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Social Communication Questionnaire Scoring Procedures for Autism Spectrum Disorder and the Prevalence of Potential Social Communication Disorder in ASD

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In analyzing data from the National Database for Autism Research, we utilized Mokken scaling techniques as a means of creating a more effective and efficient screening procedure for autism spectrum disorder (ASD) via the Social Communication Questionnaire (SCQ). With a sample of 1,040, approximately 80% (n = 827) of the sample were males while approximately 20% (n = 213) were females. In regard to ethnicity, approximately 68% of the sample were White/Caucasian, while 7% were African American, 16% were Hispanic, 4% were Asian, and 1% were Native American or American Indian. As the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM–5*) states that, "individuals with a well-established *DSM–IV* diagnosis of autistic disorder, Asperger's disorder, or pervasive developmental disorder not otherwise specified should be given the diagnosis of autism spectrum disorder," (American Psychiatric Association, 2013, p. 51), the primary labeling difference between the *DSM–IV* and the *DSM–5* would appear to be in identifying social communication disorder as a newly introduced disorder in the *DSM–5*, which we discuss. Though school psychologists are not dependent on the *DSM* to the same extent as clinical psychologists to provide services, school psychology is invested in the effective and efficient assessment of ASD. The current study demonstrates how Mokken scaling procedures may be utilized with respect to ASD identification via the SCQ as well as providing information regarding the prevalence of potential social communication disorder as a new disorder and its discrimination with ASD.

Keywords: Mokken scaling, item response theory, autism spectrum disorder

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School psychologists are quite familiar with the process of screening for mental disorders such as autism spectrum disorder (ASD) as schools are often the primary sources of referral for mental health services and many times, the primary providers of those services at least initially (Salmon & Kirby, 2008). The Social Communication Questionnaire (SCQ) is one of the most widely used and studied screening instruments for identifying individuals at risk for ASD (e.g., Bölte, Holtmann, & Poustka, 2008; Chandler et al., 2007; Corsello et al., 2007; Wiggins, Bakeman, Adamson, & Robins, 2007). Subsequent diagnostic assessment is often expensive and time-consuming work completed by a multidisciplinary team of professionals (Brooks & Benson, 2013), and the comprehensive diagnostic assessment can be a stressful process for the individual being assessed and the parents or caregivers. Thus, im-

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proving the screening process for individuals at risk for ASD via psychometric analyses is an important public health concern. Extant research indicates the sensitivity and specificity of the SCQ varies widely by study with sensitivities ranging from .61 to .88 (Allen, Silove, Williams, & Hutchins, 2007 and Chandler et al., 2007 respectively) and specificities ranging from .52 to .71 (Snow & Lecavalier, 2008 and Corsello et al., 2007, respectively) as it relates to subsequent ADOS (Autism Diagnostic Observation Scale; Lord et al., 1989; Rutter, DiLavore, Risi, Gotham, & Bishop, 2012) or ADI-R (Autism Diagnostic Interview-Revised; Lord, Rutter, & Le Couteur, 1994) standardized scores meeting cutoff for consideration of ASD diagnosis. Being derived from the ADI-R, the SCQ is correlated with the ADI-R (Berument, Rutter, Lord, Pickles, & Bailey, 1999; Rutter, Bailey, & Lord, 2003) as well as outperforming other screening instruments (Chandler et al., 2007) or performing equally well (Oosterling et al., 2009). However, the sensitivity and specificity values of SCQ scores reported in previous research fall below the sensitivity (.96) and specificity (.80) values reported by SCQ authors (Rutter et al., 2003).

Item response theory (IRT) techniques can estimate scaled scores that are considered sample- and measurement-free. As such, one limitation of the SCQ is its simple summing procedure of raw data for a total score. In this summing procedure, all items are assumed to *contribute equally* to the total scaled score but all items *do not discriminate* equally well. Item response theory techniques in combination with Mokken scaling techniques represents an *emerging and novel* body of literature that integrates IRT and Mokken analyses as applied to clinical assessments (e.g., Dichter et al., 2013; Fieo, Austin, Starr, & Deary, 2011). Contrary to extant SCQ research, which has suggested lowering SCQ cutoff scores to address the lack of predictive validity that arises from using a simple summing procedure (e.g., Allen et al., 2007; Brooks & Benson, 2013; Oosterling et al., 2010; Schanding, Nowell, & Goin-Kochel, 2012), the current study addresses this scoring limitation proactively and empirically via modern measurement and statistical analysis techniques. More efficient and effective SCQ scoring techniques could then be utilized by practitioners and researchers via new empirically derived cutoff scores. A second limitation of the SCQ in its current form is that all of the previous research on psychometrics was conducted using the *DSM–IV* criteria. Given that the *DSM–5* now collapses these disorders into ASD (with a severity rating) and the addition of a new, but related disorder entitled social communication disorder, it is unclear how this *DSM–5* reorganization of disorders associated with autism symptomology will affect the psychometric properties of the SCQ.

Level 1 screening for disabilities and disorders generally refers to the process of universal screening for developmental delays among children as they visit their primary care physician or pediatrician (Volkmar et al., 2014) using measures such as the Ages and Stages Questionnaire (Kerstjens et al., 2009) or BRIGANCE (Brigance, 2012). Level 2 screening specifically for ASD via instruments such as the Modified-Checklist for Autism in Toddlers (M-CHAT; Robins & Dumont-Mathieu, 2006; Robins, Fein, Barton, & Green, 2001) or the SCQ (Rutter et al., 2003) becomes necessary when a failure to pass a level 1 screening has occurred (Norris & Lecavalier, 2010). Thus, level 2 screening specifically for ASD is predicated upon the correct interpretation of a level 1 universal screening measure. Interpretations may vary according to the expertise of the health care providers regarding ASD and other developmental disorders. The primary objective of the current study is to reduce the number of questions from the SCQ while retaining adequate psychometric properties with regards to sensitivity and specificity for later diagnosis of ASD. The SCQ could then be integrated into level 1 screening so that all children may be universally screened for ASD using a very brief protocol that has been psychometrically validated specifically for ASD. This integration of ASD specific screening does not negate the need for further level 2 screening, but it will likely accelerate the diagnostic process if it has sufficient levels of specificity and sensitivity for identifying children later diagnosed with ASD via a comprehensive multidisciplinary evaluation. Indeed, parents of children with ASD have indicated a delay between identification of symptoms exhibited by their children to diagnosis of ASD, which then delays the subsequent receipt of services.

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The purpose of the current study was to demonstrate how Mokken scaling techniques may be utilized to develop a more psychometrically efficient (i.e., efficiency evaluated by psychometric properties) screening procedure for ASD as well as providing information regarding the prevalence and discrimination of potential social communication disorder as a new disorder. To achieve this purpose, we utilized a combination of Item Response Theory and Mokken scaling techniques. Though school psychologists are not dependent on the *DSM* to the same extent as clinical psychologists to provide services, school psychology is invested in the effective and efficient assessment of ASD. Upon developing a more efficient and effective scoring procedure for the SCQ for ASD, we next conducted a preliminary examination of its sensitivity for potentially screening for social communication disorder.

Method

Sample

The sample consisted of 1,040 individuals from the National Database for Autism Research (NDAR) who had SCQ item-level data as well as ADOS scores. See Novikova, Richman, Supker, Barnard-Brak, and Hall (2013) for a detailed description of this National Institutes of Health (NIH)-funded research data repository for NIH funded research on ASD that was from funded and completed grants related to ASD. A strength of NDAR secondary data analysis studies is the NIH peer review process that provides a level of quality control for recruitment, diagnosis, and experimental procedures that is often absent or omitted from other data repositories. Approximately 72% ($n = 748$) of the sample had an ASD diagnosis while 28% ($n = 295$) did not have an ASD diagnosis. For ASD diagnosis, we collapsed individuals with autistic disorder, ASD, and Asperger's disorder to align more with *DSM–5* criteria. Approximately 80% ($n = 827$) of the sample were males while approximately 20% ($n = 213$) were females. In regard to ethnicity, approximately 68% of the sample were White/Caucasian, while 7% were African American, 16% were Hispanic, 4% were Asian, and 1% were Native American or American Indian. The average age of individuals in the sample was 103.45 months ($SD = 70.19$).

Measures

All measures were obtained from NDAR. The SCQ is a 40-item, parent/caregiver-rated questionnaire utilized to screen for ASD (Rutter et al., 2003). The SCQ has a well-documented history of psychometric studies from its inception as the Autism Screening Questionnaire (Berument et al., 1999). The SCQ is a widely used screening instrument for ASD translated into 16 languages ranging from Icelandic to Korean (*Western Psychological Services, 2015*). The properties of data from the SCQ have varied with different samples yet the majority of the psychometric evidence appears favorable with the exception of screening ASD in individuals younger than the age of 4. The norming sample for the SCQ did not contain any individuals under the age of 4 (Berument et al., 1999), and the research literature reflects this limitation indicating that SCQ may require a lower cutoff score for younger populations (e.g., Allen et al., 2007; Corsello et al., 2007). Approximately 29% ($n = 306$) of the sample was under the age of four years old. The SCQ has a lifetime and current form. Approximately 65% ($n = 680$) of the cases utilized the lifetime form while 35% ($n = 360$) utilized the current form. The lifetime form item responses were used for analysis over current forms when scores for both forms were present because research has indicated that the current form has more psychometric limitations than the lifetime form but may be considered functionally equivalent with the major difference being time period of recollection being the past 3 months for the current form (Wei, Chesnut, Barnard-Brak, & Richman, 2015). Current form item responses were utilized in the absence of lifetime form item responses. Children under 4 years old typically receive the current form in lieu of the lifetime form (e.g., Brooks & Benson, 2013; Corsello et al., 2007; Lee, David, Rusyniak, Landa, & Newschaffer, 2007; Oosterling et al., 2010). For subsequent Receiver Operating Characteristic (ROC) curve analyses, ADOS scores were utilized to determine ASD diagnosis that had been confirmed by investigators from the individual NIH-funded grants on ASD. The ADOS-G (Generic as opposed to the ADOS-T or Toddler) has been indicated as being the "most extensively used instrument for diagnostic assessment . . ." (Volkmar et al.,

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2014, p. 541). All participants for the current study were selected through NDAR from NIH (National Institutes of Health) funded and completed grants related to ASD. As discussed in Novikova, Richman, Supker, Barnard-Brak, and Hall (2013), one of the clear strengths of NDAR for secondary data analysis studies is the rigorous and well-designed peer-review procedures for identifying studies funded by the NIH. The NIH review process for funding studies provides a level of quality control for participant recruitment, diagnosis, and experimental procedures that is often absent or omitted from other data repositories. However, each study (referred to as a "collection" in NDAR) used different comprehensive diagnostic procedures and assessment instruments to verify autism related diagnosis, but all of the studies used ADOS-G during the diagnostic process.

Procedure

Mokken scaling analyses were performed in R (*v*. 3.1.2) using the Mokken package (van der Ark, 2012). The confirmatory factor analysis was performed in *Mplus* (*v*. 7.3; Muthén & Muthén, 2014). ROC curve analyses were performed in MedCalc (*v*. 12.7, MedCalc Statistical Software, 2012), which permits the bootstrapping of area under curve (AUC) values and the statistical comparison of multiple ROC curves. Missing data were handled via multiple imputation techniques via sets of 10 as the missing data were evaluated to be missing completely at random. Approximately 16% of the cases contained missing or incomplete data. This study was approved as an exempt protocol by the university's human subjects research protection program.

Analysis

First, Mokken scaling techniques were utilized to create an abbreviated scoring version of the SCQ based upon IRT parameter estimates. IRT parameter estimates included the *a* value being discrimination parameter, the *b* value being difficulty parameter, and the *c* value referring to the pseudo guessing parameter. Mokken scaling techniques are stochastic and considered a less deterministic procedure than Guttmann techniques (Watson et al., 2012) permitting the systematic ordering of items, otherwise known as invariant item ordering (Molenaar & Sijtsma, 2000). In applying Mokken scaling techniques, the properties of monotone homogeneity (or single monotonicity) and double monotonicity were evaluated. Monotone homogeneity refers to the property that when the latent trait increases, the individual item responses increase as well (Watson et al., 2012). Double monotonicity refers to the property that individual item responses do not intersect across the latent trait (Watson et al., 2012). To evaluate the overall scalability of the measure, Loevinger's *H* coefficient was calculated. A value of $H > .30$ is indicative of acceptable scalability while *H* values $> .40$ are indicative of strong scalability (Molenaar & Sijtsma, 2000).

Second, confirmatory factor analyses were performed. Upon deriving the abbreviated scoring for the SCQ, a confirmatory factor analysis was conducted to provide evidence of construct validity of this abbreviated scored version of the SCQ along with providing the internal consistency of scores for the data obtained. Confirmatory factor analysis results were evaluated according to a variety of fit statistics. These fit statistics include the chi-square (χ^2) goodness of fit statistic, the comparative fit index (CFI), the Tucker Lewis Index (TLI), and the root mean square error of approximation (RMSEA).

Third, ROC curve analyses were then conducted to evaluate the external validity of this abbreviated scoring of the SCQ for ASD and potential social communication disorder. In predicting ASD diagnosis, the outcome variable of interest was determined by an ASD diagnosis that was obtained from a comprehensive assessment battery that varied between the NIH funded studies archived in NDAR. We used ADOS score (i.e., either ADOS-1 or −2 depending upon the year) cutoffs by module in the context of a comprehensive diagnostic process. AUC values of .70 and greater were considered indicative of acceptable fit (Fawcett, 2006). The Youden's *J* Index will provide optimal cutoff score for sensitivity versus specificity (Youden, 1950).

Results

ASD

In performing Mokken scaling techniques, we derived a seven-item scoring version of the SCQ. Full invariant item ordering was not

achieved in analyzing the data developing an abbreviated scoring version of the SCQ as the property of double monotonicity was not tenable across all items. This violation of double monotonicity can be visually observed via the intersection of item characteristic curves in Figure 1. This violation means that for all individuals, for example, with a moderate level of ASD symptoms according to the latent trait should answer questions in a consistent, hierarchical way while individuals with more mild symptoms of ASD should answer those questions consistently as well. From Figure 1, please note that items q11 and q13 could have been removed to achieve approximate or partial invariant item ordering (with consideration for confidence intervals), yet the psychometric properties of the scale in terms of internal consistency and construct validity would have been negatively impacted. However, single monotonicity (or monotone homogeneity) was held, which indicates that as values of the latent trait increased then individual item responses also increased. While double monotonicity is highly desirable in creating scalable and particularly Mokken measures, only single monotonicity is required in scaling (Watson et al., 2012). Scalability coefficients were as high as $H = .35$ for the data obtained, indicating acceptable but not particularly strong scalability, which is evident in the lack of full invariant item ordering. The scalability of items indicates whether items as whole and may be arranged to form a hierarchy of items for the data obtained, which is a function of both monotone homogeneity and double monotonicity (Molenaar & Sijtsma, 2000; Van Abswoude, van der Ark, & Sijtsma, 2004). The test–retest reliability procedure for this 7-item scale for the data obtained revealed Rho (ρ) statistic value of 0.71 indicating acceptable reliability. The latent variable model-based estimate of reliability as estimated by Raykov's Rho for the data was 0.79 (Raykov, 1997).

The internal consistency of scores for the data obtained was $\alpha = .70$. Confirmatory factor analyses revealed the 7-item scoring version to have a one-factor structure for the data obtained, $\chi^2(10) = 26.27$, $p < .05$ with a CFI value of 0.97, a TLI value of 0.95, and a RMSEA value of 0.06. For the sample data, CFI and TLI values of .95 and above while RMSEA values less than .08 were considered indicative of acceptable fit respectively (Little, 2013). Standardized factor loadings ranged from 0.39 to 0.80.

For the IRT parameters for the sample data, the *a* (item discrimination) parameter estimates ranged from 0.75 to 2.49 indicative of strong item discrimination (Baker, 1985, 2001), where values less than .20 indicate very weak item discrimination, values more than .21 and less than .40 indicate low item discrimination, values more than .41 and less than .80 indicate moderate item discrimination, *a* values more than .81 and less than 1.00 indicate high discrimination, and *a* values greater than 1.00 indicate very high item discrimination. The *b* (item difficulty) parameter estimates ranged from −0.87 to 0.34 indicating a continuum of ASD being represented. The item difficulty pa-

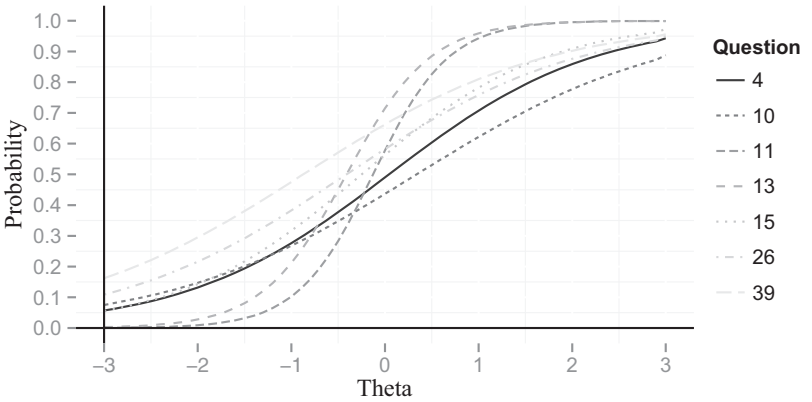

Figure 1. Item characteristics curves for the 7-item scoring procedure.

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rameter (b) is estimated as the θ-value at which individuals have a probability of .50 of endorsing the reference category (i.e., the point of inflection). A range of item difficulty values is typically desired so as to capture the full continuum of a latent trait with high discrimination values in all items. The c (pseudo guessing) parameter estimates ranged from −0.25 to 0.92 with associated probabilities (less than .20) at the y-intercept being in the acceptable range (Baker, 1985, 2001). Table 1 provides the 7 items that have been identified along with factor loadings (λ) and IRT parameter estimates (a, b, and c).

For the 7-item version, the bootstrapped ROC curve analyses reveal an AUC value of 0.84 (CI_{95}: 0.82; 0.86), $z = 23.72$, $p < .001$, which is better than typical AUC values achieved in previous literature regarding the SCQ (e.g., Allen et al., 2007; Chandler et al., 2007; Corsello et al., 2007; Snow & Lecavalier, 2008). The associated cutoff score was 3 or greater with a Youden's J Index value of .52 (CI_{95}: 0.49; 0.60). The sensitivity (0.79) and specificity (0.75) values at the cutoff value of 3 and greater were also better on average than found in previous studies analyzing psychometric properties of the SCQ (e.g., Allen et al., 2007; Chandler et al., 2007; Corsello et al., 2007; Snow & Lecavalier, 2008). Table 2 provides sensitivity and specificity values from previous research studies along with AUC values. We ranked studies by sensitivity to indicate how the study performs relatively better as compared with other studies.

For individuals under 4 years old, the bootstrapped ROC curve analyses reveal an AUC value of 0.81 (CI_{95}: 0.77; 0.86), $z = 12.74$, $p < .001$. The associated cutoff score was 3 or greater with a Youden's J Index value of .52 (CI_{95}: 0.43; 0.60). The sensitivity achieved was 0.67, and specificity value was 0.75 at the cutoff value of 3. For individuals over 4 years old, the bootstrapped ROC curve analyses reveal an AUC value of 0.81 (CI_{95}: 0.77; 0.84), $z = 13.12$, $p < .001$. The associated cutoff score was 3 or greater with a Youden's J Index value of .48 (CI_{95}: 0.38; 0.56). The sensitivity achieved was 0.82 and specificity value was 0.66 at the cutoff value of 3. There was no statistically significant difference in the AUC values for individuals under and over four years old. Figure 2 displays the ROC curves for the whole sample, a sample of individuals under the age of 4 years old, and a sample of individuals over the age of 4 years old.

Social Communication Disorder

The *DSM–5* (American Psychiatric Association, 2013) introduced the social communication disorder, which has a rule-out for an ASD diagnosis (e.g., differential diagnosis). Specifically, the *DSM–5* states that, "the two disorders can be differentiated by the presence in ASD of restricted/repetitive patterns of behavior, interests, or activities . . ." (American Psychiatric Association, 2013, p. 49). Given the recency of the *DSM–5*, there were no individuals who were diagnosed with social communication disorder in the sample as data were collected prior to the publication of the *DSM–5*. As the disorder is relatively new, we examined for its potential presence within our ASD sample to provide some estimate of prevalence based upon SCQ items. We utilized latent class analyses to examine for distinct groups of individuals within the ASD sample based upon the SCQ subscales of: all social interaction and communication items collapsed as social communication to

Table 1
Factor Loadings and IRT Parameter Estimates for 7-Item SCQ

Item	λ	a	b	c
Q4: Socially inappropriate questions/statements	.61	.92	.04	−.04
Q10: Used other's hand like a tool	.47	.75	.34	−.25
Q11: Odd, preoccupying interests	.77	2.49	−.13	.32
Q13: Unusual, intense special interests	.80	2.24	−.41	.92
Q15: Odd ways or movements	.62	1.02	−.25	.25
Q26: Look directly at you in communicating	.39	.81	−.41	.33
Q39: Playing imaginative games	.40	.77	−.87	.67

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Table 2
SCQ Studies Ranked by Sensitivity

	Sensitivity	Specificity	AUC
Study			
Berument, Rutter, Lord, Pickles, and Bailey (1999)	.96	.8	.95
Sato and colleagues (2009)	.93	.95	.98
Witwer and Lecavalier (2007)	.92	.62	.89
Chandler and colleagues (2007)	.86	.78	.90
Oner, Oner, and Munir (2014)	.84	.81	.89
Johnson and colleagues (2010)	.82	.88	.94
Current study	.79	.75	.81
Schanding, Nowell, and Goin-Kochel (2012)	.75	1.00	1.00
Eaves, Wingert, and Ho (2006)	.74	.54	—
Brooks and Benson (2013)	.71	.77	.73
Corsello and colleagues (2007)	.71	.71	.77
Eaves, Wingert, Ho, and Mickelson (2006)	.71	.79	—
Snow and Lecavalier (2008)	.70	.52	.67
Oosterling and colleagues (2009)	.66	.64	.67
Allen, Silove, Williams, and Hutchins (2007)	.61	.64	.76
Lee, David, Rusyniak, Landa, and Newschaffer (2007)	.54	.92	.88
Wiggins, Bakeman, Adamson, and Robins (2007)	.47	.89	—

Note. — indicates missing.

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align with the *DSM–5* and all restricted repetitive behavior items consistent with both *DSM–IV–TR* and *DSM–5*. In our latent class analyses, we tested for a one-, two-, three-, and four-class solutions and made model comparisons via Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) values, where lower values suggest better model fit. Table 3 provides the BIC and AIC values along with the number of free parameters for each model.

Results indicate that a two-class solution fit the data best as compared with other models. In this two-class solution, the first class consisted of approximately 69% of the sample and were revealed to have relatively high deficits in social communication ($M = 15.41$, $SD = 4.79$) and relatively high deficits as represented by restricted, repetitive behaviors as well ($M = 7.22$, $SD = 1.51$). The first class we consider to be those individuals who would likely be diagnosed with ASD under both the *DSM–IV* and

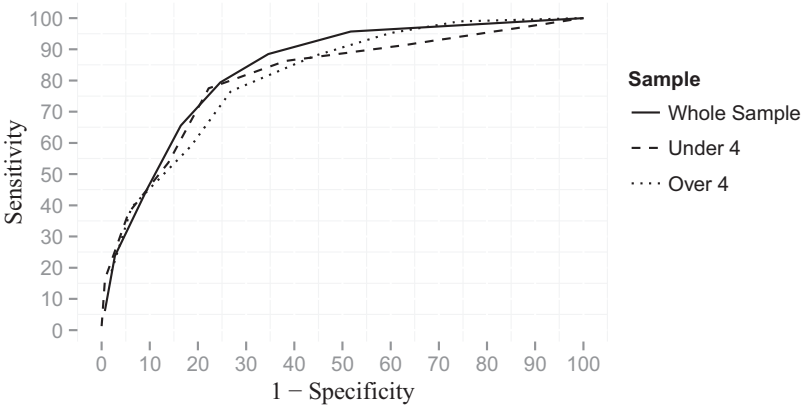

Figure 2. Comparative ROC curves for abbreviated SCQ.

Table 3
Model Statistics for Each Class Solution

Model	# of free parameters	BIC	AIC
1-class	4	6,503.39	6,485.76
2-class	**7**	**6,463.65**	**6,432.79**
3-class	10	6,475.61	6,431.53
4-class	13	6,489.44	6,432.13

Note. Results in bold indicate the best fitting model.

DSM–5 criteria as well. The second class consisted of approximately 31% of the sample and were revealed to have relatively high deficits in communication ($M = 15.29$, $SD = 4.53$) that were *not* significantly different than for those individuals in the first class who we consider would likely be diagnosed with ASD under *DSM–5* criteria (i.e., substantial deficits in social communication and repetitive and restricted interests). Deficits as represented by restricted, repetitive behaviors for individuals in this second class were revealed to be significantly lower ($M = 2.56$, $SD = 1.27$) than for individuals in the first class, $t(424.27) = -39.39$, $p < .001$, $d = -3.34$. We consider this second class of individuals to be those individuals who may be considered as potentially having social communication disorder as opposed to ASD under the *DSM–5* criteria.

Next, we conducted sensitivity analyses comparing class membership as either individuals with ASD versus potential social communication disorder via abbreviated SCQ scores. Bootstrapped ROC curve analyses reveal an AUC value of 0.87 (CI_{95}: 0.84; 0.90), $z = 25.35$, $p < .001$. The associated cutoff score was 3 or greater with a Youden's *J* Index value of .60 (CI_{95}: 0.52; 0.67). The sensitivity (0.91) and specificity (0.69) values were achieved at the cutoff value of 3. The result indicates that the abbreviated 7-item SCQ would appear to discriminate well with the new *DSM–5* diagnostic criteria for ASD as the state variable. The total SCQ performed well with an AUC value of 0.69 (CI_{95}: 0.65; 0.73), $z = 8.58$, $p < .001$. The associated cutoff score was 19 or greater with a Youden's *J* Index value of .26 (CI_{95}: 0.19; 0.31). The sensitivity (0.69) and specificity (0.58) values were achieved at the cutoff value of 19 for the total SCQ. The abbreviated SCQ performed relatively better than the total scale score such that the AUC values were significantly different, $\Delta_{AUC} = .18$, $SE = .03$, $z = 6.91$, $p < .001$. We should note that the abbreviated SCQ scoring procedure would be utilized with a different, broader population as a level 1 screening instrument as compared with the full SCQ for level 2 screening. These results indicate that both the abbreviated scored SCQ and the total scale SCQ were able to discriminate sufficiently between ASD and potential social communication disorder individuals.

Discussion

We have identified an abbreviated scoring procedure for the SCQ that appears to perform as well psychometrically as the total scaled SCQ for identifying individuals with ASD according to ADOS informed diagnosis. Data were derived from NDAR providing a sufficiently large sample to conduct IRT analyses in tandem with Mokken scaling procedures. While a combination of IRT and Mokken scaling techniques achieved this abbreviated scoring, our scale does not qualify as a true Mokken scale given that the assumption of double monotonicity was not satisfied. The primary drawback of the lack of true Mokken scaling is that the incremental scoring of items via a hierarchy cannot necessarily indicate increased severity of ASD across all levels of the latent trait. We do not consider this scaling quality to be a serious flaw as the SCQ is a screening instrument and would *not* be utilized to assess potential severity of ASD. That is, it is only designed to be a screener for potential ASD that signals the need for a comprehensive diagnostic evaluation for ASD. A comprehensive diagnostic evaluation would be the next step for ASD diagnosis based upon referral from SCQ or other screening instrument scores. There are instances when a true Mokken scale would be necessitated such as in examining functional ability, where certain abilities should predicate other abilities (Watson et al., 2012). In the case of true Mokken scaling, we would be able to more accurately estimate the severity of ASD or degree of functional ability based upon individual, ordered item responses. Mokken scaling procedures does permit researchers to create scales that are more efficient and therefore more effective by reducing the number of items while accurately capturing the continuum of a latent trait such as

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ASD symptoms thereby retaining predictive validity (Molenaar & Sijtsma, 2000; Watson et al., 2012).

Additionally, the abbreviated scoring for the SCQ appears to discriminate better between individuals with ASD versus potential social communication disorder as compared with when examining individuals with ASD versus without ASD. Yet, our analyses between individuals with ASD versus potential social communication disorder only considered individuals with an autism-related diagnosis under *DSM–IV–TR* criteria. While schools do not rely on *DSM* criteria to the same extent that clinics do in order to receive services for ASD, it is important to note that there could be potential implications of changing diagnostic criteria. Yet, the *DSM–5* does state that, "individuals with a well-established *DSM–IV* diagnosis of autistic disorder, Asperger's disorder, or pervasive developmental disorder not otherwise specified should be given the diagnosis of autism spectrum disorder," (American Psychiatric Association, 2013, p. 51). As a result of this statement from the *DSM–5*, the primary labeling difference between the *DSM–IV* and the *DSM–5* would appear to be concerned with ASD symptoms as potential social communication disorder as a newly introduced disorder. Again, we do understand that school psychology does not depend upon the *DSM* to the same extent or at all but rather educational need takes precedence. The current provided demonstrates how Mokken scaling techniques may be utilized to create more effective screening procedures for ASD, in which we acknowledge the role of potential social communication disorder. For school psychologists in a school using an Response to Intervention (RtI; see Bradley, Danielson, & Doolittle, 2005 for an introduction), this abbreviated screening procedure for SCQ could be utilized as part of universal screening given the reduced number of items, which would allow it to be integrated with other screening measures. We also consider the integration of ASD screening within existing special education populations for comorbid ASD to be especially important. For instance, the literature has indicated that individuals with intellectual disabilities are typically diagnosed with ASD much later as compared with individuals with ASD alone (Brooks & Benson, 2013; Mandell, Novak, & Zubritsky, 2005).

The current study also provides the first estimates of the potential prevalence of social communication disorder within an ASD population in the literature since the publication of the *DSM–5*. We should note that there appears to be greater homogeneity among individuals with ASD when comping individuals with and without ASD. This greater heterogeneity within the non-ASD sample may account for the better sensitivity/discrimination between ASD and potential social communication disorder. With that said, there is an unknown number of individuals without an ASD diagnosis who may qualify for an social communication disorder diagnosis, and this procedure needs to be tested with a sample consisting of those individuals as well. Furthermore, the diagnostic assessment for social communication disorder is still very much in the development stage; thus, we are careful to term this group of individuals as having potential social communication disorder without the assistance of cutoff scores or validated assessments.

Results from the current study are promising with regards to using an abbreviated scoring version of the SCQ as a level 1 screener for potential ASD, and possibly social communication disorder as described in the new *DSM–5*. Given that the current study was conducted via secondary data analyses, however, future research will need to conduct an a priori data collection to replicate the findings from the current study. That is, future research needs to confirm that the abbreviated SCQ scoring has sufficient sensitivity and specificity for ASD. The study also revealed interesting findings in discriminating between ASD and potential social communication disorder diagnoses, including prevalence estimates. Future research needs social communication disorder diagnoses completed a priori and with a comprehensive multidisciplinary diagnostic assessment of all participants before it can be concluded that the abbreviated version of the SCQ can reliably identify individuals that are later diagnosed with ASD versus social communication disorder. As a result, in the current study, we did not provide a cutoff score for potential social communication disorder via ROC curve analyses given that future research must establish the social communication disorder diagnostic assessment protocol.

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