Article

Differentiating Autism Spectrum Disorder From ADHD Using the Social Communication Questionnaire

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Abstract

Objective: This study examined the ability of the Social Communication Questionnaire (SCQ) to differentiate between autism spectrum disorder (ASD), ADHD, and typically developing (TD) children. **Method:** Children (M_{age} = 11.27 years, SD_{age} = 3.28) identified with ASD Severity Levels "1" and/or "2" (n = 28), ADHD (n = 44), dual diagnoses of ADHD and ASD (n = 29), and TD (n = 61) were assessed using the SCQ. **Results:** The SCQ differentiated between ASD and non-ASD groups. Children with ASD had higher total and domain scores on the SCQ than ADHD and TD children. The optimal cutoff total score of 13 was identified for differentiating between ASD and ADHD groups (area under the curve [AUC] = .96). Twenty eight of the 39 items were identified as significant in differentiating between ASD and ADHD. **Conclusion:** The SCQ continues to be a well-validated screening tool for ASD and is suitable for determining whether further ASD assessment is warranted in children with ADHD symptoms. *(J. of Att. Dis. 2019; 23(8) 828-837)*

Keywords

ADHD, autism spectrum disorder, screening tools, differentiating, Social Communication Questionnaire

Autism spectrum disorder (ASD) and ADHD are both childhood neurodevelopmental conditions that share common features including social interaction deficits, emotion regulation difficulties, and behavior concerns (for review, see Mannion & Leader, 2014; Matson, Rieske, & Williams, 2013). When a child displays several of these concerns, both ASD and ADHD are possible options for explaining the child's presentation. The clinician is then faced with the dilemma of determining the next best step in the assessment process. While the obvious answer is to explore both options, research has found that often there are delays in the assessment for ASD rather than ADHD (Davidovitch, Levit-Binnun, Golan, & Manning-Courtney, 2015). This may be because the prototypical behaviors and social problems that characterize ASD may not initially manifest in the child and/or do not become clear until social demands increase with age (Miodovnik, Harstad, Sideridis, & Huntington, 2015). In addition, the symptoms of ADHD such as inattentiveness, emotion dysregulation, and impulsivity can mask these difficulties but when treated with pharmacological interventions the ASD characteristics become more obvious (Matson et al., 2013).

Consequently, ASD assessment and diagnosis may not occur until the child enters and settles into formal schooling, usually after 6 years of age (Davidovitch et al., 2015). A recent study by Miodovnik and colleagues (2015) reviewed the timing of an ASD diagnosis for 1,496 children between the ages of 2 and 17 years. They found that 20% of children with ASD were initially diagnosed with ADHD and were 30 times more likely to receive a diagnosis of ASD after the age of 6 years. Delays in diagnosis were found frequently in children previously diagnosed with ADHD who were "higher functioning" and who were eventually diagnosed with Asperger's disorder or pervasive developmental disorder–not otherwise specified (PDD-NOS)—subcategories of ASD recognized within the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association [APA], 2000) (Jensen, Larrieu, & Mack, 1997; Perry & Jellinek, 2004).

Key revisions within the current diagnostic criteria, (i.e., *Diagnostic and Statistical Manual of Mental Disorders* [5th ed.; *DSM-5*; APA, 2013]) included the removal of the subcategories of ASD (i.e., autistic disorder, Asperger's disorder, childhood disintegrative disorder, and PDD-NOS).

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These previously separate disorders are now encompassed under a single condition of ASD. Moreover, *DSM-5* has included a severity ranking on a scale of 1 to 3 with regard to the level of support needed in each of the two key symptom domains of (a) social communication and (b) restricted, repetitive behaviors. A severity ranking at Level 1 refers to needing the least support and at Level 3 requiring very substantial support for each symptom area. Therefore, under *DSM-5*, the children previously diagnosed with Asperger's disorder or PDD-NOS would now be defined as ASD with core characteristics within the severity ranking of Levels 1 and/or 2 (i.e., requiring some and/or substantial support for social communication impairments and restricted behavior). Often, these children do not have a diagnosis of intellectual disability, are placed in mainstream classroom settings, but continue to have behavior problems (Zander & Bölte, 2015).

In comparison, ADHD is characterized by symptoms of inattentiveness, hyperactivity, and impulsivity (APA, 2013). ADHD is specified into three presentation types: (a) "combined" type in which symptoms of both inattentiveness and hyperactivity-impulsivity are present, (b) "predominantly inattentive" type, or (c) "predominantly hyperactive/impulsive" type. To be diagnosed as having ADHD, these characteristics must be present prior to the age of 12 years and symptoms must be present across contexts such as both home and school settings (APA, 2013).

In comparing the intervention approaches to the two conditions, interventions for ASD are typically based on behavioral frameworks (see Vismara & Rogers, 2010 for review of interventions). For ADHD, best-practice guidelines (e.g., National Institute for Health and Clinical Excellence [NICE], 2008 guidelines) recommend a multidisciplinary approach to treatment that frequently includes psychostimulant medication (which is the most commonly used evidence-based intervention) as well as non-pharmacological interventions such as behavior and parent training (see NICE, 2008; Smith, Barkley, & Shapiro, 2006).

The diagnostic process of ASD is both costly and time consuming, often involving the use of diagnostic tools that require specialist training such as the Autism Diagnostic Observation Schedule–Second Edition (ADOS-2; Lord, Rutter, DiLavore, & Risi, 2008) and the Autism Diagnostic Interview–Revised (ADI-R; Rutter, LeCouteur, & Lord, 2003), as well as a recommended developmental and/or cognitive assessment and pediatric review. By comparison, the ADHD diagnostic process is less costly and typically involves the use of behavior rating scales, cognitive functioning assessment (e.g., exploration of working memory and executive functioning) and pediatric review (Smith et al., 2006).

Central to the diagnostic process for both conditions is the heavy reliance on the clinician judgment in determining the presence and absence of the core characteristics, the level of severity of these characteristics, as well as ruling in/out differential diagnoses. The outcome of the diagnostic process influences treatment pathways, and given that the treatments for the two conditions vary, differentiating whether a child primarily meet diagnostic criteria for ADHD, ASD, or both conditions is crucial in determining the most appropriate treatment plan. Given the additional time, cost, and specialist training associated with the diagnostic procedure for ASD as well as the stress an ASD assessment can have on families (Moh & Magiati, 2012; Nicholas & Kilmer, 2015), clinicians are faced with the dilemma of determining whether families should invest in exploring ASD symptoms further.

A screening measure that could reliably identify ASD symptoms in a child with features of ADHD would be an appropriate first step in the assessment process as it would assist in determining whether a more detailed assessment for ASD should be pursued, or whether ADHD should be the primary focus of the assessment. The Social Communications Questionnaire (SCQ) is a good candidate for such a screening measure given that it is quick to administer, requires less clinician training than the interview-based process involved in ASD assessment, and has been shown to discriminate reliably between the conditions of ASD and ADHD.

SCQ in the Initial Diagnostic Process

The Social Communication Questionnaire (SCQ; Rutter, Bailey, Lord, & Berument, 2003) was originally designed "as a companion measure" to the ADI-R (Rutter et al., 2003, p. 1). This scale is comprised of 40 items that correspond directly to key questions in the ADI-R, giving it good discriminative diagnostic validity (Rutter et al., 2003). The SCQ that was developed based on *DSM-IV-TR* (APA, 2000) criteria for ASD is comprised of 15 items examining social interaction, 13 items examining communication, and eight items examining repetitive behaviors. There are two versions of the SCQ, the "current" version which is used to assess behavior over the past 3 months and the "lifetime" version that examines lifetime behavior for determining whether a child may potentially have ASD. It can be used for any age above 4 years with the authors' specifying that this includes a minimal mental age of 2 years (Rutter et al.). Scores on the SCQ range from 0 to 39, with higher total scores indicating a greater likelihood of concerns for ASD. A cutoff score of 15 or greater has been recommended as indicating a likelihood of an ASD diagnosis. This cutoff score has been reported to have sensitivity of .85 and specificity of .75 for pervasive developmental disorders, within the *DSM-IV-TR* (APA, 2000). The SCQ also provides subscores for key ASD areas of deficit; however, the authors have reported the total score provides the best differentiation from other diagnoses (Rutter, Bailey, Lord & Berument, 2003).

ASD Versus ADHD Using the SCQ

Previous research on the SCQ indicates that there are significant differences between ASD and ADHD groups on the total score of the SCQ, and that this measure can reliably differentiate ASD from non-ASD groups. For example, a U.S.-based study conducted by Ghaziuddin, Welch, Mohiuddin, Lagrou, and Ghaziuddin (2010) compared children with ASD (n = 19), ADHD (n = 57), and those with dual diagnoses of both ASD and ADHD (n = 22). Participants were recruited from child psychiatry clinics and an inclusion criteria of an IQ of 70 or greater was applied. They found that the ASD group had a significantly higher SCQ total score than the non-ASD groups. Schwenck and Freitag (2014) examined the differential validity of the SCQ in a German study comparing ASD (n = 25), ADHD (n = 25), ASD + ADHD (n = 35), and typically developing (TD) children (n = 94). While there were no inclusion criteria for IQ, these groups were matched for gender, IQ, and age. They found the SCQ to have good differential validity with the area under the curve (AUC) between ASD and TD groups of .94, and between ASD and ADHD of .86.

The SCQ has been shown to discriminate reliably between ASD and ADHD; however, there is variation regarding the clinical cutoff score for differentiating these two conditions. For example, Schwenck and Freitag (2014) indicated that a cutoff value of 14 (AUC = .86) was optimal in differentiating between children diagnosed with ASD only from those diagnosed with ADHD only. When differentiating between ASD and TD groups, a score of 9 was optimal (AUC = .94). In addition, a score of 12 (AUC = .99) was recommended for differentiating children diagnosed with both conditions (i.e., ASD + ADHD) from TD children. In comparison, Kröger and colleagues (2011) found that a score of 11 (AUC = .89) showed highest specificity and sensitivity between ASD and ADHD. These examples illustrate the lack of consensus among studies and that the recommended cutoff scores can vary greatly, making it difficult for clinicians to determine the cutoff score to use to guide their decision of whether a thorough ASD assessment is required.

Moreover, differences between children with ADHD and TD controls have not been consistently demonstrated with regard to SCQ total and domain scores. For example, Kochhar and his team (2011) in the United Kingdom compared 30 children with ADHD to 30 matched TD controls (i.e., children without a diagnosis matched for age, gender, and socioeconomic status), as well as using an inclusionary criteria of IQ of 70 or greater. They found that children with ADHD when compared with TD controls had higher total SCQ, as well as higher scores on the social and communication domains. In contrast, Schwenck and Freitag (2014) did not find significant differences between these two groups with regard to the SCQ total score. However, they did find that children with ADHD, compared with TD controls, had significantly higher scores on the social and communication domains. Interestingly, Cooper, Martin, Langley, Hamshere, and Thapar (2014) reported that total SCQ scores vary and were dependent on the severity of presentation and comorbidity with other conditions such as oppositional defiant disorder, conduct disorder, anxiety, depression, and lower cognitive ability. Therefore, it is important to clarify whether the presence of ASD characteristics in children with ADHD can be demonstrated on the SCQ in terms of significantly higher total and domain scores when compared with TD children.

Furthermore, the aforementioned evaluations of clinical utility were conducted based on former diagnostic criteria (i.e., *Diagnostic and Statistical Manual of Mental Disorders* [4th ed.; *DSM-IV*; APA, 1994] and *DSM-IV-TR*; APA, 2000). The criteria for ASD has undergone a significant shift in *DSM-5*, which has also acknowledged the overlap and comorbidity between ASD and ADHD such that dual diagnoses of ASD and ADHD are now accepted. Based on the current authors' knowledge, no study yet has examined the clinical utility of the SCQ in relation to the current *DSM-5* criteria.

Moreover, while the SCQ has been shown to differentiate between ASD and ADHD with regard to the overall and domain scores, more research is needed with regard to whether there are particular items in the SCQ that are better at differentiating between ASD and ADHD, and whether these items can be used to assist clinicians in developing a typical "profile" for ASD versus ADHD on this screening tool. There is only one study to date that has attempted to examine this issue. Using a series of multinomial logistic regression, Ghaziuddin and his colleagues (2010) identified nine items (i.e., SCQ Items 6, 7, 13, 14, 26, 27, 33, 36, and 37) as "particularly significant in differentiating between ADHD and ASD groups" (Ghaziuddin et al., 2010, p. 362). However, these authors did not provide a clear explanation of the statistical criteria used for determining inclusion into the "particularly significant" item pool. Moreover, although the sample was adequately powered, the sample included all former ASD diagnoses including PDD-NOS, Asperger's syndrome, and autistic disorder into one group. While this reflects the spectrum of ASD disorders, the sample is not necessarily a reflection of cases of ASD Severity Levels 1 and/or 2 that often present more similarly to children with ADHD. Other researchers have also criticized the authors for not using a receiver operating characteristic (ROC) curve analysis to confirm the validity of clinical cutoff scores to be generalized to the ASD group (e.g., Schwenck & Freitag, 2014).

Current Study

This study had two main goals. First, to address the aforementioned key areas where there is currently a lack of consensus. Namely, (a) examine the ability of the SCQ in differentiating between ASD and ADHD and determine the clinical cutoff

scores on the SCQ for differentiating between these two conditions, using current *DSM-5* criteria that specifies a dyad of core characteristics, social communication, and repetitive behaviors and (b) whether children with ADHD obtain higher scores in comparison with TD children with regard to overall and domain scores (i.e., total, social communication, and repetitive behaviors). Second, to replicate the study by Ghaziuddin and his colleagues (2010) with regard to the identification of SCQ items that best differentiate ASD and ADHD using current diagnostic criteria.

For consistency with previous research, the current study recruited participants from child psychiatry/pediatric clinics and an exclusionary criteria for intellectual disability was applied. However, in contrast to previous studies, only children diagnosed with ASD with a Severity Level 1 and/or Level 2 on both core symptoms were included in the study. This was done to better reflect the group of children whose diagnosis may be less clear-cut (i.e., high functioning and in mainstream classrooms) and where there may be more difficulties in differentiating ASD from ADHD. In addition to the clinical groups of ASD and ADHD, additional comparison groups of dual diagnoses of ASD and ADHD (ASD + ADHD) as well as a group of TD children were included. ROC analyses were also conducted on the SCQ to examine the scale's ability in differentiating between ASD from non-ASD groups.

Method

Participants

A statistical power analysis was performed for sample size estimation (medium effect size, power = .80, two-sided alpha = .05) identified a sample size of 195 for the planned statistical procedures. However, due to a low return rate of forms, this target sample size was not achieved. The final sample was comprised of 162 children and adolescents aged between 6 and 17 years, inclusive (M_{age} = 11.27 years, SD_{age} = 3.28). These participants were recruited over a 7-month period. Participants in the clinical groups (i.e., ASD, ADHD, and ASD+ADHD) were recruited from the Children's Hospital at Westmead and a private pediatric clinic in Sydney (Australia). Participants were excluded from the study if they had a general cognitive ability score to suggest an intellectual disability (i.e., general cognitive ability score less than 70). The general cognitive ability score was based on a preexisting standardized test score obtained from the participants' client files.

Clinical groups. The ASD group consisted of 27 participants (74.1% males; M_{age} = 11.65 months, SD_{age} = 2.92). Only participants with an existing ASD diagnosis were recruited and were required to provide documentation of their diagnosis that included a pediatric/psychiatric or multidisciplinary assessment using *DSM* criteria. Any ASD diagnosis made using *DSM-IV-TR* criteria was reevaluated using current *DSM-5* criteria. Only participants with ASD met the criteria for Severity Levels 1 and/or 2 in either of the two ASD symptom domains were included in the study. A small proportion of these participants (7.4%) were on stimulant medications, 37% were on other forms of medication (e.g., Selective Serotonin Reuptake Inhibitors, antipsychotics) and 70.4% were receiving other nonmedication-based interventions.

The ADHD group consisted of 46 participants (87% males; M_{age} = 11.82 years, SD_{age} = 3.19). Only children with an existing ADHD diagnosis were included in the study and had to provide documentation of their diagnosis that included evidence of pediatric/psychiatric assessment using *DSM* criteria. A large proportion of these participants (80.4%) were on stimulant medications and 56.5% were receiving other nonmedication interventions.

There were 28 participants (92.9% males; M_{age} = 11.33 years, SD_{age} = 3.81) who had documented diagnoses of both ASD and ADHD. Like the ADHD group, a large proportion of participants in this group (78.6%) were on stimulant medications, 14.3% were on other medications. In all, 92.9% were receiving other nonmedication interventions.

TD group. The TD group consisted of 61 participants (41% males; M_{age} = 10.66 years, SD_{age} = 3.21) and were recruited through distribution of the study information sheet to social and professional networks of the three authors. Participants in this group were administered the KBIT-2 (Kaufman Brief Intelligence Test, Second Edition; Kaufman & Kaufman, 2004b) to ensure that their IQ was greater than 70. The Conners-3 (Conners, 2008) and the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) were administered to participants in this group to ensure that they did not meet recommended clinical cutoff scores for behaviors consistent with ADHD or showing features of ASD. A demographic questionnaire was also given to confirm that they had never been referred to a professional such as a psychologist or pediatrician for ASD and/or ADHD.

Measures

The SCQ-Lifetime version (Rutter et al., 2003) was administered to all participants. Respondents were required to select a yes/no response to each of the items in this questionnaire. It has strong psychometric properties including a high correlation (r = .71) with the ADI-R (see Rutter et al., 2003). In the current sample, Cronbach's alpha found the SCQ full scale to have strong internal consistency reliability (α = .93). Cronbach's alpha for both the SCQ social communication domain (α = .89) and the SCQ repetitive behaviors (α = .89) domain indicated strong internal consistency reliability.

Table 1. Mean Scores on SCQ Scores.

	ASD		ADHD		ASD + ADHD		TD	
	M (*SD*)	Adjusted *M* (*SE*)	*M* (*SD*)	Adjusted *M* (*SE*)	*M* (*SD*)	Adjusted *M* (*SE*)	*M* (*SD*)	Adjusted *M* (*SE*)
SCQ total	19 (4.71)[a]	19.04 (0.85)	7.13 (4.8)[b]	7.26 (0.67)	19.32 (6.27)[a]	19.49 (0.85)	2.54 (2.45)[c]	2.35 (0.61)
SCQ social communication	12.63 (3.6)[a]	12.64 (0.67)	4.83 (3.32)[b]	4.85 (0.53)	12.86 (5.2)[a]	12.89 (0.68)	2.3 (2.34)[c]	2.26 (0.48)
SCQ repetitive behaviors	4.85 (2.18)[a]	4.87 (0.33)	1.74 (1.98)[b]	1.81 (0.26)	5 (2.23)[a]	5.1 (0.33)	0.25 (0.67)[c]	0.14 (0.24)

Note. Significant differences are denoted as superscript letters. Groups with differing superscript letters indicate significant differences at the .05 level. SCQ = Social Communication Questionnaire; ASD = children with autism spectrum disorder; ADHD = children with ADHD; ASD + ADHD = has a combined diagnosis of both ASD and ADHD; TD = typically developing children; SCQ total = total score on the SCQ; SCQ social communication = total score for social items and communication items on the SCQ; SCQ repetitive behaviors = total score for repetitive behavior items on the SCQ.

Procedures

After obtaining approval from the relevant human research ethics committees, the CBCL, Conners-3, and SCQ were mailed out to the parents of participants with a reply-paid envelope (to encourage return of the forms). Both the CBCL (Achenbach & Rescorla, 2001) and Conners-3–parent version (Conners, 2008) with updated *DSM-5* constructs were used to confirm diagnosis of ADHD for children in the ADHD and ASD + ADHD groups.

Results

To determine whether there were differences between the four groups, ASD, ADHD, ASD + ADHD, and TD, with regard to gender and age, a chi-square test and an ANOVA were conducted, respectively. There was a significant difference in the number of females between the groups with more females in the TD group than the other three groups, $\chi^2(3, n = 162) = 36.77$, $p < .001$. No other significant differences were observed between the remaining three groups. The ANOVA indicated that the four groups were not significantly different with regard to age ($p > .05$).

Mean Differences for SCQ Scores

ANCOVA with gender as a covariate showed a significant difference among the four groups with regard to SCQ total scores, $F(3, 162) = 132.37$, $p < .001$, $\eta^2 = .72$, SCQ social communication domain scores, $F(3, 162) = 84.16$, $p < .0001$, $\eta^2 = .62$, and SCQ repetitive behaviors domain scores, $F(3, 162) = 69.48$, $p < .001$, $\eta^2 = .57$.

As seen in Table 1, pairwise comparisons (with Bonferroni adjustment) indicated that the TD group had a significantly lower mean scores on SCQ total, social communication domain, and repetitive behaviors domain in comparison with the three clinical groups. The ADHD-only group was also found to have a significantly lower mean scores on SCQ total, social communication domain, and repetitive behaviors domain compared with the ASD only and ASD + ADHD groups. No other group differences were observed ($p > .05$).

Determining Optimal Cutoff Scores on the SCQ

A ROC curve analysis was used to evaluate the ability of the SCQ to discriminate between children with ASD from children without this condition (i.e., ADHD and TD), and to determine the optimal cutoff scores for the SCQ for identifying children who are likely to have ASD. The full SCQ scale was subjected to a ROC analysis using the ASD, ADHD, and TD groups. Note that the ASD + ADHD group was not included in this analysis given that this group contains children with an ASD diagnosis. However, a further ROC curve analysis was conducted to evaluate the ability of the SCQ to differentiate between children diagnosed with both conditions (i.e., ASD + ADHD) from those diagnosed with ADHD only.

The AUC measures how well the target scale (i.e., the SCQ) can distinguish between children with ASD versus children without ASD (Fawcett, 2006). The range for discriminability varies between 0.5 (poor classification ability) to 1.0 (perfect classification ability). The AUC was determined as 0.98, $SE = .009$, 95% confidence interval (CI) = [0.96, 1.00], $p < .0001$, indicating excellent ability in discriminating the ASD and non-ASD groups (Greiner, Pfeiffer, & Smith, 2000). To establish the optimal cutoff score, the coordinates of the curve were examined and the point at which there was the best trade-off between sensitivity (percentage of cases correctly identified) and false positive rates (percentage of cases incorrectly identified) was determined (Greiner et al., 2000). Based on this, the optimal SCQ cutoff score for detecting ASD was considered to be 9.

The analysis was repeated using the ASD and ADHD groups only. The AUC was determined as 0.96 ($SE = .022$, 95% CI = [0.91, 1.00], $p < .0001$), indicating excellent ability in discriminating the ASD and ADHD groups (Greiner et al., 2000). The optimal SCQ cutoff score for detecting ASD was 13.

With regard to the analysis using children with both conditions (i.e., ASD + ADHD) versus children diagnosed only with ADHD, the AUC was determined as .93 ($SE = .03$, 95% CI = [0.87, 0.99], $p < .0001$) with an optimal SCQ cutoff score of 13 (see Table 2).

Table 2. Summary of ROC Analysis of the SCQ for ASD Versus Non-ASD Groups.

	ASD Versus ADHD and TD				ASD Versus ADHD				ADHD Versus ASD + ADHD			
Score type	Optimal cutoff	AUC	Sensitivity	Specificity	Optimal cutoff	AUC	Sensitivity	Specificity	Optimal cutoff	AUC	Sensitivity	Specificity
SCQ total	9	.98***	1.0	.84	13	.96***	0.96	.87	13	.93***	0.87	.85
SCQ social communication	7	.96***	0.96	.84	7	.93***	0.96	.73	9	.89***	0.83	.77
SCQ repetitive behaviors	2	.91***	0.93	.79	3	.84***	0.81	.74	4	.87***	0.83	.77

Note. ROC = receiver operating characteristic; SCQ = Social Communication Questionnaire; ASD = children with autism spectrum disorder; non-ASD = children with ADHD or TD; ADHD = children with ADHD; TD = typically developing children; AUC = area under the curve; SCQ total = total score on the SCQ; SCQ social communication = total score for social items and communication items on the SCQ; SCQ repetitive behaviors = total score for repetitive behavior items on the SCQ.
***$p < .0001$.

The social communication domain of the SCQ was also subjected to a ROC curve analysis using the ASD, ADHD, and TD groups. The AUC was determined as 0.96 (SE = .015, 95% CI = [0.94, 0.99], $p < .0001$), also indicating excellent ability in discriminating the ASD group from non-ASD groups. The optimal SCQ social communication cutoff score for detecting ASD was considered to be at 7. Another ROC analysis was conducted for ASD versus ADHD groups only. Very similar results were found with regard to the AUC that was 0.93 (SE = .027, 95% CI = [0.88, 0.99], $p < .0001$) and cutoff score for detecting ASD was considered to also be 7 (see Table 2). The ROC curve analysis conducted for ASD + ADHD versus ADHD only indicated an AUC of .89 (SE = .041, 95% CI = [0.81, 0.97], $p < .0001$) and a cutoff score of 9.

Using a ROC curve analysis for the repetitive behaviors domain of the SCQ for the ASD, ADHD, and TD groups, the AUC was determined as 0.91 (SE = .032, 95% CI = [0.85, 0.97], $p < .0001$). This also indicated strong ability in discriminating the ASD and non-ASD groups. The optimal SCQ repetitive behaviors cutoff score for detecting ASD was considered to be at 2. In the analysis involving only ASD versus ADHD groups, the AUC was 0.84 (SE = .049, 95% CI = [0.75, 0.94], $p < .0001$) and the cutoff score was 3. In the ROC curve analysis conducted to discriminate between ASD + ADHD group and the ADHD only group, the AUC was .87 (SE = .046, 95% CI = [0.78, 0.96], $p < .0001$).

Discriminating Items

A series of multinomial logistic regression analyses were used to determine how well each of the SCQ items (i.e., Items 2-40) predicted diagnostic category of ASD. Note SCQ Item 1 is a general question that does not have a score value and was therefore not included in the analyses. This set of analyses found that all the items were significant in discriminating between the ASD and TD groups. In contrast, none of the SCQ items was found to be significant in distinguishing between the ASD and ASD + ADHD groups.

The 28 SCQ items presented in Table 3 were identified as significant in discriminating between the ASD and ADHD groups. To evaluate the ability of these 28 SCQ items to distinguish between children in the ASD group versus children in the ADHD and TD groups, a ROC curve analysis was conducted. The AUC for this revised model was .99, SE = .008, 95% CI = [0.97, 1.00], $p < .0001$, indicating excellent ability in discriminating the ASD and non-ASD groups (Greiner et al., 2000).

Discussion

Given the recent changes to the diagnostic criteria for ASD, the current study replicated and extended previous studies with regard to the clinical utility of the SCQ (under *DSM-5* criteria) in differentiating ASD from ADHD. The current study also addressed some of the contradictory findings with regard to clinical cutoff scores on the SCQ (total score, social communication, and repetitive behavior domain scores), and the identification of key differentiating items on the SCQ.

The study demonstrated that the SCQ is a reliable and valid screening tool to be used in clinical practice. Consistent with the study by Ghaziuddin et al. (2010), there was a significant difference in overall total SCQ scores between the ASD group versus the ADHD and TD groups. This study also found that the ASD group obtaining higher scores than the other two groups on the two domain scores (i.e., social communication and repetitive behaviors). As expected, there were no significant differences in SCQ scores between the ASD and the combined ASD + ADHD groups, given that the latter group also included children with ASD. These findings are consistent with previous studies (e.g., Ghaziuddin et al., 2010; Kochhar et al., 2011; Schwenck & Freitag, 2014) all of which concluded that the SCQ can differentiate between ASD and non-ASD groups (i.e., ADHD and TD).

With regard to ADHD versus TD children, the ADHD group was found to have significantly higher scores, compared with the TD group, on the SCQ total score and SCQ social communication domain. This finding is consistent with previous research (e.g., Kochhar et al., 2011), which

Table 3. SCQ Items That Discriminate Between ASD and ADHD.

SCQ item	Item description	*p* value	Odds ratio	Nagelkerke
3	Stereotyped utterances	.009	0.256	.416
4	Inappropriate questions	.000081	0.094	.486
6	Neologisms	.000137	0.081	.432
8	Compulsions and rituals	.003	0.197	.499
9	Inappropriate facial expression	.034	0.28	.291
10	Use of other's body to communicate	.044	0.253	.333
11	Unusual preoccupations	.000193	0.108	.559
12	Repetitive use of objects	.000155	0.109	.454
13	Circumscribed interests	.001	0.122	.485
14	Unusual sensory interests	.02	0.297	.467
15	Hand and finger mannerisms	.001	0.135	.455
16	Complex body mannerisms	.000192	0.101	.465
18	Unusual attachment to objects	.041	0.293	.414
20	Social chat	.007	0.215	.382
22	Pointing to express interest	.014	0.227	.339
26	Eye gaze	.0006	0.15	.437
27	Social smiling	.002	0.102	.36
29	Offering to share	.001	0.171	.428
30	Seeking to share enjoyment	.001	0.061	.458
31	Offering comfort	.000007	0.064	.451
33	Range of facial expression	.01	0.059	.406
34	Imitative social play	.004	0.213	.355
35	Imaginative play	.001	0.142	.318
36	Interest in children	.00045	0.146	.4
37	Response to other children's approaches	.005	0.13	.445
38	Attention to voice	.001	0.18	.487
39	Imaginative play with peers	.000003	0.055	.455
40	Group play	.001	0.141	.527

Note. Reference group = ASD; odds ratio < 1 indicates the outcome is more likely to be in the ASD group as score increases. SCQ = Social Communication Questionnaire; ASD = children with autism spectrum disorder.

reported that the means for ADHD group were higher than the TD group for SCQ total scores and social communication scores. However, in contrast to previous studies (e.g., Kochhar et al., 2011; Schwenck & Freitag, 2014), the current study found a significant group difference between the ADHD and TD groups on the repetitive behaviors domain, with the ADHD group having higher scores. The difference in findings between these studies could be due to differences in the nature of the samples used in these studies. For example, the ADHD group recruited by Kochhar et al. (2011) had a high proportion of children with comorbidities for conduct disorders. Perhaps, as argued by Kochhar et al. (2011), repetitive behaviors were less noticeable by parents due to more pressing and concerning behaviors such as aggression, violence, and noncompliance, often seen in those with conduct disorders. While comorbidities were not screened for in the clinical groups of this current study, most of the participants in the clinical groups were receiving medical and/or other interventions (e.g., psychological interventions) that may have assisted in parents identifying repetitive behaviors more accurately. The current findings support the proposition that there are increased ASD symptoms (i.e., presence of social communication difficulties and repetitive behaviors) in ADHD, but that these symptoms can still be very clearly delineated between ASD and ADHD (i.e., are significantly more frequent in children diagnosed with ASD, than in children with ADHD).

In terms of optimal cutoff scores in differentiating ASD from ADHD, the findings of the current study are relatively consistent with the cutoff scores that have been reported in previous studies. The current study identified that an SCQ total score of 9 had 100% sensitivity and 84% specificity when discriminating between ASD and non-ASD groups (i.e., ADHD and TD). But when determining the cutoff to differentiate between ASD and ADHD groups, the cutoff score was higher at 13, with 96% sensitivity and 87% specificity (i.e., the best trade-off between sensitivity and specificity). A cutoff score of 13 (87% sensitivity and 85% specificity) was also found for differentiating between children with ADHD only from those diagnosed with both conditions (i.e., ASD = ADHD).

The original authors of the SCQ (i.e., Rutter et al., 2003) recommended 15 as the cutoff value to rate clinical concerns for possible ASD. The current study found that the sensitivity was 85% and specificity was 96% at a cutoff score of 15. Schwenck and Freitag (2014) recommend a cutoff value of 14 to differentiate ASD and ADHD with a sensitivity of 68% and specificity of 92%. The current study found that sensitivity was 92% and 87% at a cutoff of 14. Clinically, these results mean that a child with an SCQ total score of 13 or greater (regardless of whether the referral is for ASD or ADHD) warrants further investigation and more detailed assessment for ASD, to rule this condition in or out.

The current study did additional analyses to determine optimal cutoff scores in each ASD domain. A score of 7 was enough to have 96% specificity and 84% sensitivity on social communication questions of the SCQ when discriminating between both ASD and non-ASD groups as well as 96% specificity and 73% sensitivity between ASD and ADHD. A higher cutoff score of 9 was obtained for discriminating between children with both conditions from children with a diagnosis of ADHD only (83% sensitivity and 77% specificity).

A score of 2 was enough to have 93% specificity and 79% sensitivity on repetitive behaviors questions of the SCQ between ASD and non-ASD groups. A higher cutoff score of 3 was obtained for differentiating between ASD and ADHD only, with a sensitivity of 81% and specificity of 74%. For discriminating between children with both conditions from those with ADHD only, a higher cutoff score of 4 (sensitivity of 83% and specificity of 77%) was obtained. Therefore, these findings suggest that reports of any instance of repetitive behavior in a child on the SCQ may warrant further investigation for ASD. However, it is important to be mindful that such decisions should not be made based purely on SCQ scores, but instead need to incorporate other information the clinician may have about the child including concerns from developmental history, current presentation, and direct observations. The clinician also needs to rule out other possibilities for repetitive behaviors such as tic disorders, anxiety, and even response to trauma.

The final aim of the current study was to determine whether there were specific items within the SCQ that are better at differentiating between ASD and ADHD. In contrast to Ghaziuddin et al. (2010) who identified nine items, the multinomial logistic regression analyses in the current study identified 28 (out of the 39 items) to be significant in discriminating between ASD and ADHD. A large proportion of these items (i.e., 12 of the 28 items) were within the Reciprocal Social Interaction domain, while about a quarter (i.e., seven of the 28 items) fell within the Restricted and Repetitive Behavior domain or the Communication domain (i.e., seven of the 28 items). The difference in findings between the current study and those of Ghaziuddin et al. is likely to be due to the rather vague statistical criteria used in the study by Ghaziuddin et al. These authors stated that the nine items they identified were "particularly" significant (Ghaziuddin et al., 2010, p. 362) without further clarification on the statistical criteria used to define "particularly" significant.

The findings of the current study have clinical implications. They suggest that rather than tease out which SCQ items may be appropriate for identifying symptom profiles of ADHD, the tool as a whole has strong clinical utility for identifying ASD symptoms. These findings suggest that in clinical practice, the SCQ is a very strong reliable measure that can be used to discriminate between ADHD and ASD. It is a fast and simple tool that is easy to both administer and score. Using the SCQ as part of standard practice will assist clinicians in determining whether to refer families for further ASD assessment, which can potentially help save time, cost, and distress for families. The SCQ would be useful for not only psychologists working with this population but also medical professionals such as pediatricians and psychiatrists. Often these medical professionals have busy and full clinics with limited time constraints, and they would benefit from the use of the SCQ to further understand the child's presentation and make recommendations for further referral and assessment to appropriate services. In the draft Australian National Guidelines for ASD (Whitehouse, Evans, Eapen, Prior, & Wray, 2017), general practitioners (GPs) have been recommended to play a role in ASD assessments in rural areas where there is the absence of specialist services. The SCQ would be a helpful screening tool to help GPs determine whether the child needs further assessment.

In Australia, given the introduction of a new funding scheme (i.e., the National Disability Insurance Scheme), a "missed" diagnosis would have implications for accessing funding and treatments. The SCQ would act as a tool to improve clinical practice to screen for ASD in these children who would more likely receive a later or misdiagnosis due to their ADHD symptoms. This would then play some minor role in helping to ensure that funding would not be missed/delayed.

Limitations of the current study should be considered that included the smaller than planned number of sample size, although the sample was larger than that used by Ghaziuddin et al. (2010). Moreover, diagnostic information about ASD and ADHD were based on previous assessments and/or diagnostic letters, and detailed comorbidity information (besides ASD and ADHD) were not obtained from parents. There was also a gender discrepancy between clinical and nonclinical groups, although this was controlled for in the analyses examining group differences on SCQ scores. Furthermore, the recruitment procedure used for the TD group may not have resulted in a representative sample of children from the general population. This procedure was determined to be the most efficacious way of recruiting TD children (who were not related to children in the three clinical groups) given the cost and time constraints associated with this study.1

One of the key strengths of the study was that the sample was comprised of children diagnosed with ASD Severity Levels 1 and/or 2, or "higher functioning," as formerly described. It was important to focus on this sample of the population because this is the specific cohort of ASD that often gets "missed" (e.g., Davidovitch et al., 2015; Jensen et al., 1997; Perry & Jellinek, 2004). Other studies including Ghaziuddin et al. (2010) and Kröger and colleagues (2011) examined ASD across the spectrum. This study also addressed an important gap in the study conducted by Ghaziuddin and his colleagues (2010), in that this study incorporated the use of ROC curve analyses in examining the ability of the SCQ to discriminate between ASD, ADHD, and TD children. Another strength of the study was that the evaluation of the SCQ to differentiate between ASD and non-ASD groups was based on *DSM-5* specifications (i.e., a dyad of core symptoms of social communication and repetitive behaviors rather than a triad of social interactions, communication, and repetitive behaviors). Despite the changes in diagnostic specifications, the findings of this study indicate that the SCQ is a reliable and valid screening tool for ASD.

Future directions for this research include replicating these methods in a sample of ASD with severity levels of 3. While it may be difficult to differentiate between symptoms of ASD and ADHD in "high functioning" ASD cases, the difficulties in making differential diagnosis among ASD, ADHD, and ASD + ADHD is even more challenging in children with comorbid intellectual disability (i.e., "lower functioning samples" of Severity 3 in the current *DSM-5* diagnostic criteria). For example, in individuals with both ASD and intellectual disability, the ASD symptoms are exacerbated with higher rates of stereotyped/challenging behaviors, poorer social and adaptive functioning as well as greater deficits in verbal and nonverbal communication abilities (Goldin, Matson, & Cervantes, 2014; LoVullo & Matson, 2009). Therefore, it would be clinically helpful to determine whether these samples score even higher on the SCQ, whether the SCQ can differentiate between ASD and ADHD or whether there is an overlap of symptomology, and whether the recommended cutoff score would be lower, higher, or the same as those with Levels 1 and/or 2 severity as demonstrated in this study.

The current study also did not break down the ADHD sample into the specific subtypes of combined, predominantly inattentive, or predominately hyperactive/impulsive. Future studies could determine whether there are group differences among the different subtypes of ADHD on the SCQ.

In summary, the findings of the study indicate that the SCQ is particularly sensitive to differentiating ASD symptoms over and above those of ADHD. Moreover, the study reinforces previous results that ASD and ADHD can be differentiated using the SCQ in children who do not have an intellectual disability. The SCQ has strong clinical utility under *DSM-5* diagnostic criteria and should continue to be used to screen for ASD in children with ADHD. The clinical cut points are consistent with previous research. A value of 13 on SCQ total score is enough to warrant further investigation of possible ASD in ADHD.

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1. This was an unfunded study completed by the first author as part of her masters in psychology (Clinical) degree.

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