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The Social Responsiveness Scale in relation to DSM IV and DSM5 ASD in Korean Children

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Abstract

LAY ABSTRACT—The Social Responsiveness Scale(SRS) is an autism rating scales in widespread use, with over 20 official foreign language translations. It has proven highly feasible for quantitative ascertainment of autistic social impairment in public health settings, however, little is known about the validity of the reinforcement in Asia populations or in references to DSM5. The current study aims to evaluate psychometric properties and cross-cultural aspects of the SRS-Korean version (K-SRS). Our results indicate that the K-SRS exhibits adequate reliability and

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Disclosure

Dr. Constantino receives royalties from Western Psychological Services for the commercial distribution of the Social Responsiveness Scale.

validity for measuring Autism Spectrum Disorder (ASD) symptoms in Korean children with DSM IV PDD and DSM5 ASD. Our findings further suggest that it is difficult to distinguish Social Communication Disorder (SCD) from other child psychiatric conditions using the K-SRS. This is the first study to examine the relationship between the SRS subscales and DSM5 based clinical diagnosis. This study provides cross-cultural confirmation of the factor structure of ASD symptoms and traits measured by the SRS.

SCIENTIFIC ABSTRACT—The Social Responsiveness Scale(SRS) is an autism rating scales in widespread use, with over 20 official foreign language translations. It has proven highly feasible for quantitative ascertainment of autistic social impairment in public health settings, however, little is known about the validity of the reinforcement in Asia populations or in references to DSM5. The current study aims to evaluate psychometric properties and cross-cultural aspects of the SRS-Korean version(K-SRS). The study subjects were ascertained from three samples: a general sample from 3 regular education elementary schools(n=790), a clinical sample(n=154) of 6–12-year-olds from four psychiatric clinics, and an epidemiological sample of children with ASD, diagnosed using both DSM IV PDD, DSM5 ASD and SCD criteria(n=151). Their parents completed the K-SRS and the Autism Spectrum Screening Questionnaire(ASSQ). Descriptive statistics, correlation analyses and principal components analysis (PCA) were performed on the total population. Mean total scores on the K-SRS differed significantly between the three samples. ASSQ scores were significantly correlated with the K-SRS T-scores. PCA suggested a one-factor solution for the total population. Our results indicate that the K-SRS exhibits adequate reliability and validity for measuring ASD symptoms in Korean children with DSM IV PDD and DSM5 ASD. Our findings further suggest that it is difficult to distinguish SCD from other child psychiatric conditions using the K-SRS. This is the first study to examine the relationship between the SRS subscales and DSM5-based clinical diagnoses. This study provides cross-cultural confirmation of the factor structure for ASD symptoms and traits measured by the SRS.

Keywords

Korean SRS; Validity; Reliability; DSM IV PDD; DSM5 ASD

INTRODUCTION

Autism spectrum disorder (ASD) is characterized by early-onset, pervasive impairment in social reciprocity/communication and the presence of restricted interests and repetitive behaviors (RRB), with prevalence ranging from 1.4–2.6% in the previous studies using community samples [APA, 1994; Autism and Developmental Disabilities Monitoring Network Surveillance Year 2010 Principal Investigators, 2014; Kim et al., 2011; Maenner et al., 2014]. In the American Psychiatric Association (APA) Diagnostic and Statistical Manual for Mental Disorders, 5th Edition (DSM-5) released May 2013, changes include major alterations in criteria for neurodevelopmental disorders[Maenner et al., 2014]. These changes include: (1) Elimination of Pervasive Developmental Disorder (PDD) and the five PDD subtypes found in DSM IV; (2) Creation of the new, diagnostic category, ASD, that is adapted to the individual's clinical presentation by inclusion of clinical specifiers and "associated features,"such as intellectual impairment and/or language impairment, motor deficits, self-injury, disruptive/challenging behaviors, anxiety and depression;(3) Changing

from the DSM IV PDD three domain criteria that included social reciprocity, communication and restrictive 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 domain criteria; and, (5) For DSM-5, changing the specification of the age of onset from “age three” to “early childhood.” Additionally, DSM-5 adds a new diagnostic category, “Social Communication Disorder (SCD).” SCD appears to include individuals who primarily have problems with the pragmatic aspects of social communication that adversely impact social behavior/adaptation. According to DSM-5, individuals with SCD have difficulties similar to ASD but these problems are solely restricted to the realm of social communication and do not include the DSM5 RRB criteria found in ASD[Maenner et al., 2014].

Apparent differences between DSM IV PDD and DSM5 ASD criteria have led to an interesting challenge in the use of existing ASD screening questionnaires for DSM5 ASD. Established screening instruments have typically been validated for DSM IV PDD diagnoses; there are few published reports on the relationship between existing screeners and their application to DSM5 ASD and SCD diagnoses[Mayes, Black, & Tierney, 2013; Mayes et al., 2014]. Screeners with established psychometric properties for both DSM IV PDD and DSM 5 ASD will be useful for clinical care and clinical research efforts during this period of transition from DSM IV to DSM 5.

Early identification of children with ASD in the community is crucial to providing early intervention. Effective and efficient screening instruments play a critical role in the early identification of children with ASD. The Social Responsiveness Scale (SRS), a 65-item scale, completed by parentsand/or teachers, has been extensively used as a screening instrument in the general population and as an aid to clinical diagnosis of ASD[Constantino & Gruber, 2012]. While the SRS, like most screeners, aims to predict a diagnosis of ASD itself, it has an added benefit of providing a quantitative score for social impairment in ASD; this allows for comparisons across settings and against norms that can be standardized with different raters[Constantino et al., 2003a; Constantino & Gruber, 2012]. Additionally, the SRS has the ability to quantify subtle differences in the degree of impairment, strong reliability across various informants, stability of inter-individual differences over the course of years, and minimal correlation with IQ[Constantino & Gruber, 2012]. Pronounced elevations in SRS scores on the order of 2–3 standard deviations greater than population means are highly predictive of an ASD diagnosis, but not with the diagnosis of other child psychiatric disorders[Constantino, Hudziak, & Todd, 2003b].

Several previous studies suggest the utility of the SRS as a diagnostic screener for ASD. Aldridge et al. used SRS in a tertiary level, autism spectrum disorder assessment clinic [Kamio et al., 2013]. Charman and his colleagues also reported that the SRS showed strong to moderate ability to identify autistic-spectrum disorder in an at-risk sample of school-age children receiving special education[Charman et al., 2007]. Duvekot, van der Ende, Verhulst, & Greaves-Lord [2015] reported that the SRS, based on parent report, demonstrated excellent correspondence to an ASD classification according to the Developmental, Dimensional, and Diagnostic Interview (3 Di), and both the 3 Di and ADOS.

The psychometric properties of the SRS have been examined extensively in clinically-ascertained individuals with ASD. Clinical samples are often compromised by biases related to severity, comorbidity and access to health care[Gerhard, 2008]. Indeed, our ASD prevalence study[Kim et al., 2011], using a total population approach, demonstrated that there are distinct differences in the characteristics of children with ASD who have received clinical/educational services(the clinical sample of ASD) versus those who did not (non-clinical sample). For example, among children from the clinical setting, 72% were diagnosed with the most narrowly defined syndrome, Autistic Disorder (AD), the male to female ratio was 5:1, the mean performance IQ (PIQ) was 75±28, and the T-scoreson the Behavioral Assessment System for Children II Parent Rating Scales (BASC II-PRS; [Reynolds & Kamphaus, 2004]) adaptability subscale was 38 (general population mean=50). In sharp contrast, of those children with ASD from a non-clinical sample, only 28% met criteria for AD, the male to female ratio was 2.5:1, the mean PIQ was98±19, and mean T-score on the BASC II-PRS adaptability subscale was 43. These differences suggest that unbiased, population-based samples that represent a broad distribution of the ASD phenotype are essential to develop and validate effective ASD screening instruments.

Cross-cultural validity of the SRS has been established in a large German sample[Bolte, Poustka, & Constantino, 2008] and a UK general population of children[Wigham, McConachie, Tandos, Le Couteur, & Gateshead Millennium Study core, 2012]; published data for Asians are limited to Japanese children from a clinically-identified ASD sample and typically developing children[Kamio et al., 2013] as well as a Taiwanese preschool population recruited from a clinical setting and community[Wang, Lee, Chen, & Hsu, 2012].

Finally, to date, there are no validated screening instruments available for use with DSM-5 ASD and SCD diagnoses.

MATERIALS AND METHODS

Subjects

This study involves three independent samples.

1) General Sample—The sample was children between the ages of 7 and 12 years(born between 1996–2003) and attending three elementary schools in Cheon-An city from year 2009–2010. Cheon-An, with a population of approximately 600,000, is located in the northeast corner of Chungcheong province, South Korea. Cheon-Anis characterized by a concentration of high tech company headquarters, resulting insomewhat higher levels of educational and socioeconomic status of the residents when compared to the general population in Korea. Parents of 817 students out of eligible 1711 children at participating schools returned questionnaires. After excluding the students who were outside the 7–12 years age range and those with missing data (N=27), the final participants included 790students (412 Male, 378 Female).

2) Clinical Sample—The clinical sample included 7–12-year-old children who were born between 1998–2004 and evaluated at a child and adolescent psychiatry clinic in four university/university-affiliated medical centers during 2010–2011. A Korean Board Certified

Child and Adolescent Psychiatrist evaluated all of the children in outpatient clinics and made clinical diagnoses based on DSM-IV criteria. The total number in the clinical sample was 154(118 Male, 36 female). Diagnoses included ADHD (62%), DisruptiveBehaviorDisorders (ODD+CD: 3%), Tic Disorder(12%), Anxiety disorder (8%), Depressive Disorders (7%), and others (3%), with25% having multiple diagnoses.

3) Epidemiological Sample of ASD—151, 7–12 year old children born between 1993–2000 and confirmed to have DSM IV PDD, or DSM-5 ASD (n=133) and SCD (n=16) were ascertained during 2006–2010 from a total-population prevalence study of ASD in a metropolitan Seoul suburb. All 7–12-year-old children in the target city (N=55,226) were screened with parent- and/or teacher-reports using the Autism Spectrum Screening Questionnaire (ASSQ)[Kim et al., 2011]. For children who screened positive (parental ASSQ scores in upper 5^{th} percentile and/or teacher ASSQ scores ≥ 10), confirmatory diagnostic assessments were conducted with the Autism Diagnostic Observation Schedule (ADOS), the Autism Diagnostic Interview-Revised (ADI-R) and cognitive testing. Best-estimate clinical diagnoses for subtypes of DSMIV PDD, DSM-5 ASD and SCD, along with comorbid conditions, were generated by teams of child psychiatrists and/or a child psychologist, after all relevant data were reviewed (Table 1). (Details can be reviewed in the original report[Kim et al., 2011]. Approved by the Yale University IRB in US, as well asYonsei, Hallym, Kwandongand Dankook Universities and Ilsan Hospital IRBs in Korea, the present study was conducted between 2005–2011.

Measures

SRS[Constantino & Gruber, 2005]—The focus of the SRS is the behavior of a child or adolescent between the ages of 4 and 18 years. It aims toreliably identify a wide spectrum of deficits in reciprocal social behavior, ranging from absent to severe, based on observations of a child's behavior in naturalistic social settings. It is a 65-item questionnaire that is completed by teacher, a parent, and/or another adult caregiver. Scoring is on a four-point Likert Scale. Five subscales are also provided: Social Awareness (AWA), Social cognition(COG), Social Communication (COM), Social Motivation (MOT), and Autistic Mannerism(MANN). The SRS also generates the DSM-5 ASD subscale scores: Social CommunicationIndex (SCI) is indexed by AWA + COG + COMM + MOT and RRB Index (RRBI) is indexed by MANN[Constantino & Gruber, 2012]. We note that the derivation of the DSM-5 subscales is described in the SRS-2 manual [Constantino & Gruber, 2012], and that the item content of the SRS and the SRS-2 for 4–18 year olds is identical. The only differences relate to T-scores generated by the instrument, which were updated in the latterversion on the basis of more complete acquisition of U.S. standardization data.

In its primary application, the SRS demonstrated a singular, continuously distributed underlying factor, resulting in disparate phenotypic manifestations across the three criterion domains for autistic disorder (social deficits, language deficits, and repetitive/stereotypic behaviors), as well as generating a Total Score for all 65 questions; sex-specific SRS total raw score cut points have been recommended [Constantino et al., 2004]. For males, a cut-point of 70 for the SRS total raw score is recommended for the purpose of screening for any autism spectrum condition (PDD-NOS, Asperger's Disorder, or Autistic Disorder) in school

or other general population group. Similar levels of sensitivity and specificity are achieved when an SRS total raw score cut-point of 65 is used for females.

For the current study, the SRS was translated into Korean by a team of researchers, including child and adolescent psychiatrists and clinical psychologists. The translation team translated the SRS into Korean, and the Korean version of the SRS was then back-translated into English by a bilingual child psychiatrist. The back-translated version was reviewed and reconfirmed by a child and adolescent psychiatrist at the University of California San Francisco. After completing the translation and back translation, the translation team modified the instrument based on a series of detailed discussions about areas that needed to be adjusted in order to address specific cultural differences. For example, item 36 (has difficulty in relating to adults) was translated into Korean “has difficulty in making social relationships with adults,” because the direct translation did not convey an accurate meaning. In order to examine the feasibility of using this instrument (parents’ understanding of questions and time needed to complete the questionnaire), the Korean version of SRS (K-SRS) was administered to a sample of parents who visited the clinics (N=5). Once this process was completed and reviewed for adequate performance, the instrument was released for use in this study.

ASSQ[Ehlers, Gillberg, & Wing, 1999]—The Autism Spectrum Screening Questionnaire (ASSQ), composed of 27 items, measures social interaction, communication problems, restricted and repetitive behaviors, motor clumsiness and associated features. The ability of the ASSQ to distinguish autism from other diagnoses is well-established with cut-off scores of 13 for parent ratings and 11 for teacher ratings in European children[Ehlers et al., 1999]. The ASSQ was translated and back-translated by the investigators, and adequate psychometric properties were demonstratedin Korean children from the Korean epidemiological study (n=22,660) [Yim, 2012]. Parents from all three study samplescompleted the ASSQ.

Cognitive tests—To assess cognitive levels, the Korean-Wechsler Intelligence Scale for Children-III (K-WISC-III) was used for verbal children and Leiter International Performance Scale-Revised was used for those children with difficulty understanding verbal instructions. The K-WISC-III and Leiter were used to measure cognitive function of the subjects in both the clinical and ASD samples.

Statistical Analyses

Means and standard deviation (SD) of the K-SRS raw scores and T-scores of 5 subscales, SCI (AWA + COG + COMM + MOT) and total scores were compared amongthe three study samplesusing Multivariate Analysis of Variance (MANOVA). Internal consistency for the K-SRS total scores was examined by the item reliability statistics, and Cronbach’s α was calculated for the three study samples. We also performed correlation analyses between the scores of the K-SRS, performance IQ, and the ASSQ completed by the parents in our study samples. After K-SRS norm data were established in Korean children using the general population sample (n=790), T-score (a standardized Z score scaled to have a mean of 50 and a standard deviation of 10) [Larsen & Marx, 2000] was computed for the clinical sample and

the epidemiological samples of ASD. We compared the T-scores from the K-SRS and the ASSQ (completed by the parents) total scores for children with several clinical disorders in the clinical sample, using one way Analysis of Variance (ANOVA). Principal components analysis (PCA) was performed to examine the factor structure of the autistic trait data. T-scores and cutoff scores for ASD diagnoses were compared between those from the K-SRS and the SRS to examine cross-cultural comparability. Statistical analyses were performed using IBM SPSS version 20 (IBM Korea Inc., Seoul, Korea) for Windows.

RESULTS

Demographic Characteristics and the K-SRS Scores in Study Samples

While there were no significant differences in mean age among the three study samples, children with ASD were slightly older. Sex distribution in thegeneral sample was even, whereas more males were present in both the clinical sample and the epidemiological sample of ASD (Table 1). The mean scoresfor the verbal IQ, the performance IQ and the full scale IQ (FSIQ) for the clinical sample and epidemiological ASD sample were 94.4±17.4, 93.5±17.5 and 92.6±17.1 respectively, and 101.1±23.8, 95.1±22.1 and 98.2±24.4 respectively.

Mean total raw and T- scores for the K-SRSdiffered significantly in the three study samples. The total scores along with all five subscales and two DSM5 subscales (SCI and RRBI) were highest in the epidemiological ASD sample, followed by the clinical sample; they were lowest in the general sample (Table 1). Figure 1 depicts the distributions the T-scores of the K-SRS for each of the three samples. It shows that the K-SRS scores are normally distributed, both in males and females, in the general sample. The age of the subjects did not influence the K-SRS scores in the three study samples. Gender affected the scores for social awareness, the communication subscale, the autistic mannerism subscale and the total score of the K-SRS, in the general sample. In the clinical sample, the social motivation subscale of the K-SRS differed significantly by gender. However, gender did not significantly affect the scores of five subscales and the total scores of the K-SRS in the epidemiological ASD sample (Table 1).

Internal consistency of the K-SRS

The item reliability ranged from 0.30~0.99 in three samples. Except the MANN-AWA subscales in general sample, and the MOT-AWA subscales in epidemiological ASD sample (0.30 and 0.31), the reliability test scored fair to excellent among majority of the K-SRS items(Table 2). Additionally, Cronbach’s Alphas for the total items for general, clinical and epidemiological ASD sample, based on standardized items, were0.81, 0.88 and 0.86, respectively: those for the subscales of the K-SRS were demonstrated in Table 2.

Correlation between the scores of the K-SRS, IQ and ASSQ

The total score of the ASSQ, completedby the parents, was significantly associated with the total T-scores of the K-SRS in the entire study sample. Thecorrelation scatter plot between the ASSQ scores assessed by the parents and the T-scores of the K-SRS in three samples was shown in Figure 2. The K-SRS T-score was not correlated with the IQ score, except for

a minimal negative correlation with the performance IQ (PIQ) score. When the subjects were divided into two groups, according to the presence/absence of intellectual disability (ID: cut-off IQ ≤70), modest but significant correlations were detected between communication, motivation and total scores on the K-SRS and PIQ, only in the subjects with ID (Table 3).

Comparisons of means for K-SRS T scores across diagnostic categories in the Clinical Sample

Means of the K-SRS T-scoresdid not differ significantly by diagnostic categories (ADHD, depressive disorder, anxiety disorder and tic disorder) in the clinical sample (n=154), while there were significant differences between the clinical sample, the epidemiological sample of children withASD, and the general sample. The mean scores of the K-SRS total T-scores in ADHD (n=72), depressive disorder (n=10), anxiety disorder (n=13) and tic disorder (n=14) were 64.5, 67.2, 64.6 and 57.4, respectively. The K-SRS mean scores for each clinical diagnosis were significantly different from the mean score in the epidemiological sample of children with ASD (74.5, n=151)($p<0.01$, comparison by one way ANOVA).

The proportion of confirmed ASD cases exceeding specific K-SRS T-Score cut off in the epidemiologic ASD sample

Among the children who were ASSQ screen positive, the proportion of the confirmed ASD cases (DSM IV PDD and DSM5 ASD) exceeding K-SRS total T-Score thresholds at different cut-off points of 55, 60, 65, 70, 75, 80 and 85, by sex, in the epidemiologic sample isdisplayed in Table 4. They were 84, 77, 66, 56, 48, 37 and 30%, respectively for males, and 88, 81, 66, 50, 44, 28 and 22%, respectively for females.

Factor structure of the K-SRS data

Principal components analysis (PCA) suggested a one-factor solutionfor the 1,095 children in the general sample, the clinical sample and epidemiological sample of children with ASD (Table 5.) When 20 items with the factor loadings<0.400 were excluded, the first component explained 78.1% of variance in the SRS scores for the Korean sample, which is consistent with the original US data, German data for child psychiatric patients and Japanese data for school children.

Comparisons of norm and cut off scores for ASD diagnoses between K-SRS and SRS

K-SRS total raw scores for males and females were 35 and 31, respectively, at K-SRS T-scores of 50 and 52, while K-SRS total raw scores were 52 and 48 at T-score of 60 (indicating clinically significant deficiencies in reciprocal social behaviors). The K-SRS total raw scores in males and females were 79 and 75 at T-score of 76 (strongly associated with a clinical diagnosis of ASD) (See Appendix 1&2). The raw scores in the Korean population were similar to those for the SRS in the US population at T-score less than 60; differences appeared in males at higher T-scores. For example, raw scores in Korean and US males at a T-score of 76 were 79 and 88, respectively. Percentages of confirmed ASD diagnoses at a given raw score cutoff scores were higher for the K-SRS when compared to those in SRS: 92.3 vs. 87.9%, respectively at raw score 55, and 92.3 vs. 80.4% at raw score

60. When K-SRS raw scores in males and females were compared to those from the SRS (70 for males and 65 for females) they were 64 and 66, respectively. K-SRS raw scores of 52 in males and 51 in females achieved sensitivity and specificity of 0.80 and 0.76 respectively and 0.92 and 0.87 respectively.

DISCUSSION

This study examined the psychometric properties of the K-SRS in relation to DSM IV and DSM-5 ASD in a study population comprised of three informative samples. We also examined the relationship between DSM-5 subscales, including two subscales, e.g. Social Communication Index (SCI) and Restrictive and Repetitive Behaviors Index (RRBI), derived from the SRS and clinical diagnosis. The study confirmed the one-factor structure of autistic symptoms and traits as measured by the K-SRS in these Korean samples. However, internal consistency and the item reliability of the K-SRS were only poor to good in the three samples. K-SRS scores were most elevated in the epidemiologically-ascertained ASD sample, including the individuals with DSM IV PDD and DSM-5 ASD, followed by the clinical sample, and then the general sample. These findings are consistent with the initial reports on SRS psychometric properties by the developers [Constantino, Przybeck, Friesen, & Todd, 2000]. The validity of K-SRS was further supported by the significant correlations with the total score of the ASSQ, an established ASD screening instrument that is used in community and clinical settings in Korea [Yim, 2012] and Europe [Ehlers et al., 1999] and the fact that K-SRS means differed across children with ASD and children with other forms of developmental psychopathology, such as ADHD, depressive disorder and anxiety disorder. There was a nominally negative correlation between performance IQ (PIQ) and the K-SRS among individuals with intellectual disability (ID), whereas no correlation was observed among those without ID. This supports the notion that the ASD screening capacity for the K-SRS is not likely to be affected by the subjects' intellectual function, especially in cognitively intact children with ASD. However, for the K-SRS to be recommended as a screener in either clinical practice or research, further work needs to be done to develop and test appropriate cutpoints.

Along with the reports from Taiwanese and Japanese populations, our findings in Korean children provide further cross-cultural validation of ASD symptoms. There have been suggestions in both the lay and scientific communities that the accurate diagnosis and identification of ASD symptoms can be jeopardized by cultural biases with respect to the diagnosis of ASD, especially for Asian children, [Kamio et al., 2013; Wang et al., 2012]. These conclusions are apparently based on the untested and unproven assumptions that the purported deferential attitude of Asian children, such as poor eye contact or directed facial expression, cannot be distinguished from symptoms of ASD [Kim, in submission]. Therefore, this cross-cultural validation of ASD symptoms and ASD assessment tools bears particular pertinence to the interpretation of increasing prevalence of ASD and integration of the research findings in ASD, across various ethnics/racial groups and cultures.

The K-SRS norm scores established in this study provide two interesting findings: (1) A K-SRS raw score at mean T-score (50) was similar to that in SRS in the US population for both males and females; and (2), K-SRS raw scores at higher T-score (79) was lower than that

(88) on the SRS for males, but not in females[Constantino & Gruber, 2012]. Similar findings have been reported in cross-cultural comparison studies that included the assessment of children's behavior problems. In a study using the ADHD Rating Scale (ARS) in Korean children, the raw scores from the Korean Teacher reports on the ARS, in a general sample, were lower than those reported for American children [Kim et al., 2003]. In a multi-cultural comparison study of the CBCL in preschool children, mean Total Problem Scores for Korean children ranked 4th from the bottom among 24 countries and lowest for DSM-IV Oppositional Defiant Disorder [Rescorla et al., 2011]. Other studies have reported that Korean parents report fewer problems in their offspring on the CBCL-internalizing and externalizing behavior scales than do parents from the US[Chung et al., 2013]or Australia [Oh, Shin, Moon, Hudson, & Rapee, 2002]. Since there is no evidence of prevalence differences between US and South Korea [Autism and Developmental Disabilities Monitoring Network Surveillance Year 2010 Principal Investigators, 2014; Kim et al., 2011; Zablotsky, Black, Maenner, Schieve, & Blumberg, 2015], observed discrepancies in the SRS raw scores between Korean and US children may reflect cultural differences in US and Korean parental reporting of their children's behaviors[Crijnen, Achenbach, & Verhulst, 1999]; that is, Korean parents may underreport their children's social problems compared to the parents in the US. It has been hypothesized that Korean parents are reluctant to report their children's behavior problems due to especially negative societal stigma related to having behavior and emotional problems[Chung et al., 2013]. In addition, such cultural differences in the parental reports were more prominent in boys than in girls in our study: such gender differences have been reported in other Asian cultures[Chao & Tseng, 2002]. In order to minimize such sex-based cultural bias in identifying behavioral/social difficulties in children, use of sex-based standardized cut-off scores (such as sex-based T score), rather than raw cut-off scores is recommended across different cultures.

The K-SRS data indicate rather low specificity to distinguish individuals with SCD from those with other child psychiatric conditions, whereas it is useful to distinguish them from typically developing children. This may partially result from the way SCD diagnoses were made for the clinical sample; they were based on clinical diagnoses rather than using semi-structured or structured diagnostic interviews. The usefulness of the SRS for differentiating SCD from other child psychiatric disorders warrants further investigation.

Finally, the strong correlation between SCI and RRBI of K-SRS in all three study samples raises questions about the independence of ASD and SCD as diagnostic entities. Further research with larger numbers of subjects will help clarify whether SCD patients are uniquely distinguished by dissociation between SCI and RRB symptoms that are otherwise highly correlated in children.

Study limitations include: Test-retest stability and inter-rater reliability of the K-SRS were not measured in this study. Secondly, the number of the subjects for SCD diagnoses was very small. Thirdly, the low response rate in the general sample could be a source for bias in establishing K-SRS norms. While we do not have further data for non-participants in the general sample, we have access to additional SRS parental survey data ascertained from a later, independent cohort of children from another geographic area in South Korea(N=4,811, 1st and 4th graders of all elementary schools in a city in southern western peninsula of South

Korea) [Personal communication: Kim et al. 2015]. The mean (31) and SD (15) in this independent cohort were similar to those in our general sample. Such consistency suggests that the low participation rate in the general sample may have not biased the K-SRS norm data established in the present study. Finally, the lack of gender effects on the K-SRS in epidemiological sample of ASD children in the present study appears to stem from lack of statistical power due to the uneven distribution of genders in this sample.

To the best of our knowledge, the present study is the first to examine the relationship between DSM-5 subscales, including SCI and RRBI, derived from the SRS and DSM IV and DSM-5 ASD diagnosis using an epidemiologic sample. In addition, this study is the first study to examine the psychometric properties of the SRS in Korean children.

Conclusions

The SRS Korean versionhad adequate reliability and validity for measuring ASD symptoms in Korean subjects. Our findings suggest that the K-SRS may also be useful as a screening tool for DSM IV PDD and DSM 5 ASD in Korean children but further work needs to be done to develop and test appropriate cutpoints.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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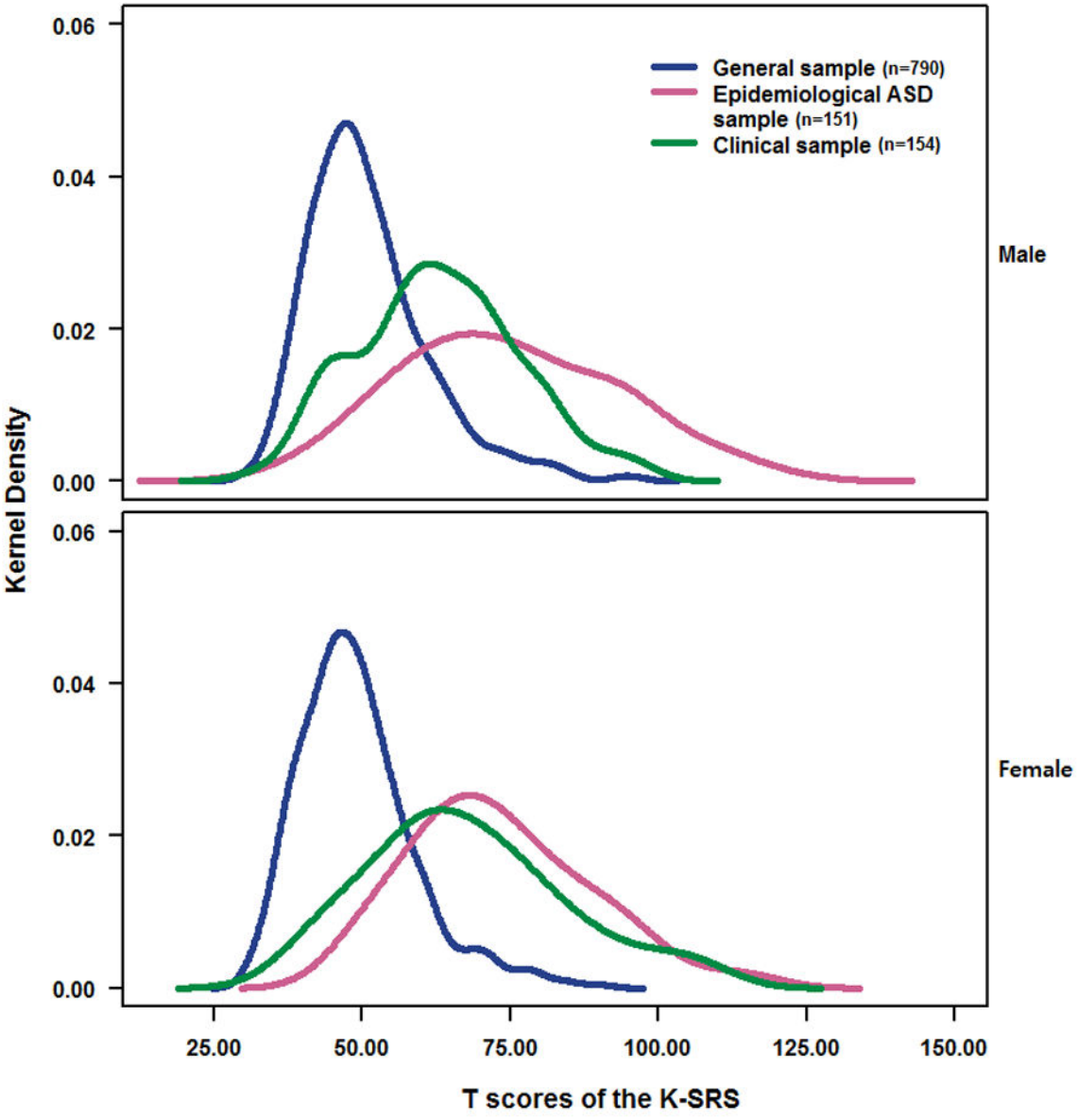

Figure 1.

Distribution of the T-scores of the K-SRS for each of three samples(n=1,095)

Kernel Density: the local relative frequency or density of points along the number line of a plot

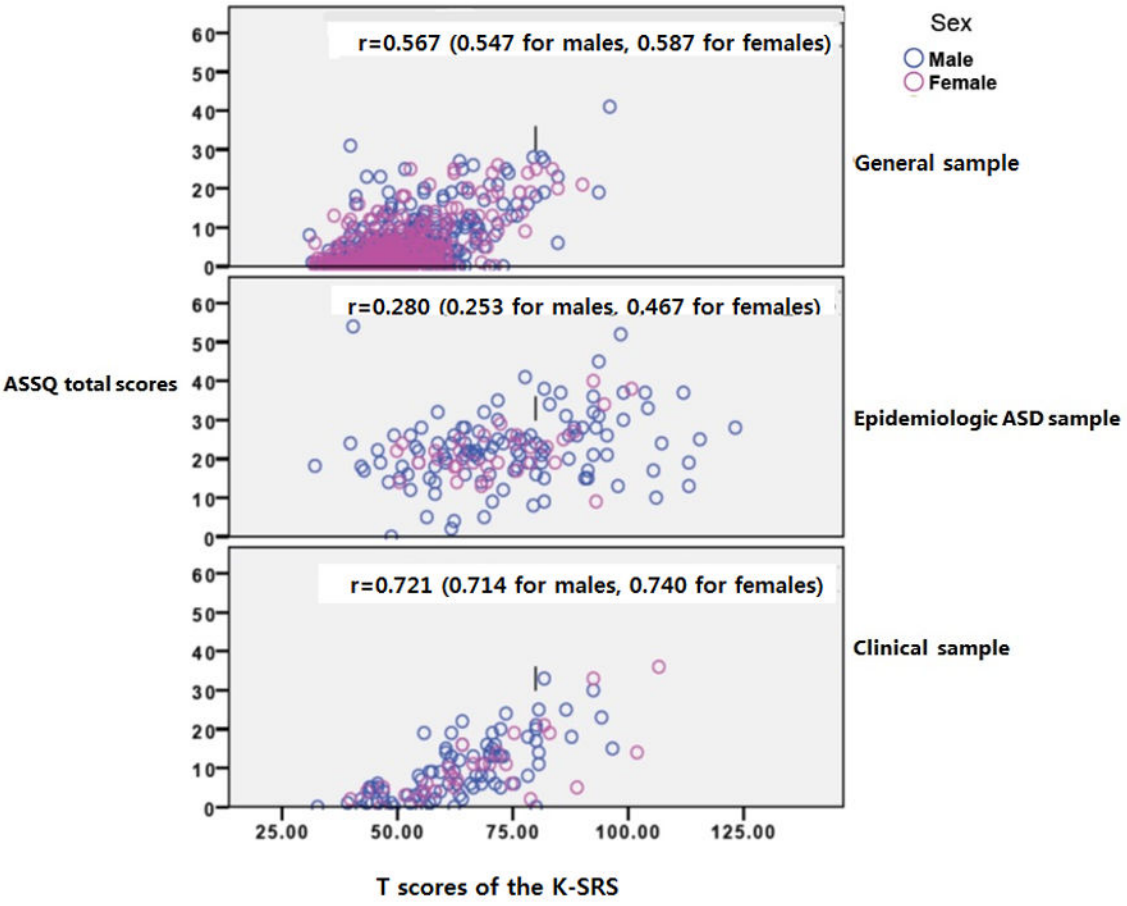

Figure 2.

Scattering plots of the Correlation between the ASSQ scores and the total T-scores of the K-SRS in three samples($p<0.01$).

ASSQ: Autism Spectrum Screening Questionnaire assessed by Parents.

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Table 1

Demographic characteristics and the K-SRS scores of three samples.

	General Sample (n=790)		Clinical Sample (n=154)		Epidemiological ASD Sample (n=151)					
					DSMIV PDD (n=151)		DSM5 ASD (n=133)[b]		DSM5 SCD (n=20)[b]	
Sex	M (n=412)	F (n=378)	M (n=118)	F (n=36)	M (n=119)	F (n=32)	M (n=107)	F (n=26)	M (n=11)	F (n=9)
Age/Mean (S.D)	9.08(1.70)	9.13(1.74)	9.42(2.50) [a]	10.76(3.03) [a]	10.31(1.74)	10.20(1.92)	10.19(1.70)	10.77(1.90)	10.27(1.70)	10.89(1.76)
K-SRS raw score [K-SRS T-score]/Mean (S.D.)										
AWA *	6.89(2.84) [51.02(9.55)] [a]	6.26(3.09) [48.89(10.37)][a]	7.53(3.30) [53.15(11.09)]	7.17(3.01) [51.94(9.55)]	9.63(3.93) [60.21(13.21)]	8.69(3.05) [57.05(10.25)]	9.91(3.84) [61.14(12.90)]	8.92(3.30) [57.84(11.07)]	7.91(3.59) [54.43(12.05)]	6.78(1.72) [50.64(5.76)]
COG *	8.03(4.39) [50.60(10.04)]	7.48(4.34) [49.35(9.92)]	9.19(6.10) [53.25(13.94)]	10.64(6.87) [53.25(13.94)]	15.69(6.98) [68.14(15.97)]	13.81(4.90) [63.84(11.20)]	16.40(6.77) [69.77(15.49)]	14.27(4.86) [64.89(11.13)]	9.36(4.97) [53.66(11.36)]	8.56(6.29) [51.81(14.40)]
COMM *	10.81(6.35) [51.02(10.05)] [a]	9.46(6.22) [48.89(9.84)] [a]	15.18(9.28) [57.93(14.67)]	17.28(12.42) [61.25(19.64)]	25.66(12.47) [74.51(19.72)]	25.00(10.77) [73.47(17.04)]	26.82(12.00) [76.36(18.99)]	26.62(10.82) [76.03(17.12)]	15.18(10.93) [57.94(17.30)]	14.00(8.62) [56.07(13.63)]
MOT *	5.98(3.30) [49.89(10.13)]	6.05(3.21) [50.12(9.87)]	7.31(5.03) [53.97(15.44)] [a]	9.25(5.56) [59.94(17.07)] [a]	12.25(5.51) [69.16(16.94)]	13.60(5.55) [73.28(17.03)]	12.51(5.60) [69.97(17.19)]	14.12(4.64) [74.88(14.26)]	9.36(4.46) [60.29(13.68)]	8.22(8.30) [56.79(25.50)]
MANN (RRBI) *	3.08(3.38) [50.97(10.76)] [a]	2.44(2.83) [48.95(9.00)] [a]	6.56(5.66) [62.04(18.02)]	8.47(6.98) [68.12(22.21)]	11.92(6.97) [79.08(22.16)]	11.47(5.68) [77.66(18.07)]	12.54(6.93) [81.07(22.05)]	12.65(5.49) [81.43(17.47)]	5.82(3.54) [59.68(11.28)]	4.56(3.58) [55.66(11.70)]
SCI *	31.71(14.82) [50.63(8.55)] [a]	29.25(14.66) [49.31(8.55)] [a]	39.19(21.31) [54.58 (12.17)]	44.33(25.52) [57.43(14.05)]	63.23(25.80) [68.00(14.31)]	61.09(21.05) [66.91(11.72)]	65.64(24.85) [69.31(13.81)]	63.92(20.41) [68.41(11.23)]	41.82(22.48) [56.58(12.63)]	37.56(23.72) [53.82(14.02)]
K-SRS total score *	34.79(17.21) [50.88(10.18)] [a]	31.69(16.44) [49.05(9.72)] [a]	55.16(22.88) [62.93(13.53)]	63.32(28.49) [67.76(16.85)]	75.14(31.81) [74.75(18.82)]	72.56(25.93) [73.22(15.34)]	78.19(30.78) [76.55(18.21)]	76.58(25.23) [75.60(14.92)]	50.80(24.52) [60.35(14.50)]	55.17(23.20) [62.93(13.72)]

* p< 0.001 significant difference among three samples by Multivariate Analysis of Variance (MANOVA),

[a] p< 0.05 between gender groups by one way ANOVA,

[b] p< 0.05 between DSM5 ASD and DSM5 SCD by one way ANOVA

S.D.: Standard Deviation, M: male, F: female, DSM IV PDD: Subjects with Pervasive Developmental Disorder diagnosed by DSM IV criteria, DSM5 ASD: Subjects with Autism Spectrum Disorder by DSM5 criteria, DSM5 SCD: Subjects with Social Communication Disorder by DSM5 criteria. AWA: Social Awareness, COG: Social Cognition, COMM: Social Communication, MOT: Social Motivation, MANN: Autistic Mannerism, RRBI: Restricted interests & Repetitive Behaviors Index, SCI: Social Communication Index (AWA+COG+COMM+MOT)

Table 2

The Item Reliability test (internal consistency) of the K-SRS in three samples.

		AWA			COG			COMM			MOT			MANN (RRBI)			SCI			K-SRS total		
		GEN	CLI	EPI	GEN	CLI	EPI	GEN	CLI	EPI	GEN	CLI	EPI	GEN	CLI	EPI	GEN	CLI	EPI	GEN	CLI	EPI
AWA	GEN	1																				
	CLI		1																			
	EPI			1																		
COG	GEN	0.62			1																	
	CLI		0.64			1																
	EPI			0.58			1															
COMM	GEN	0.64			0.78			1														
	CLI		0.71			0.83			1													
	EPI			0.58			0.76			1												
MOT	GEN	0.48			0.66			0.70			1											
	CLI		0.41			0.57			0.70			1										
	EPI			0.31			0.51			0.65			1									
MANN (RRBI)	GEN	0.30			0.57			0.63			0.54			1								
	CLI		0.61			0.78			0.80			0.61			1							
	EPI			0.44			0.68			0.79			0.60			1						
SCI	GEN	0.76			0.90			0.94			0.81			0.62			1					
	CLI		0.76			0.89			0.97			0.78			0.83			1				
	EPI			0.69			0.87			0.95			0.75			0.79			1			
K-SRS total	GEN	0.72			0.89			0.94			0.81			0.73			0.99			1		
	CLI		0.75			0.90			0.96			0.76			0.89			0.99			1	
	EPI			0.65			0.86			0.95			0.74			0.87			0.99			1
Cronba-ch's Alpha	GEN		0.80			0.76			0.72			0.78			0.79			0.79			0.81	
	CLI		0.81			0.77			0.71			0.80			0.77			0.80			0.88	
	EPI		0.81			0.77			0.70			0.79			0.76			0.79			0.86	

All items are significant at $p < 0.001$ by inter-item correlation analysis. AWA: Social Awareness, COG: Social Cognition, COMM: Social Communication, MOT: Social Motivation, MANN: Autistic Mannerism, RRBI: Restricted interests & Repetitive Behaviors Index, SCI: Social Communication Index (AWA+COG+COMM+MOT), GEN: General Sample (n=790), CLI: Clinical Sample (n=151), EPI: Epidemiological ASD Sample (n=154)

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Table 3

Correlation between the IQ and the K-SRS T-scores in the clinical and epidemiological ASD samples.

	AWA	COG	COMM	MOT	MANN (RRBI)	SCI	K-SRS total
Total IQ Subjects (n=266)							
FSIQ	0.15	−0.00	−0.01	0.02	0.02	0.00	−0.12
VIQ	0.04	0.00	0.01	0.00	0.03	0.01	−0.08
PIQ	−0.04	−0.09	−0.09	−0.05	−0.06	−0.08	−0.18*
Subjects > IQ 70 (n=241)							
FSIQ	0.05	0.05	0.05	0.05	0.07	0.06	−0.06
VIQ	0.07	0.06	0.06	0.04	0.08	0.07	−0.03
PIQ	0.04	0.03	0.03	0.02	0.05	0.03	−0.07
Subjects ≤ IQ 70 (n=25)							
FSIQ	0.02	−0.07	−0.11	−0.11	0.05	−0.09	−0.15
VIQ	0.03	−0.14	−0.13	−0.16	0.02	−0.13	−0.20
PIQ	−0.27	−0.28	−0.45*	−0.29*	−0.22	−0.38*	−0.42*

*Correlation is significant at the 0.01 level by Pearson correlation analysis,

AWA: Social Awareness, COG: Social Cognition, COMM: Social Communication, MOT: Social Motivation, MANN: Autistic Mannerism, RRBI: Restricted interests & Repetitive Behaviors Index, SCI: Social Communication Index (AWA+COG+COMM+MOT), FSIQ: Full-scale IQ, VIQ: Verbal IQ, PIQ: Performance IQ

Table 4

The proportion of confirmed ASD cases exceeding specific K-SRS T-Score cut off in the epidemiologic sample

Subjects	K-SRS T-score cut off	DSM IV PDD (n=151) % of total subjects	DSM5 ASD (n=133) % of total subjects
Male	55	84.0	87.9
	60	76.5	80.4
	65	66.4	70.1
	70	55.5	58.9
	75	47.9	51.4
	80	37.0	39.3
	85	30.3	32.7
Female	55	87.5	92.3
	60	81.3	92.3
	65	65.6	73.1
	70	50.0	53.8
	75	43.8	46.2
	80	28.1	30.8
	85	21.9	26.9
Total	55	84.8	88.7
	60	77.5	82.7
	65	66.2	70.7
	70	54.3	57.9
	75	47.0	50.4
	80	35.1	37.6
	85	28.5	31.6

DSM IV PDD: Subjects with Pervasive Developmental Disorder diagnosed by DSM IV criteria, DSM5 ASD: Subjects with Autism Spectrum Disorder by DSM 5 criteria.

Table 5

Principal components analysis of the K-SRS data

a)

	General Sample (n=790)			Clinical Sample (n=154)			Epidemiological ASD Sample (n=151)		
Components	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	12.897	19.841	19.841	18.804	28.929	28.929	17.999	27.690	27.690
2	5.812	8.942	28.784	3.526	5.425	34.354	3.594	5.530	33.220
3	2.115	3.254	32.038	2.948	4.536	38.890	2.899	4.460	37.680
4	1.905	2.931	34.969	2.388	3.674	42.564	2.466	3.794	41.474
5	1.677	2.580	37.549	2.291	3.525	46.089	2.274	3.499	44.973

b)

	Total Combined Sample (n= 1,095)		
Component	**Total**	**% of variance**	**Cumulative %**
1	50.765	78.100	78.100
2	6.676	10.271	88.371
3	1.050	1.615	89.986

ASD, autism spectrum disorders.