K. A., Baio, J., et al. (2020). Prevalence of autism spectrum disorder among children aged 8 years — Autism and developmental disabilities monitoring network 11 sites, United States, 2016. *MMWR Surveillance Summaries*. https://doi.org/10.15585/mmwr.ss6904a1

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal, 11*(3), 320–341. https://doi.org/10.1207/s15328007sem1103_2

Masuda, T., Ellsworth, P. C., Mesquita, B., Leu, J., Tanida, S., & Van de Veerdonk, E. (2008). Placing the face in context: Cultural differences in the perception of facial emotion. *Journal of Personality and Social Psychology, 94*(3), 365–381. https://doi.org/10.1037/0022-3514.94.3.365

Murray, A. L., Booth, T., McKenzie, K., Kuenssberg, R., & O'Donnell, M. (2013). Are autistic traits measured equivalently in individuals with and without an autism spectrum disorder? An invariance analysis of the autism spectrum quotient short form. *Journal of Autism and Developmental Disorders, 44*(1), 55–64. https://doi.org/10.1007/s10803-013-1851-6

Muthén, L. K., & Muthén, B. O. (2012). *Mplus* (7th ed.). Muthén and Muthén.

National Bureau of Statistics of China (2019). *Per Capita Income and Consumption Expenditure Nationwide*. Retrieved September 11, 2021 from http://www.stats.gov.cn/tjsj/ndsj/2019/indexch.htm

Norbury, C. F., & Sparks, A. (2013). Difference or disorder? Cultural issues in understanding neurodevelopmental disorders. *Developmental Psychology, 49*(1), 45–58. https://doi.org/10.1037/a0027446

Norris, M., & Lecavalier, L. (2010). Evaluating the use of exploratory factor analysis in developmental disability psychological research. *Journal of Autism and Developmental Disorders, 40*(1), 8–20. https://doi.org/10.1007/s10803-009-0816-2

Nunnally, J. C. (1975). Psychometric theory— 25 Years ago and now. *Educational Researcher, 4*(10), 7–21. https://doi.org/10.3102/0013189x004010007

Pang, Y., Lee, C. M., Wright, M., Shen, J., Shen, B., & Bo, J. (2018). Challenges of case identification and diagnosis of autism spectrum disorders in China: A critical review of procedures,

assessment, and diagnostic criteria. *Research in Autism Spectrum Disorders, 53*, 53–66. https://doi.org/10.1016/j.rasd.2018.06.003

Ratto, A. B., Reznick, J. S., & Turner-Brown, L. (2016). Cultural effects on the diagnosis of autism spectrum disorder among Latinos. *Focus on Autism and Other Developmental Disabilities, 31*(4), 275–283. https://doi.org/10.1177/1088357615587501

Robins, D. L., Fein, D., Barton, M. L., & Green, J. A. (2001). The modified checklist for autism in toddlers: An initial study investigating the early detection of autism and pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 31*(2), 131–144. https://doi.org/10.1023/a:1010738829569

Saito, A., Stickley, A., Haraguchi, H., Takahashi, H., Ishitobi, M., & Kamio, Y. (2017). Association between autistic traits in preschool children and later emotional/behavioral outcomes. *Journal of Autism and Developmental Disorders, 47*(11), 3333–3346. https://doi.org/10.1007/s10803-017-3245-7

Scarpa, A., Reyes, N. M., Patriquin, M. A., Lorenzi, J., Hassenfeldt, T. A., Desai, V. J., & Kerkering, K. W. (2013). The modified checklist for autism in toddlers: Reliability in a diverse rural American sample. *Journal of Autism and Developmental Disorders, 43*(10), 2269–2279. https://doi.org/10.1007/s10803-013-1779-x

Scheeren, A. M., Koot, H. M., & Begeer, S. (2019). Stability and change in social interaction style of children with autism spectrum disorder: A 4-year follow-up study. *Autism Research*. https://doi.org/10.1002/aur.2201

Statistics Netherlands (CBS). (2019). Retrieved September 11, 2021 from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83932NED/table?%20ts=1565008102724

Steiger, J. H., & Lind, J. M. (1980). *Statistically based tests for the number of common factors*. Paper presented at Meeting of the psychometric society.

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80*(1), 99–103. https://doi.org/10.1207/s15327752jpa8001_18

Su, S., Paynter, J., & Gilmore, L. (2019). Chinese parents' understanding of autism spectrum disorder. *International Journal of Disability, Development and Education*. https://doi.org/10.1080/1034912x.2019.1687857

Sun, F., Dai, M., Lin, L., Sun, X., Murray, A. L., Auyeung, B., & Jing, J. (2019). Psychometric properties of the chinese version of autism spectrum quotient-children's version: A sex-specific analysis. *Autism Research, 12*(2), 303–315. https://doi.org/10.1002/aur.2053

Sun, X., Allison, C., Auyeung, B., Matthews, F. E., Baron-Cohen, S., & Brayne, C. (2013). Service provision for autism in mainland China: Preliminary mapping of service pathways. *Social Science and Medicine, 98*, 87–94. https://doi.org/10.1016/j.socscimed.2013.08.016

Szatmari, P., Liu, X., Goldberg, J., Zwaigenbaum, L., Paterson, A. D., Woodbury-Smith, M., Georgiades, S., Duku, E., & Thompson, A. (2012). Sex differences in repetitive stereotyped behaviors in autism: Implications for genetic liability. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, 159B*(1), 5–12. https://doi.org/10.1002/ajmg.b.31238

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Pearson Education, Cop.

Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*(1), 1–10. https://doi.org/10.1007/bf02291170

van Rentergem, J. A. A., Lever, A. G., & Geurts, H. M. (2019). Negatively phrased items of the autism spectrum quotient function differently for groups with and without autism. *Autism, 23*(7), 1752–1764. https://doi.org/10.1177/1362361319828361

Waizbard-Bartov, E., Ferrer, E., Young, G. S., Heath, B., Rogers, S., Wu Nordahl, C., Solomon, M., & Amaral, D. G. (2020). Trajectories of autism symptom severity change during early childhood. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04526-z

Wakabayashi, A., Baron-Cohen, S., Uchiyama, T., Yoshida, Y., Tojo, Y., Kuroda, M., & Wheelwright, S. (2006a). The autism-spectrum quotient (AQ) children's version in japan: A cross-cultural comparison. *Journal of Autism and Developmental Disorders, 37*(3), 491–500. https://doi.org/10.1007/s10803-006-0181-3

Wakabayashi, A., Baron-Cohen, S., & Wheelwright, S. (2006b). Are autistic traits an independent personality dimension? A study of the autism-spectrum quotient (AQ) and the NEO-PI-R. *Personality and Individual Differences, 41*(5), 873–883. https://doi.org/10.1016/j.paid.2006.04.003

Ward, J., Ren, Z., & Qiu, J. (2021). Autistic traits in the neurotypical Chinese population: A Chinese version of Glasgow sensory questionnaire and a cross-cultural difference in attention-to-detail. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04829-1

West, E. A., Travers, J. C., Kemper, T. D., Liberty, L. M., Cote, D. L., McCollow, M. M., & Stansberry Brusnahan, L. L. (2016). Racial and ethnic diversity of participants in research supporting evidence-based practices for learners with autism spectrum disorder. *The Journal of Special Education, 50*(3), 151–163. https://doi.org/10.1177/0022466916632495

World Bank's Gini coefficient in the Netherlands https://data.worldbank.org/indicator/SI.POV.GINI?locations=NL and in China https://data.worldbank.org/indicator/SI.POV.GINI?locations=CN

Xu, G., Strathearn, L., Liu, B., & Bao, W. (2018). Corrected prevalence of autism spectrum disorder among US children and adolescents. *JAMA, 319*(5), 505. https://doi.org/10.1001/jama.2018.0001

Zhang, M.-X., Yang, P.-Y., Hu, X., Guo, K.-F., Situ, M.-J., & Huang, Y. (2018). Reliability and validity of the abridged Chinese version of autism spectrum quotient-child form in China. *Journal of Sichuan University, 49*(4), 599–603.

Zhou, H., Xu, X., Yan, W., Zou, X., Wu, L., Luo, X., Li, T., Huang, Y., Guan, H., Chen, X., Mao, M., Xia, K., Zhang, L., Li, E., Ge, X., Zhang, L., Li, C., Zhang, X., Zhou, Y., & Ding, D. (2020). Prevalence of autism spectrum disorder in china: A nationwide multi-center population-based study among children aged 6 to 12 years. *Neuroscience Bulletin, 36*(9), 961–971. https://doi.org/10.1007/s12264-020-00530-6