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Journal

Journal of Child and Adolescent Psychopharmacology, 26(9)

ISSN

1044-5463

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Publication Date

2016-11-01

DOI

10.1089/cap.2016.0021

Peer reviewed

Often Asked but Rarely Answered: Can Asians Meet DSM-5/ICD-10 Autism Spectrum Disorder Criteria?

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Abstract

Objectives: To evaluate whether Asian (Korean children) populations can be validly diagnosed with autism spectrum disorder (ASD) using Western-based diagnostic instruments and criteria based on *Diagnostic and Statistical Manual on Mental Disorders*, 5th edition (DSM-5).

Methods: Participants included an epidemiologically ascertained 7–14-year-old ($N=292$) South Korean cohort from a larger prevalence study ($N=55,266$). Main outcomes were based on Western-based diagnostic methods for Korean children using gold standard instruments, Autism Diagnostic Interview-Revised, and Autism Diagnostic Observation Schedule. Factor analysis and ANOVAs were performed to examine factor structure of autism symptoms and identify phenotypic differences between Korean children with ASD and non-ASD diagnoses.

Results: Using Western-based diagnostic methods, Korean children with ASD were successfully identified with moderate-to-high diagnostic validity (sensitivities/specificities ranging 64%–93%), strong internal consistency, and convergent/concurrent validity. The patterns of autism phenotypes in a Korean population were similar to those observed in a Western population with two symptom domains (social communication and restricted and repetitive behavior factors). Statistically significant differences in the use of socially acceptable communicative behaviors (e.g., direct gaze, range of facial expressions) emerged between ASD versus non-ASD cases (mostly $p < 0.001$), ensuring that these can be a similarly valid part of the ASD phenotype in both Asian and Western populations.

Conclusions: Despite myths, biases, and stereotypes about Asian social behavior, Asians (at least Korean children) typically use elements of reciprocal social interactions similar to those in the West. Therefore, standardized diagnostic methods widely used for ASD in Western culture can be validly used as part of the assessment process and research with Koreans and, possibly, other Asians.

Keywords: autism spectrum disorder, diagnostic assessment, cross-cultural application

Introduction

QUESTIONS HAVE BEEN raised about cultural variability in autism (and autism spectrum disorder [ASD]) phenotypic expression, including how ASD symptoms are perceived and diagnostic instruments/methods are used outside the “Western” context. The lay and scientific communities have concerns about the following: Cultural factors impacting parent, teacher, and clinician perceptions of social and communication deficits; socio-cultural factors affecting interpretations of ASD symptoms; and the validity of Western-developed diagnostic instruments/methods for

ASD in non-European populations (Lotter 1978; Lian 1996; Daley 2004; Matson and Kozlowski 2011; DeWeerd 2012; Grinker et al. 2012; Baker 2013; Kang-Yi et al. 2013). Academic, clinical, and policy decision-making with respect to ASD in non-European populations are affected by the absence of data, as well as bias and preconceived notions about particular cultural groups.

ASD is characterized by impairments in social reciprocity and/or communication, stereotyped behavior, and restricted interests. Experienced clinicians reliably diagnose ASD by age 2, based on the *Diagnostic and Statistical Manual on Mental Disorders*, 5th edition (DSM-5; American Psychiatric Association 2013), and International

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Funding: This work was supported by Autism Speaks Pilot Research Grant, a Children’s Brain Research Foundation Research Grant, NIMH Career Awards (K01MH079317, K23MH082883), SFARI Pilot Award (M134793), and NIEHS R01 (ES021462).

Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10; World Health Organization 1990). Although diagnostic methods and criteria are largely based on observations from Western or European psychiatry, there is general acceptance of ASD diagnostic criteria (Cohen and Volkmar 1997).

Studies suggest that cultural differences in appropriate social behavior can mediate the manifestations of ASD and the diagnostic process (Lotter 1978; Daley 2004; Matson and Kozlowski 2011). Some argue that reduced eye contact is not reliable for use with Asians as it is “well known” that Asian children avoid eye contact, not because of social impairment but, rather, due to Asian social norms in which direct eye contact with people in positions of authority is a sign of disrespect (Lian 1996). It is further argued that the Western diagnostic instruments are inappropriate for standardized assessment with non-European populations since Western instruments cannot validly quantify core ASD symptoms in the other populations (DeWeerd 2012; Grinker et al. 2012; Baker 2013; Kang-Yi et al. 2013; Kim and Leventhal 2013). On the contrary, others suggest that ASD symptoms are consistent across cultures given that the neurobiology of ASD is similar across cultures (Campbell 1966; Berry et al. 1992; Cuccaro et al. 1996; Morgan 1996). “Autism experts” have emphasized as follows: “there is no other developmental or psychiatric disorders in children (or, for persons at any other age) for which such well-grounded and internationally accepted diagnostic criteria exist” (Cohen and Volkmar 1997, p. 947). However, does universal acceptance of ASD diagnostic criteria, created primarily in Western populations, support the existence of fundamental social and communication deficits and/or restricted interests and repetitive behaviors that are independent of cultural influences?

ASD diagnostic criteria in DSM-5 released in 2013 included major alterations as follows: (1) Elimination of the five subtypes found in *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. (DSM-IV; American Psychiatric Association 1994); (2) creation of a new diagnostic category of ASD that is adapted to the individual’s clinical presentation by inclusion of clinical specifiers and associated features; (3) changing from the DSM-IV three-domain criteria that included social reciprocity, communication, and restricted and repetitive behaviors (RRB) to two DSM-5 ASD domain criteria composed of social communication/interaction and RRB; (4) for DSM-5, inclusion of sensory symptoms in the RRB component of diagnostic criteria; and (5) changing the specification of the age of onset from “age three” to “early childhood” (APA 2013). Apparent differences between DSM-IV and DSM-5 ASD criteria have led to debates over potential changes the way individuals will be diagnosed with ASD and the eligibility of individuals for clinical and other services (Carey 2012). This uncertainty may be partially ameliorated when provided with validated and reliable, standardized, gold standard diagnostic assessments.

Based on the foregoing, this study evaluates whether Asian children (Koreans, 7–14-year olds) can be validly evaluated for ASD based on the DSM-5/ICD-10 criteria by the following:

- (1) Assessing the validity of the Asian ASD diagnoses made utilizing Western diagnostic methods and instruments [Autism Diagnostic Interview-Revised (ADI-R; Rutter et al. 2003) and Autism Diagnostic Observation Schedule (ADOS; Lord et al. 2000)].
- (2) Examining cultural variability in autism and ASD phenotypic expression in Asian children, while also examining symptom structure (and its predictive validity) in differentiating ASD from typical development and other disorders.

Methods

The Yale University IRB approved this study.

Participants

Analyses were conducted on 292 participants (214 males), age 7–14 years old (mean = 10.2, standard deviation = 1.8), recruited from all children attending schools in a suburb of Seoul, South Korea, as part of a total population, epidemiologic study. Of the eligible children, parents of 23,337 elementary school children (63%) returned screening questionnaires [Autism Spectrum Screening Questionnaire; ASSQ (Ehlers et al. 1999; Yim 2013); scores range 0–54]. “Screen positives” were those with parental ASSQ scores in the top 5th percentile and/or whose teacher ASSQ scores ≥ 10 . In addition, all children enrolled in the local Disability Registry or special education were considered “screen positive.” A total of 869 (72%) parents of 1214 screen-positive, sampled children consented to participate in the diagnostic stage. Two hundred ninety-two completed full assessment with ADOS, ADI-R, and IQ tests. Potential sampling bias that may stem from nonparticipants has been dealt extensively in Kim et al. (2011). In summary, various sensitivity analyses suggested that the likelihood of diagnosis of ASD among those screen-positive children who did not complete diagnostic evaluation was not different from those children who had a full confirmative diagnostic assessment. All children were native language speaking Koreans (Kim et al. 2011).

The data set includes 176 participants with a clinical diagnosis of ASD and 116 with non-ASD (NA). NA participants were screen positives who completed diagnostic assessment and were confirmed not to have any ASD (no psychiatric disorders [30%], externalizing disorders [44%], internalizing disorders [17%], intellectual disabilities [6%], tic spectrum disorder [3%]). ADOS modules were selected based on age and language levels. Analyses for ADOS were restricted to the 80% of children receiving Module 3 ($n = 225$) since

TABLE 1. SAMPLE CHARACTERISTICS

All	DSM-5 ASD	NA
<i>N</i> (male)	176 (143)	116 (71)
Age		
Mean (SD)	10.15 (1.74)	10.21 (1.82)
Minimum–maximum	7–14	7–14
IQ ^a		
Mean (SD)	86.45 (30.07)	101.59 (20.63)
Minimum–maximum	30–139	30–134
<i>Cases with K-ADOS-Module 3 Only</i>	ASD	NA
<i>N</i> (male)	126 (100)	103 (64)
Age		
Mean (SD)	9.89 (1.58)	10.05 (1.8)
Minimum–maximum	7–14	7–14
IQ ^a		
Mean (SD)	94.58 (25.06)	103.1 (17.96)
Minimum–maximum	30–139	33–134

Two hundred ninety cases included complete data of a K-ADI-R, full-scale IQ and best estimate clinical diagnosis. Out of 290 children, 23 children with ASD were nonverbal, based on the K-ADI-R (Item 30. Overall Level of Language = 1 or 2); 225 cases included K-ADOS Module 3, full-scale IQ and best estimate clinical diagnosis. The number of cases receiving other modules were limited ($n < 20$).

^aSignificant difference emerged between the two groups for IQ scores. ASD, autism spectrum disorder; DSM-5, Diagnostic and Statistical Manual on Mental Disorders, 5th edition; IQ, interquartile range; NA, non-ASD; RRB, restricted and repetitive behaviors; SD, standard deviation.

sample sizes for other modules were too small ($n < 20$). Due to significant IQ differences among the diagnostic groups ($p < 0.05$), IQ was controlled in all applicable analyses in addition to age and gender (Table 1).

Measures

The ADI-R is a standardized, semistructured, clinician-administered interview of caregivers. The ADOS is a standardized, semistructured, clinician-administered observation of communication, social interaction, and play. Both instruments provide diagnostic algorithms for autism and a broader classification of ASD (“relaxed” criteria; e.g., Gotham et al. 2007).

The ADI-R and ADOS were translated, back-translated, and validated in Korean, as the Korean-ADI-R (K-ADI-R) and Korean-ADOS (K-ADOS), by a team of Korean child psychiatrists and psychologists who were certified ADI-R/ADOS trainers and/or ADI-R/ADOS research reliable (Y.S.K., Y.J.K., S.J.K., E.J.L.). The back-translated versions were reviewed and reconfirmed by a team of U.S. child psychiatrists and psychologists who have extensive experience with the instrument. A pilot study of 71 ADOS and 63 ADI-R administrations was performed with Korean children with ASD; it resulted in kappa values for diagnostic validity of 0.795 and 0.714, respectively, indicating very good agreement between expert clinical judgment and our Korean versions of the ADOS and ADI-R (see Kim et al. 2011 for more details). Optimal K-ADI-R and K-ADOS reliability was monitored and maintained throughout. The Korean Wechsler Intelligence Scale for Children-III (Wechsler 1991) (89% of sample) or the Leiter International Performance Scale-Revised (Roid and Miller 1997) was administered to determine IQ scores on the same day as the ADI-R/ADOS.

A consensus best estimate diagnosis

To generate the best estimate clinical diagnosis using the new diagnostic criteria based on the DSM-5, all systematically obtained relevant data for each participant were reviewed by one of two experienced clinical teams, independent of the original clinical evaluators. These data include teachers’ and/or parents’ written reports of their concerns about their children, as well as their ratings on behavioral assessment questionnaires, including ASSQ, Social Responsiveness Scale (SRS; Constantino and Gruber 2005; Song et al., “Cross-cultural aspect of behavior assessment system for children,” unpublished data), and Behavioral Assessment System for Children II (BASC; Merenda and Peter 1996; Cheon et al. in press), prior health/educational records when available, the detailed descriptions of symptoms endorsed from the K-ADOS and K-ADI-R, and the behavioral observations and scores from the cognitive assessments. Each diagnostic team included one board-certified, Korean child psychiatrist, trained both in Korea and the United States, plus a second board-certified child psychiatrist or child psychologist (Team 1: Y.S.K./K.A.C.; Team 2: Y.J.K./S.J.K.). Sixty out of 292 cases (21%) were randomly chosen to examine diagnostic reliability between clinicians, for which each Korean team reached consensus diagnoses on all cases. Before case ascertainment, we carefully addressed potential cultural biases in case identification using community focus groups and diagnostic team composed of Korean diagnosticians with extensive clinical and research experience both in Korea and the United States.

Cultural consideration for best estimate diagnosis

We carefully addressed potential cultural biases in case identification. The team organized parent and teacher focus groups to identify

local beliefs that might influence symptom reporting and to address stigma and misunderstandings related to ASDs (see Kim et al., 2011, for more details). To minimize possible cultural biases in diagnosis, each diagnostic team was composed of Korean diagnosticians with extensive clinical and research experience in both the United States and Korea. Moreover, to maintain reliability between teams and to assure consistency of diagnosis between the United States and Korea, 49 randomly selected cases were reviewed by a team of two North American child psychiatrists who are clinicians with extensive ASD clinical experience and have extensive involvement in research using the ADI-R/ADOS as part of the research diagnostic process. Agreement between Korean and North American ASD expert assessment teams regarding the presence or absence of ASD was 93.9%, with a kappa value of 0.75 (see Kim et al., 2011, for details).

Design and analyses

To examine potential cultural influences on the validity of Asian ASD diagnoses made utilizing Western diagnostic instruments, we obtained internal consistency for all K-ADI-R and K-ADOS items using Cronbach’s alpha. Item correlations for each item with domain-total-minus-the-item were examined using the subset of items included in the algorithms. Concurrent and convergent validity was also examined by obtaining correlations between the domains and participant characteristics (e.g., age, IQ) and correlations between K-ADI-R/K-ADOS totals and scores from other measures (ASSQ and SRS), both standardized for Korean children [reliability and validity previously reported (Cheon et al. 2011)]. Sensitivity, specificity, positive predictive values (PPVs), and negative predictive values (NPVs) of the K-ADI-R and K-ADOS were examined for the instrument classifications of both autism and ASD.

To determine cultural variability in ASD phenotypic expression, we first examined patterns of symptoms that differentiated ASD from NA cases by obtaining the distributions of individual item and domain total scores from both instruments and comparing them across diagnostic groups with ANOVAs, while controlling for IQ, age, and gender. The structure of ASD symptoms was examined based on a confirmatory factor analysis only for the K-ADOS, since the sample size for the cases with the K-ADI-R data was not large enough (sample size: variables ratio = 270:47), even based on the most lenient criteria (MacCallum et al. 1999). This was done in Mplus 5.2 using the geomin rotation. Next, we used logistic regression to assess the relative predictive value of different symptom domains. For the K-ADI-R, this analysis was done only for verbal children; the number of nonverbal children ($n = 22$) was too small.

Results

Validity of Western instruments and methods in a Korean population

Strong internal consistency was obtained for both instruments using Cronbach’s Alpha = 0.94 for both and all algorithm items. The significant item and domain-total-minus-the-item correlations for the K-ADI-R ranged from 0.5 to 0.7 for social, from 0.3 to 0.6 for communication, and from 0.1 to 0.5 for RRB domain. The significant correlations for the K-ADOS ranged from 0.6 to 0.8 for social affect and from 0.3 to 0.4 for RRB. Strong concurrent and convergent validity was confirmed by mostly modest associations between the K-ADI-R/K-ADOS and participant characteristics such as age and IQ ($r = 0.1-0.5$), consistent with previous research with Western populations (De Bildt et al. 2004; Ventola et al. 2006; Corsello et al. 2007). Moderate correlations with other measures

($r=0.1-0.6$) were obtained, suggesting that these instruments provide overlapping, but not identical information. Moderate agreement between the K-ADI-R and K-ADOS ($r=0.3-0.5$) suggests the additive values of each measure, highlighting that combining information from multiple sources yields higher diagnostic validity, compared to the use of single measure, also consistent with U.S. studies (Risi et al. 2006; Le Couteur et al. 2008; Kim and Lord 2011) (detailed results in Supplementary Tables S1 and S2; Supplementary Data are available online at www.liebertpub.com/cap).

The K-ADI-R classifications of autism and ASD yielded sensitivities, specificities, PPVs, and NPVs against DSM-5 ASD diagnoses ranging from 64% to 89%, from 66% to 93%, from 80% to 93%, and from 63% to 79%, respectively (Table 2). The K-ADOS classifications of autism and ASD yielded sensitivities, specificities, PPVs, and NPVs ranging from 85% to 94%, from 63% to 71%, from 74% to 79%, and 98%, respectively.

Examination of cultural variability in phenotypic expression: Patterns of symptoms

Children with ASD consistently showed higher means than NA children for all items (Table 3 for ADI-R; Table 4 for ADOS). ANOVAs showed significant diagnostic group differences for all items included in the algorithms for both K-ADI-R and K-ADOS, except for one item, *neologisms/idiosyncratic language* on the K-ADI-R. Diagnostic group differences also emerged for all K-ADI-R and K-ADOS domains, after controlling for IQ, gender, and age (Table 5).

Examination of cultural variability in phenotypic expression: Symptom structures and their predictive values

Confirmatory factor analysis, K-ADOS-Module 3. Using the Korean sample, the two-factor model (social affect and RRBs) from the U.S. sample replicated satisfactorily with root mean square error approximation (RMSEA) value of 0.07 and the Comparative Fit Index (CFI) of 0.9 (RMSEA ≤ 0.08 and CFI = 0.9–1.0), indicating good fit (Browne and Cudeck 1993).

Logistic regression check on prediction of diagnosis for each domain. Logistic regression for the K-ADI-R indicated that all three domains (social, communication, and RRB domains) inde-

pendently and significantly predicted a diagnosis of ASD versus NA ($p < 0.05$), controlling for each other domain IQ, chronological age, and gender. For the K-ADOS, both social affect and RRB domains were significant predictors of ASD diagnosis versus NA ($p < 0.001$) (Supplementary Table S3).

Discussion

Our study addresses skepticism about using Western ASD diagnostic criteria based on the DSM-5 in other cultural/national groups. We demonstrate that diagnostic instruments and procedures developed and implemented for Western populations can be validly applied to an Asian (Korean) population. Using standardized instruments with DSM-5 and ICD-10 diagnostic criteria, Korean children with ASD were clinically differentiated from the NA group with moderate-to-strong diagnostic validity. Children with ASD consistently scored significantly higher in autism symptom severity as measured by gold standard instruments than did the NA group. These results demonstrate that autism phenotypic patterns in Asians are similar to those in Western populations and that ASD symptoms can be robustly measured by these instruments in this Asian population.

Our results confirm that clinicians and researchers can validly use Western diagnostic methods in other cultural groups, in this case, Korean children. Excellent sensitivities above 80% were obtained with both the K-ADI-R and K-ADOS classifications of autism (more stringent criteria) and ASD (less restrictive criteria), comparable to that reported in U.S. study samples (Lord et al. 1993; Gotham et al. 2007; Kim and Lord 2011), except for the most restrictive criteria using the K-ADI-R autism classification, which resulted in a lower sensitivity. Even though the NA group included children who were ASSQ screen positive and had other neurodevelopmental disorders, we were able to obtain moderate levels of specificities.

The Korean results are similar to those from the U.S. samples in many ways (Gotham et al. 2007; Kim and Lord 2011). The two-factor structure of ASD symptoms measured by the K-ADOS (social affect, with social and communication symptoms, and RRBs) is well replicated in the Korean sample. The results from the logistic regression also show that the combined social and communication and RRB domains independently contribute to the diagnosis of ASD. In fact, the K-ADI-R social and communication domains were highly correlated with each other ($r=0.78$, $p < 0.001$), indicating highly associated features of these symptoms, consistent with studies in European populations (Lang et al. 2006; Gotham et al. 2007; Frazier et al. 2008; Snow et al. 2009; Kim and Lord 2011). These results fit well with changes in DSM-5 (Frazier et al. 2008), in which social and communication behaviors are in a single domain.

Our data appear to repudiate the common myth that lack of eye contact is not appropriate as an autism symptom for Asians, due to differences in cultural norms (Lian 1996). Our study children with ASD showed significantly higher scores than the NA group on the K-ADI-R item, *Direct Gaze* and a similar K-ADOS item, *Unusual Eye Contact*, with 81% and 66% of NA children scoring 0 on these items, respectively, demonstrating that Korean children without ASD normatively use reciprocal direct gaze to communicate across a range of situations similar to Western children. In contrast, more than half of Korean children with ASD showed identifiable abnormalities in the use of direct gaze. Therefore, for clinical and research diagnoses of autism/ASD, differences between the ASD and NA groups, in the use of socially acceptable direct gaze, can be validly assessed by the K-ADI-R and K-ADOS, ensuring that this is

TABLE 2. DIAGNOSTIC VALIDITY OF ALGORITHM FOR DSM-5 ASD VERSUS NA COMPARISON

	<i>sens</i>	<i>spec</i>	<i>PPV</i>	<i>NPV</i>
K-ADI-R autism classification	64	93	93	63
K-ADI-R broader ASD classification ^a	89	66	80	79
K-ADOS-Module 3 autism classification (cutoff=9)	85	71	78	80
K-ADOS-Module 3 ASD classification (cutoff=7)	94	63	75	90

^aMeets criteria on social and communication domains or meets criteria on social and within two points of communication criteria or meets criteria on communication and within two points of social criteria or within one point on both social and communication domains.

ASD, autism spectrum disorder; DSM-5, Diagnostic and Statistical Manual on Mental Disorders, 5th edition; K-ADI-R, Korean Autism Diagnostic Interview-Revised; K-ADOS, Korean Autism Diagnostic Observation Schedule; NA, no-ASD; NPV, negative predictive value; PPV, positive predictive value; *sens*, sensitivity; *spec*, specificity.

TABLE 3. DIAGNOSTIC DIFFERENCES IN K-ADI-R ALGORITHM ITEM RAW SCORES

	DSM-5 ASD	NA	Significance
A. Reciprocal social interaction			
A1. Failure to use nonverbal behaviors to regulate social interaction			
Direct gaze	0.85 (0.83)	0.24 (0.52)	<0.001
Social smiling	1.07 (0.94)	0.27 (0.64)	<0.001
Range of facial expressions	0.97 (0.82)	0.28 (0.61)	<0.001
A2. Failure to develop peer relationships			
Imaginative play with peers	1.66 (0.61)	0.71 (0.87)	<0.001
Interest in children	1.37 (0.72)	0.66 (0.77)	<0.001
Response to other children	1.07 (0.78)	0.38 (0.61)	<0.001
Group play with peers or friendships ^a	1.66 (0.56)	0.76 (0.76)	<0.001
A3. Lack of shared enjoyment			
Showing and directing attention	1.35 (0.87)	0.44 (0.78)	<0.001
Offering to share	1.58 (0.75)	0.88 (0.92)	<0.001
Seeking to share her/his enjoyment	1.31 (0.85)	0.50 (0.81)	<0.001
A4. Lack of socioemotional reciprocity			
Use of others' body to communicate	0.62 (0.87)	0.11 (0.36)	<0.001
Offering comfort	1.31 (0.81)	0.63 (0.81)	<0.001
Quality of social overtures	1.01 (0.86)	0.30 (0.58)	<0.001
Inappropriate facial expressions	0.91 (0.79)	0.31 (0.54)	<0.001
Appropriateness of social responses	1.20 (0.81)	0.63 (0.76)	<0.001
B. Qualitative abnormalities in communication			
B1. Lack of or delay in spoken language and failure to compensate through gesture			
Pointing to express interest	1.33 (0.88)	0.67 (0.84)	<0.001
Nodding	1.03 (0.97)	0.42 (0.79)	<0.001
Head shaking	0.94 (0.99)	0.27 (0.65)	<0.001
Conventional/instrumental gestures	1.14 (0.87)	0.54 (0.75)	<0.001
B4. Lack of varied spontaneous make-believe or social imitative play			
Spontaneous imitation of actions	1.10 (0.84)	0.53 (0.68)	<0.001
Imaginative play	1.67 (0.64)	1.00 (0.87)	<0.001
Imitative social play	1.11 (0.77)	0.43 (0.63)	<0.001
B2 (V): Relative failure to initiate or sustain conversational interchange^b			
Social verbalization/chat	1.59 (0.70)	0.84 (0.84)	<0.001
Reciprocal conversation	1.64 (0.62)	0.80 (0.88)	<0.001
B3 (V): Stereotyped, repetitive, or idiosyncratic speech^b			
Stereotyped utterances	0.72 (0.82)	0.43 (0.70)	0.003
Inappropriate questions or statements	0.89 (0.84)	0.60 (0.78)	0.004
Pronominal reversal	0.48 (0.69)	0.30 (0.52)	0.018
Neologisms/idiosyncratic language	0.19 (0.45)	0.11 (0.34)	ns (0.105)
C. Restricted, repetitive, and stereotyped patterns of behavior			
C1: Encompassing preoccupation or circumscribed pattern of interest			
Unusual preoccupations	0.71 (0.87)	0.18 (0.50)	<0.001
Circumscribed interests	1.33 (0.74)	0.85 (0.85)	<0.001
C2: Apparently compulsive adherence to nonfunctional routines or rituals			
Verbal rituals ^b	0.14 (0.44)	0.04 (0.23)	0.026
Compulsions/rituals	0.64 (0.83)	0.22 (0.58)	<0.001
C3: Stereotyped and repetitive motor mannerisms			
Hand and finger/complex mannerisms or stereotyped body movements	1.30 (0.78)	0.74 (0.68)	<0.001
C4: Preoccupation with parts of objects or nonfunctional elements of material			
Repetitive use of objects or unusual sensory interests ^a	0.57 (0.83)	0.11 (0.39)	<0.001

All scores were converted to 0–2-point scale as they are in the ASDI-R algorithm.

^aHighest score from two items specified.

^bAnalysis only done with verbal subjects.

ASD, autism spectrum disorder; DSM-5, Diagnostic and Statistical Manual on Mental Disorders, 5th edition; NA, no-ASD.

a meaningful part of the ASD phenotype and is similar in Asian and Western populations.

Likewise, children with ASD showed significantly more impairments in the range of facial expressions compared to the children with NA. This finding does not support the stereotypic expectation that Asians tend to have less facial expressions so that this cannot be used to differentiate individuals with ASD for Asians.

Korean children with ASD also scored significantly higher than NA children on most of the RRB items associated with motor mannerisms, hand and finger mannerism (on both K-ADI-R and K-ADOS), stereotyped body movements (K-ADI-R), repetitive use of objects (K-ADI-R), similar to what have been found in studies in the United States (Lang et al. 2006; Frazier et al. 2008; Lam et al. 2008; Snow et al. 2009). They also showed higher scores on the

TABLE 4. DIAGNOSTIC DIFFERENCES IN K-ADOS-MODULE 3 ALGORITHM ITEM SCORES

SA	ASD	NA	Significance
Communication			
Reporting of events	0.87 (0.70)	0.53 (0.57)	<0.001
Conversation	1.21 (0.70)	0.65 (0.71)	<0.001
Gestures	0.70 (0.62)	0.33 (0.49)	<0.001
Reciprocal social interaction			
Unusual eye contact	1.63 (0.78)	0.68 (0.95)	<0.001
Facial expression directed to others	1.20 (0.61)	0.54 (0.71)	<0.001
Shared enjoyment in interaction	1.30 (0.68)	0.56 (0.71)	<0.001
Quality of social overtures	0.98 (0.57)	0.39 (0.51)	<0.001
Quality of social response	0.93 (0.40)	0.47 (0.50)	<0.001
Amount of reciprocal social communication	1.08 (0.75)	0.53 (0.64)	<0.001
Overall quality of rapport	0.97 (0.56)	0.36 (0.52)	<0.001
RRB			
Stereotyped/idiosyncratic use of words	0.47 (0.59)	0.13 (0.33)	<0.001
Unusual sensory interest	0.56 (0.64)	0.34 (0.52)	0.006
Hand and finger/other complex mannerisms	0.17 (0.42)	0.05 (0.26)	0.010
Excessive interest in highly specific topics	0.57 (0.68)	0.20 (0.47)	<0.001

All scores were converted to 0–2-point scale as they are in the ADOS algorithm.

ADOS, Autism Diagnostic Observation Schedule; ASD, autism spectrum disorder; NA, no-ASD; RRB, restricted and repetitive behavior; SA, social affect.

items associated with *Stereotyped/Idiosyncratic Use of Words or Phrases* and *Unusual Sensory Interests*. These are consistent with the DSM-5 ASD criteria requiring at least two RRB symptoms, including sensory interest (APA 2013). Children with ASD also showed significantly more *Circumscribed Interests/Excessive Interests in Highly Specific Topics* measured by both K-ADI-R and

K-ADOS, compatible with previous U.S. studies showing that circumscribed interests are unique to children with ASD (Lam et al. 2008). In contrast, one K-ADI-R item, *Neologisms/Idiosyncratic Language*, did not significantly differentiate children with ASD from those with NA. However, it is important to note that children with autism from controls in the original validity study done with the U.S. sample also did not show a significantly high score on this item (Rutter et al. 2003).

TABLE 5. DIAGNOSTIC DIFFERENCES IN ALGORITHM DOMAIN TOTALS

	DSM-5 ASD	NA
K-ADI-R social		
Mean (SD)	17.88 (7.48)	7.15 (6.00)
Minimum–maximum	3–30	0–26
K-ADI-R Comm-Verbal^a		
Mean (SD)	13.99 (5.19)	10.98 (5.82)
Minimum–maximum	2–24	0–24
K-ADI-R Comm-nonverbal^a		
Mean (SD)	13.53 (1.63)	12.00 (1.41)
Minimum–maximum	11–19	11–13
K-ADI-R RRBs		
Mean (SD)	4.77 (2.40)	2.18 (1.96)
Minimum–maximum	1–10	0–9
K-ADOS-Module 3-social affect		
Mean (SD)	10.89 (4.26)	5.05 (4.35)
Minimum–maximum	0–20	0–17
K-ADOS-Module 3-RRBs		
Mean (SD)	1.79 (1.42)	0.72 (0.85)
Minimum–maximum	0–6	0–3

^aCommunication verbal scores were available for 153 ASD and 114 NA cases and nonverbal scores for 21 ASD and 2 NA cases. Due to the limited number of NA cases receiving the nonverbal algorithm, the diagnostic comparison was not performed for the K-ADI-R Comm-Nonverbal; all significant at $p < 0.001$, except for K-ADI-R Comm-Nonverbal.

ASD, autism spectrum disorder; Comm, communication; K-ADI-R, Korean Autism Diagnostic Interview-Revised; K-ADOS, Korean Autism Diagnostic Observation Schedule; NA, no-ASD; RRB, restricted and repetitive behaviors; SD, standard deviation.

Limitations and future directions

Our sample included only 7–14-year-old children and a limited number of nonverbal children ($n = 23$). The validity of the K-ADOS was also focused only on Module 3, since the number of children who received other modules was limited. We are collecting more data, partly to replicate these results in younger children, older adolescents, and adults with a range of language abilities.

Consistent with good clinical practices, experienced clinical teams used the information from the ADOS and ADI-R to generate independent best estimate diagnoses; the administration of these instruments was a part of comprehensive, standard diagnostic process. However, diagnosticians used information from other sources, including the behavioral observations and scores from cognitive assessments, and behavioral profiles obtained from the teacher and parent ratings of symptoms of DSM-IV-based emotional and behavioral disorders, which were independent of original administration of K-ADI-R and K-ADOS.

A comparison or control group of Western population with ASD was determined to not be necessary for this particular study, since the findings were derived from a comparison between clinical studies of Korean children and results standardized on a control Western population. Similarly, as the intention of our study was to evaluate the validity of the diagnostic methods developed and standardized based on the Western samples in Korean children, the cross cultural comparison between the Korean and Western samples was beyond the scope of this article and thus not directly tested; however, this is an important topic that warrants further investigations.

Finally, the generalization of these results to other non-Western populations, aside from Koreans, should be done with caution until further investigations are completed with different cultural, ethnic, and linguistic groups.

Conclusions

Based on our study, biases and stereotypes, rather than data and diagnostic methods, appear to distinguish some views of ASD in different cultures. Indeed, on more than one occasion, we have been told (personal communications) that it is impossible to validly make a diagnosis of ASD in Korean samples due to unjustified assumptions about Asian social behavior. These sorts of unfortunate and misguided conclusions have restricted access to data from Asian populations and fostered unnecessary bias for patients and their families with respect to ASD and possibly other forms of developmental psychopathology. Hopefully, data from the present study will bring an end to scientific and lay discrimination.

Despite myths, biases, and stereotypes about Asian social behavior, including the assumption of so-called normative inscrutability and avoidance of eye contact, it appears that Asians (at least Korean children) typically use elements of reciprocal social interactions that are similar to those in the West. Furthermore, the inability to use these reciprocal social skills, as well as the presence of RRBs, can be similarly identified as landmarks of ASD in both Korean and U.S. populations. These data offer clear indications that cultural and linguistic factors have a modest-to-no impact on the validity of these gold standard diagnostic instruments.

Finally, and perhaps most importantly, these data lend support to the notion that autism/ASD is a common disorder and that the fundamental behavioral phenotypes of ASD can be reliably and validly identified around the world and across cultures.

Clinical Significance

Despite myths, biases, and stereotypes about Asian social behavior, including the assumption of normative inscrutability and avoidance of eye contact, Asians (at least Korean children) typically use elements of reciprocal social interactions similar to those in the West. Therefore, standardized diagnostic methods widely used for ASD in Western culture can be validly used as part of the assessment process with Koreans and, possibly, other Asians.

Acknowledgments

We thank the families who participated in the study. We thank Ms. Ji-Hyun Kim and Dr. Youeun Song.

Disclosures

No competing financial interests exist.

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