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Which DSM-IV-TR criteria best differentiate high-functioning autism spectrum disorder from ADHD and anxiety disorders in older children?

SIGAN L. HARTLEY and

University of Wisconsin–Madison, USA

DARRYN M. SIKORA

Oregon Health and Science University, USA

Abstract

Diagnosis of autism spectrum disorder (ASD) is often delayed in high-functioning children with milder and more varied forms of ASD. The substantial overlap between ASD and other psychiatric disorders is thought to contribute to this delay. This study examined the endorsement of DSM-IV-TR diagnostic criteria for ASD based on semi-structured parent interviews across three groups of older children referred to an ASD clinic: 55 children diagnosed with high-functioning ASD, 27 children diagnosed with attention-deficit/hyperactivity disorder (ADHD), and 23 children diagnosed with anxiety disorder. Results indicate that the criteria within the domains of communication and social relatedness were largely able to discriminate the high-functioning ASD group from the ADHD and anxiety disorder groups, but criteria within the domain of restricted/repetitive/stereotyped patterns were not.

Keywords

ADHD; anxiety disorder; autism; diagnostic differentiation

Diagnosis of autism spectrum disorders (ASDs) does not occur until older childhood or beyond for a marked portion of individuals with ASD (Howlin and Asgharian, 1999; Mandell et al., 2002). Children who are high functioning (i.e. IQ within normal limits) and have milder and more varied forms of ASD including pervasive developmental disorder not otherwise specified (PDD-NOS) and Asperger's disorder are at particular risk for delayed diagnosis (Cederlund and Gillberg, 2004; Latif and Williams, 2007). Diagnosis is complicated in this group by the overlap in symptomatology of ASD and other psychiatric disorders (Mandell et al., 2002; Sikora et al., 2008). In particular, symptom overlap between ASD and attention-deficit/hyperactivity disorder (ADHD) and anxiety disorders can lead to diagnostic uncertainty (Cath et al., 2008; Luteijn et al., 2000; Sikora et al., 2008). The purpose of this study is to identify the *Diagnostic and Statistic Manual*, Fourth Edition, Text Revision (DSM-IV-TR: American Psychiatric Association, 2000) diagnostic criteria for ASD that distinguish high-functioning ASD from ADHD and anxiety disorders in older children referred to an ASD clinic.

ADDRESS Correspondence should be addressed to: SIGAN L. HARLEY, PhD, Postdoctoral Fellow, Waisman Center, University of Wisconsin–Madison, 1500 Highland Ave, Madison, WI 53705, USA. hartley@waisman.wisc.edu.

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A clinical diagnosis of ASD involves information from standardized interviews, checklists, observations, and assessments in concert with clinical judgment (American Academy of Child and Adolescent Psychiatry, 1999). While this information comes from a variety of sources (e.g. child, teachers, and medical records), parents provide critical insight into their child's early developmental history and current behavior, which is essential for determining whether a child's symptomatology is consistent with ASD or an alternative psychiatric disorder. Structured or semi-structured parent interviews are generally based on diagnostic criteria in the DSM-IV-TR for ASD (Le Couteur et al., 2003; Schopler et al., 1980). These criteria include impairments in *social relatedness* (e.g. lack of social interest and inability to develop friendships), *communication* (e.g. idiosyncratic language or lack of imaginary play) and *restricted/repetitive/stereotyped patterns* (e.g. repetitive motor movements or limited range of interests). Identification of the parent-reported DSM-IV-TR ASD criteria that best differentiate older children with high-functioning ASD from those with ADHD and anxiety disorders is needed to reduce delays in accurate diagnosis. Diagnosis informs theoretical beliefs on etiology, which subsequently direct intervention. Improving the differential diagnostic process in ASD evaluations can help ensure that children receive appropriate treatment.

ASD versus ADHD

Decisions of differential diagnosis of ASD versus ADHD are particularly difficult given the overlap in the core impairments of these disorders (Clark et al., 1999; Gadow et al., 2005; Luteijn et al., 2000). As with ASD, ADHD often involves difficulties with social interaction, communication, and restricted interests (Clark et al., 1999; Gadow et al., 2005). Moreover, difficulties with inattention and hyperactivity are evident in a high percentage of children with ASD. Previous studies indicate that 50 to 80 percent of children with ASD also met criteria for ADHD (Frazier et al., 2001; Gadow et al., 2005). However, criteria for ADHD in the DSM-IV-TR does not allow a child with ASD to be given this diagnosis.

A few studies have examined the parent-reported diagnostic criteria that best differentiate ASD from ADHD (Geurts et al., 2004; Koyama et al., 2006; Luteijn et al., 2000). Koyama et al. (2006) examined scores on the Childhood Autism Rating Scale–Tokyo Version (CARS: Schopler et al., 1980), which is based on parent report and clinician observations of autistic behaviors, among 27 children with high-functioning PDD-NOS and 27 children with ADHD with comparable age, IQ, and sex. In the social relatedness domain, items pertaining to relationships with people, affect, visual responsiveness, non-verbal communication, and affect differentiated the PDD-NOS and ADHD groups, whereas items asking about auditory and near receptor responsiveness did not. In the communication domain, items inquiring about verbal communication differentiated the groups, but an item regarding imitation did not. In the restricted/repetitive/stereotyped patterns domain, the PDD-NOS group was rated higher than the ADHD group on items related to use of body and relation to non-human objects, but there was not a significant difference between the groups in adaptation to environmental change.

Geurts and colleagues (2004) examined parent-reported scores on the Children's Communication Checklist (Bishop, 1998) in children with ADHD, high-functioning ASD, and normal controls. When both using a clinical and a more narrowly (or more strictly) defined sample (i.e. no comorbid psychiatric disorders), parents reported more problems with conversational ability in the high-functioning ASD group than the ADHD group. However, the ability to form and have social relationships did not consistently differentiate the high-functioning ASD and ADHD groups. In another study, clinicians completed a DSM-IV checklist of the severity of criteria largely based on parent report for 140 children who met criteria for PDD-NOS, 81 children who met criteria for ADHD, and 43 children

who met criteria for both PDD-NOS and ADHD. The PDD-NOS group received more severe scores in the social relatedness, communication, and restricted/repetitive/stereotyped patterns domains than the ADHD group. However, the comorbid PDD-NOS/ADHD group only scored higher than the ADHD group in the social relatedness domain (Luteijn et al., 2000). Overall, these studies suggest that criteria within the domains of social relatedness and communication may be better able to distinguish high-functioning ASD from ADHD than criteria within the domain of restricted/repetitive/stereotyped patterns, although findings regarding the importance of specific criteria within these domains remains discrepant.

ASD versus anxiety disorder

Discriminating ASD from anxiety disorders is also made difficult by the overlapping presentation of these disorders (Martin et al., 1999; Sikora et al., 2008; Weisbrot et al., 2005). As with ASD, anxiety disorders often include preoccupations with topics, rigid routines, repetitive activities and behaviors, and social withdrawal, and thus these behaviors may be poor indicators for differential diagnosis. Moreover, a large prevalence of children with high-functioning ASD experience anxiety (Gillott et al., 2001).

There has been little systematic investigation of the autistic behaviors that best differentiate ASD from anxiety disorders. Cath and colleagues (2008) compared scores on the Autism Questionnaire (Baron-Cohen et al., 2001) between 15 children with ASD and co-occurring anxiety symptoms and 15 children with Obsessive-Compulsive Disorder or Social Anxiety Disorder, who were matched on age, sex, and educational level. Scores in the domains of communication problems and lack of imagination best discriminated between the groups with and without ASD. In contrast, both groups had elevated scores in the social skill domain. These findings suggest that ASD, either with or without a co-occurring anxiety disorder, is best distinguished from anxiety disorders alone through criteria within the domain of communication.

In this study, we conducted semi-structured parent interviews to identify the DSM-IV-TR criteria for ASD that distinguished high-functioning ASD from ADHD and anxiety disorders in older children referred to an ASD clinic. It was hypothesized that criteria within the social relatedness and communication domains would differentiate high-functioning ASD from ADHD. Criteria within the domain of communication were predicted to best differentiate high-functioning ASD from anxiety disorders.

Method

Participants

Four hundred and seventeen older children and young adults (aged 6 to 25 years) were referred to an ASD clinic in the northwest region of the United States by their primary medical care provider in 2003 to 2007. Table 1 displays the subject characteristics of the older children and young adults. One hundred and sixteen participants (28.1%) were diagnosed with ASD and 301 were not. Of the 116 ASD participants, 62 were high functioning (full-scale IQ > 70), and complete data were obtained for 55 of these participants (88.7%), whose age ranged from 6 to 15 years.

Of the 301 non-ASD participants, 230 had an IQ within normal limits (full-scale IQ > 70), and complete data were obtained for 203 (88.3%) of these participants. Only the 203 non-ASD high-functioning participants will be further discussed. Twenty-seven participants were diagnosed with ADHD and 23 with an anxiety disorder (11 generalized anxiety disorder, five anxiety disorder not otherwise specified, four social anxiety disorder, two

obsessive-compulsive disorder). Three participants were diagnosed with both ADHD and anxiety disorder; these participants were excluded from the study. The age range for the remaining ADHD and anxiety disorder participants was 6 to 16 years.

Table 2 presents the subject characteristics of the 55 high-functioning older children with ASD, 27 non-ASD older children with ADHD, and 23 non-ASD older children with anxiety disorders included in this study. Detailed information on the diagnostic procedure is outlined later in this section. Caregivers who completed measures were parents, the large majority of whom were mothers. A foster mother completed measures for one child in the high-functioning ASD group.

Measures

Cognitive functioning—Children were individually administered one of the following standardized measures of intellectual functioning. The Stanford–Binet, Fifth Edition (SB5: Roid, 2003) assesses the verbal and non-verbal cognitive abilities of individuals aged 2 years through adulthood. The five factor indices combine to form the full-scale IQ (mean = 100, SD = 15), which has adequate internal consistency (ranging 0.95 to 0.98) and good concurrent and criterion validity (Roid, 2003). The Wechsler intelligence scales – the Wechsler Preschool and Primary Scale of Intelligence, Third Edition (WPPSI–III: Wechsler, 2002) and the Wechsler Intelligence Scale for Children, Fourth Edition (WISC–IV: Wechsler, 2003) – are standardized intelligence tests designed for individuals across the lifespan. Manuals report good internal reliability and validity for the full-scale IQ (mean = 100, SD = 15).

Adaptive behavior—Parents completed one of the following measures of adaptive behavior. The Adaptive Behavior Assessment System, Second Edition (ABAS–II: Harrison and Oakland, 2006) assesses various skill areas to yield the general adaptive composite score (mean = 100, SD = 15), which has satisfactory internal consistency (0.97 to 0.99), test–retest reliability (0.86 to 0.99) and concurrent validity (Harrison and Oakland, 2003). The Vineland Adaptive Behavior Scales, Parent/Caregiver Rating Form (VABS–II: Sparrow et al., 2005) assesses three domains of adaptive behavior, which combine to form the adaptive behavior composite score (mean = 100, SD = 15). The VABS–II has adequate split half reliability for domains (0.83 to 0.90) and is positively correlated with measures of intellectual functioning (Sparrow et al., 2005).

Autism Diagnostic Observation Scale–Generic—The ADOS–G is a semi-structured, standardized play-based assessment of ASD behaviors. Each item is scored on a 0–3 scale (0 = no evidence of abnormal behavior to 3 = markedly abnormal behavior) (Lord et al., 2000). A diagnostic algorithm is used in which cutoff scores in the domains of communication, social interaction, and combined (communication + social interaction) allow a child to be given a classification of autism, ASD, or non-spectrum. This diagnostic algorithm has been shown to result in high specificity and sensitivity in diagnosing ASD (Lord et al., 2000). The ADOS–G modules used were: module 2 ($N = 8$), module 3 ($N = 83$), and module 4 ($N = 14$). In this study, a child had to receive a classification of autism or ASD in all three domains to receive an overall classification of ASD. Table 3 presents the number of children in the ADHD and anxiety disorder groups with an ADOS–G classification of below versus at or above the cutoff for ASD. Table 3 also displays the specificity of the ADOS–G domain scores for the ADHD and anxiety disorder groups.

Interview of ASD DSM-IV-TR criteria—A semi-structured interview of DSM-IV-TR criteria for autistic disorder was conducted with parents by a licensed developmental pediatrician or psychologist. The 12 DSM-IV-TR criteria inquired about were in the

domains of social relatedness ('impaired non-verbal behavior', 'failure to develop peer relationships', 'lack of seeking to share', and 'lack of social/emotional reciprocity'), communication ('delay/lack of speech', 'impaired conversational ability', 'stereotyped/repetitive/idiosyncratic language', and 'lack of make-believe/imitative play'), and restricted/repetitive/stereotyped patterns ('stereotyped/restricted patterns of interest', 'non-functional routine or ritual', 'stereotyped or repetitive motor mannerisms', and 'preoccupation with parts of objects'). The intent of this interview was not to form classification categories (e.g. non-spectrum versus ASD versus autism) and thus such a scoring system was not created.

The interview procedure was as follows. The interview record included 'Yes/No' checkboxes for the 12 DSM-IV-TR criteria and described a series of specific behaviors under each criterion (see Appendix). For each specific behavior, a rating of 1 (behavior present and seen regularly in different situations and environments), 2 (behavior sometimes seen or seen only in a specific situation or environment), or 3 (behavior not seen or not yet developed) was given. The developmental pediatrician or psychologist first asked open-ended general inquiries regarding the criterion (e.g. 'How does your child interact with others?'), and then follow-up probing questions based on the specific behaviors. The follow-up questions were modified from items on the Autism Diagnostic Interview-Revised (ADI-R: Le Couteur et al., 2003) and questions recommended by the American Academy of Pediatrics. Professionals were unable to use the ADI-R as most third-party payers would not cover the cost of administration; therefore, questions were incorporated into a broader developmental and medical history interview. Parents were required to give descriptions and examples in their discussion of their child's behavior.

Decisions for scoring each criterion as 'Yes' (i.e. present) or 'No' (i.e. absent) were based on responses to the open-ended inquiries and follow-up questions. Criteria that were not easily rated were discussed with the team and consensus was reached between the psychologist and the developmental pediatrician. In general, if at least two specific behaviors were endorsed (i.e. *regular* absence of appropriate behavior or presence of atypical behavior), the criterion was scored 'Yes'. Only the 'Yes/No' checkbox ratings were analyzed.

The number of criteria positively endorsed ranged from three to 11 (mean = 5.62, SD = 1.89) in the high-functioning ASD group, from zero to seven (mean = 3.04, SD = 2.12) in the ADHD group, and from zero to nine (mean = 3.48, SD = 2.39) in the anxiety disorder group. A one-way analysis of variance and Student-Newman-Keuls *post hoc* statistics indicated that there was a significant difference among the groups ($F(2, 103) = 16.85, p < 0.01$), such that the high-functioning ASD group showed a higher endorsement of symptoms than the ADHD or the anxiety disorder group. Analyses were also conducted to compare endorsement of DSM-IV-TR ASD criteria to ADOS scores. There was a significant positive correlation between the number of criteria endorsed in the social relatedness and communication domains in the interview and the ADOS-G combined score ($r = 0.31, p < 0.01$). There was also a significant positive correlation between the number of criteria endorsed in the restricted/repetitive/stereotyped patterns domain in the interview and the ADOS-G stereotyped behavior and restricted interests score ($r = 0.20, p = 0.04$). Moreover, as shown in Table 3, the children with ADHD and anxiety disorder falsely classified as on the ASD spectrum also received a high endorsement of DSM-IV-TR ASD criteria in the parent interview.

ADHD and anxiety disorder—Parents were asked screening questions to identify the presence of alternative psychiatric disorders, including ADHD and anxiety disorders. If a screening question was endorsed, further questioning was used to determine whether the child met DSM-IV-TR diagnostic criteria for that psychiatric disorder. Parents were also

required to mail school records (individualized education plans and teacher-completed behavior scales or notes) and medical records for their child prior to the evaluation. Diagnoses of ADHD and anxiety disorders were based on team consensus using information from the mailed records, clinical observations, Child Behavior Checklist (CBCL: Achenbach and Rescorla, 2000) and parent interview. To be consistent with the DSM-IV-TR, a dual diagnosis of ASD and ADHD was not given. A dual diagnosis of ASD and anxiety disorder was given to five children; further analyses regarding this dual diagnosis were not conducted.

In support of the convergent validity of diagnoses, all children diagnosed with ADHD had a CBCL attention-deficit/hyperactivity problems subscale *t*-score in the borderline clinical or clinically significant range (mean = 72.3, SD = 5.63). All children diagnosed with anxiety disorders received a CBCL anxiety problems subscale *t*-score in the borderline clinical or clinically significant range (mean = 70.4, SD = 4.24).

Procedure

Assessments were completed by a multidisciplinary team (speech and language pathologist, developmental pediatrician, psychologist, and occupational therapist). The developmental pediatrician and psychologist were considered to be experts in ASD. All children were individually administered a standardized intelligence test, the OWLS, academic testing, and the ADOS-G. The ADOS-G was scored immediately after administration by two clinicians, at least one of whom had clinical reliability (Lord et al., 2000). Parents completed the semi-structured interview of DSM-IV-TR criteria, which took 1 to 2 hours, and interview of ADHD or anxiety disorder, which took 20 to 75 minutes. Parents also completed one of the caregiver ratings of adaptive behavior. All children diagnosed with ASD received an ADOS-G classification of autism or ASD in all domains and met DSM-IV-TR criteria for ASD based on the parent interview, standardized testing and team consensus. All children diagnosed with ADHD or anxiety disorder were not considered by the team to meet DSM-IV-TR criteria for ASD.

Results

Data analyses

One-way analyses of variance (ANOVAs) were first conducted to examine potential differences in subject characteristics between the high-functioning ASD, ADHD and anxiety disorder groups. Chi-square statistics were then used to examine the endorsement of each DSM-IV-TR criterion in the high-functioning ASD group compared to the ADHD or anxiety disorder groups. The sensitivity and specificity for the DSM-IV-TR criteria in children with high-functioning ASD versus ADHD and anxiety disorders were calculated.

Subject characteristics by group

One-way ANOVAs were conducted to identify differences in subject characteristics among the high-functioning ASD, ADHD, and anxiety disorders groups: age (months), gender (0 = male, 1 = female), ethnicity (0 = Caucasian, 1 = non-Caucasian), full-scale IQ (standard score), adaptive behavior (Vineland ABC or ABAS-I GAC standard score), expressive language (OWLS expressive language standard score), receptive language (OWLS receptive language standard score), language disorder (0 = absent, 1 = present), learning disorder (0 = absent, 1 = present), and comorbid psychiatric disorder (0 = absent, 1 = present). There was not a significant difference between the groups in age ($F(2, 103) = 2.16, p = 0.12$), gender ($F(2, 103) = 2.51, p = 0.09$), ethnicity ($F(2, 103) = 0.65, p = 0.94$), full-scale IQ ($F(2, 103) = 0.12, p = 0.89$), adaptive behavior ($F(2, 103) = 1.51, p = 0.23$), expressive language ($F(2, 103) = 0.37, p = 0.69$), receptive language ($F(2, 103) = 1.53, p = 0.22$), language disorder

($F(2, 103) = 1.15, p = 0.32$), learning disorder ($F(2, 103) = 1.82, p = 0.17$), or comorbid psychiatric disorder ($F(2, 103) = 2.00, p = 0.14$).

DSM-IV-TR criteria

Tables 4 and 5 present the chi-square and phi statistics for endorsement of DSM-IV-TR criteria in the high-functioning ASD versus ADHD or anxiety disorder groups. The high-functioning ASD group had a significantly higher endorsement of 'non-verbal behavior', 'failure to develop peer relationships', stereotyped/repetitive/idiosyncratic language', and 'lack of make-believe/imaginative play' than the ADHD group. There was a trend for the high-functioning ASD group to have a higher endorsement of 'delay/lack of speech' than the ADHD group. There was not a significant difference between the high-functioning ASD and ADHD groups in 'lack of seeking to share', 'lack of social/emotional reciprocity', 'impaired conversational ability', 'stereotyped/restricted pattern of interest', 'non-functional routine or ritual', 'stereotyped or repetitive motor mannerisms', and 'preoccupation with parts of object'. The high-functioning ASD group had a significantly higher endorsement of 'non-verbal behavior', 'lack of seeking to share', 'delay/lack of speech', 'impaired conversational ability', 'stereotyped/repetitive/idiosyncratic language', and 'lack of make-believe/imaginative play' than the anxiety disorders group. There was a trend for the high-functioning ASD group to have a higher endorsement of 'failure to develop peer relationships' and 'lack of social/emotional reciprocity' than the anxiety disorder group. There was not a significant difference between the high-functioning ASD and anxiety disorders groups in 'stereotyped/restricted pattern of interest', 'non-functional routine or ritual', 'stereotyped or repetitive motor mannerisms', and 'preoccupation with parts of objects'.

Characteristics of DSM-IV-TR criteria in differentiating groups

Table 4 and 5 also present the sensitivity (i.e. true positive rate) and specificity (i.e. true negative rate) of the DSM-IV-TR criteria for ASD for children with high-functioning ASD versus ADHD and anxiety disorders. The criteria with the highest sensitivity ($\geq 60.00\%$) included 'failure to develop peer relationships', 'non-functional routine or ritual', 'non-verbal behavior', and 'stereotyped or repetitive motor mannerisms'. In contrast, 'preoccupation with parts of objects', 'lack of seeking to share', 'delay/lack of speech' and 'lack of make-believe/imaginary play' had relatively low sensitivity ($\leq 41.82\%$). The criteria with the highest specificity ($\geq 77.78\%$) in both the ADHD and anxiety disorders groups included 'delay/lack of speech', 'lack of make-believe/imaginative play', 'preoccupation with parts of objects', 'stereotyped/repetitive/idiosyncratic language', and 'lack of seeking to share'. In contrast, 'failure to develop peer relationships', 'lack of social/emotional reciprocity', and 'non-verbal behavior' had low relatively specificity ($\leq 69.57\%$) for both the ADHD and anxiety disorders groups. In addition, 'impaired conversational ability' (48.15%) and 'stereotyped/restricted patterns of interest' (62.96%) had relatively low specificity for the ADHD group, and 'non-functional routine or ritual' (52.17%) and 'stereotyped or repetitive motor mannerisms' (69.57%) had relatively low specificity for the anxiety disorders group.

Discussion

Overlap in the symptom presentation of high-functioning ASD and ADHD and anxiety disorders is thought to contribute to delays in diagnosis in children who are high functioning and/or have PDD-NOS or Asperger's disorder (Luteijn et al., 2000; Sikora et al., 2008). In this study, we examined parent-reported DSM-IV-TR criteria for ASD in older children with high-functioning ASD, ADHD, and anxiety disorders referred to an ASD clinic. Criteria within the restricted/repetitive/stereotyped patterns domain did not distinguish high-functioning ASD from ADHD and anxiety disorders. In support of previous studies

(Koyama et al., 2006; Luteijn et al., 2000), both the ADHD and high-functioning ASD groups had a similar endorsement of stereotyped or repetitive motor movements and restricted patterns of interest. The endorsement of non-functional routines or rituals and preoccupation with parts of objects was also similar for the ADHD and high-functioning ASD groups. Similarly, there was not a significant difference in the restricted/repetitive/stereotyped patterns criteria between the high-functioning ASD and anxiety disorders groups. Indeed, none of the restricted/repetitive/stereotyped patterns criteria determined ASD membership at a level better than chance when comparing the high-functioning ASD to ADHD or anxiety disorders groups. Sensitivity for the restricted/repetitive/stereotyped patterns domain, and particularly preoccupation with parts of objects, was low.

The high-functioning ASD group was best set apart from the ADHD and anxiety disorders groups through the communication domain. This finding supports the study by Cath and colleagues (2008), which also found that children with anxiety disorders were distinguished from children with ASD through deficits in the communication domain. The high-functioning ASD group had a higher endorsement of stereotyped or idiosyncratic language and limited pretend or imaginary play than the ADHD group. Stereotyped or idiosyncratic language and limited pretend or imaginary play also distinguished high-functioning ASD from ADHD in an earlier study (Koyama et al., 2006). In this study, there was also a trend for the high-functioning ASD group to have a higher endorsement of delayed or lack of speech than the ADHD group. The absence of a strong difference in this criterion between the high-functioning ASD and ADHD groups is likely due to the presence of language disorders in several children with ADHD. Impaired conversational ability was unable to differentiate the high-functioning ASD and ADHD groups, which is consistent with a past study (Luteijn et al., 2000). With the exception of impaired conversational ability, criteria within the communication domain had a relatively high specificity in children with ADHD and anxiety disorders.

Criteria within the social relatedness domain were also useful in differentiating high-functioning ASD from ADHD and anxiety disorders. In support of a previous study (Koyama et al., 2006), the high-functioning ASD group had a higher endorsement of impaired non-verbal social behavior than the ADHD or anxiety disorders groups. The high-functioning ASD group had a higher endorsement of difficulties developing friendships than the ADHD group. This finding is also consistent with a past study (Koyama et al., 2006). In line with Cath et al. (2008), the high-functioning ASD group had a higher endorsement of lack of seeking to share than the anxiety disorders group and this criterion determined ASD membership at a level significantly better than chance. In contrast, poor social or emotional reciprocity were poor indicators of ASD when compared to either the ADHD or the anxiety disorders groups, which supports previous findings (Cath et al., 2008; Geurts et al., 2004). In this study, poor social/emotional reciprocity criteria had relatively low specificity and sensitivity.

In conclusion, findings support previous research that criteria within the communication and social relatedness domains are most useful for differential diagnostic decisions regarding high-functioning ASD versus ADHD or anxiety disorders (Cath et al., 2008; Geurts et al., 2004; Koyama et al., 2006; Luteijn et al., 2000). More specifically, the most relevant indicators for distinguishing ASD from ADHD or anxiety disorders were non-verbal social behavior, stereotyped or idiosyncratic language, and lack of make-believe or imaginary play. Several previous studies found that a greater number of criteria within the social relatedness and communication domains could distinguish high-functioning ASD from ADHD (Geurts et al., 2004; Koyama et al., 2006; Luteijn et al., 2000) than in this study. This discrepancy is likely due to sampling differences. This study included autistic disorder, PDD-NOS, and Asperger's disorder, whereas previous studies only included PDD-NOS (Koyama et al.,

2006; Luteijn et al., 2000). Moreover, this study recruited participants with ADHD and anxiety disorders from an ASD clinic, whereas previous studies did not (Geurts et al., 2004; Koyama et al., 2006; Luteijn et al., 2000). Children referred to ASD clinics likely have more complex or atypical presentations, and comorbid language, learning, or psychiatric disorders, than the broader ADHD and anxiety disorders population. A more restricted set of criteria is therefore likely to be useful for differential diagnosis in samples from ASD clinics than in samples of ‘purer’ ADHD or anxiety disorders. For instance, there was only a trend toward a difference between the high-functioning ASD and ADHD groups in delays or lack of speech in this study, whereas this criterion differentiated these groups in previous studies of ADHD children without comorbid language disorders (Geurts et al., 2004; Koyama et al., 2006). Thus, findings from this study cannot speak to the ASD criteria useful for differential diagnosis in the broader ADHD or anxiety disorders population. However, children were recruited from a large tertiary hospital and research university that serves a wide geographical region, and thus are thought to be similar to those referred to other large specialty ASD clinics. Thus, findings from this study can speak to the restricted set of DSM-IV-TR criteria for ASD useful for differential diagnosis in actual ASD clinics.

There are several limitations to this study and findings are preliminary. The reliability and validity of our parent interview of DSM-IV-TR ASD criteria have not been examined. In this study, the DSM-IV-TR ASD criteria interview was correlated with the ADOS-G, and children falsely categorized as being on the spectrum on the ADOS-G also had high endorsement of ASD criteria. However, additional research on the validity and inter-rater reliability of this interview is required to add confidence in findings from this study. Our interview was not as nuanced as the scoring system on the ADI-R. Thus, it is likely that better sensitivity and specificity for differentiating high-functioning ASD from ADHD and anxiety disorder in older children may be achieved using the ADI-R. It is also important to highlight that we examined the sensitivity and specificity of each DSM-IV-TR ASD criterion in isolation. In most cases, parents of children with ADHD or anxiety disorder endorsed only a small number of DSM-IV-TR ASD criteria. In addition, the present study only evaluated high-functioning children. A different set of DSM-IV-TR criteria may best distinguish ASD from ADHD and anxiety disorder in lower-functioning children. A further limitation to this study is that clinical diagnoses in this study were based on DSM-IV-TR parent interview, in addition to other standardized measures. Therefore, agreement between the parent interview of DSM-IV-TR ASD criteria and clinical diagnosis of ASD may be inflated.

Directions for future research

This study examined differences in DSM-IV-TR criteria for ASD based on an ‘all or nothing’ algorithm (i.e. present or absent). However, there may be important differences in the severity of criteria displayed among children with high-functioning ASD, ADHD, and anxiety disorders. For instance, children with ADHD may display poor social and emotional reciprocity, but the severity of impairment may be lower than for children with high-functioning ASD. Future research is needed to determine whether thresholds in the severity of impairments can better distinguish ASD from ADHD and anxiety disorders than a dichotomous rating. In addition, specific ASD criteria may have more or less value for differential diagnosis by ASD subtype – autistic disorder, PDD-NOS, and Asperger’s disorder – and should be examined in future studies.

This study examined high-functioning ASD, ADHD, and anxiety disorders separately. An important topic for future study is the dual diagnosis of these disorders. Clear guidelines for diagnosing comorbid psychiatric disorders in ASD have yet to be reached (e.g. Matson and Nebel-Schwalm, 2007). The high prevalence of inattention and anxiety in children with ASD begs the question of whether these behaviors warrant a separate diagnosis or are better seen

as part of ASD (e.g. Matson and Nebel-Schwalm, 2007). In our sample, a separate diagnosis of anxiety disorder was not given to children with high-functioning ASD if anxious symptoms were better construed as part of ASD. Consensus regarding this issue is needed. Future studies should compare the diagnostic criteria that differentiate children with only ASD to those with a dual diagnosis of ADHD or anxiety disorder. We hypothesize that a dually diagnosed ASD and ADHD or anxiety disorder group would exhibit similar ASD impairments, but at a greater severity, than an ASD-only group.

Research is also needed to further identify differences in the ASD diagnostic criteria useful for differentiating ASD from other psychiatric disorders in both ‘purer’ and clinical samples of children. The former samples can inform theoretical understanding of these disorders, while the latter samples can inform clinical practice. We hypothesize that a broader set of criteria would be useful for differentiating high-functioning ASD from other psychiatric disorders in ‘purer’ samples as opposed to clinical samples. Future researchers are also encouraged to examine the sensitivity and specificity of specific items on the ADOS-G to determine whether a similar set of specific deficits within the social interaction and communication domains best distinguishes high-functioning children with ASD from those with ADHD or anxiety disorder in actual interactions.

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Appendix: DSM-IV diagnostic criteria for autism, interview record

Where appropriate rate each question: (1) behavior present and seen regularly in different situations and environments; (2) behavior sometimes seen or seen only in a specific situation or environment; or (3) behavior not seen or not yet developed.

Qualitative impairment in social interaction, as manifested by two of the following

Marked impairment in the use of multiple non-verbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction

- In general, will he look you/others in the eye, e.g. when he wants something? Y N
- Will ____ nod his head for 'yes', shake his head for 'no', wave 'bye-bye' at appropriate times, point to indicate his wants, use other gestures? Y N
- Does ____ look at you when you start talking to him or doing things with him? Will he turn his head to look at you when you call his name? Y N
- Will he look where you point when you point to show him a toy or a picture in a book? Y N
- Does he point to a toy or object to show you he is interested in it? Y N
- Does he smile, frown, raise his eyebrows, show a variety of facial expressions (can you tell how he's feeling or what he's thinking by his facial expressions)? Y N
- Does he gesture with his hands when he's talking? Y N

Failure to develop peer relationships appropriate to developmental level

- Is he interested in other children? Y N
- Does he talk to or try to join other children in their play (e.g. at the park, school or daycare, how does he join another child or a group, for example, start playing next to them)? Y N
- How does he respond if other children talk to or try to play with him? Y N
- How many friends does ____ have (children he plays with regularly)? Y N
- Does he invite friends over to play and is he invited to play at other children's houses (ask about play 'dates' set up by parent)? Y N
- What do they do when they play together, e.g. parallel play only, chase, video games, make-believe play? Y N
- Are his relationships based primarily on his special interests? Y N
- Does he have trouble participating in groups, following cooperative rules of games? Y N

A lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g. by a lack of showing, bringing, or pointing out objects of interest)

- Does he try to involve you in his play, in his favorite activities, or does he prefer to play by himself? Y N
- How does he try to engage you? Y N
- Does he bring a toy or book to show you what he is doing? Y N
- How does he respond to praise? Y N
- Does he offer to share things (toys or food) with you; and will he offer to share things with other children? Y N
- At different times, does he frown and pout, act embarrassed, look surprised or look happy and excited (show a range of emotions)? Y N
- How does he share his feelings with you, e.g. his excitement after drawing a picture that he really likes, and how does he respond to praise? Y N
- Does he like to be held or cuddled, does he give hugs and kisses (does he imitate you or does he spontaneously give a hug)? Y N

Lack of social or emotional reciprocity

- Will he play ball by rolling or throwing it back and forth? Y N
- Does he play other games that require turn taking? Y N
- Is he interested in what game you want to play or what you want to do? Y N
- Does he recognize how you are feeling, e.g. when you're happy, angry or sad? When you're sad or ill, will he try to comfort you? Y N
- Does he notice when others are upset or hurt? Y N
- Does ____ realize certain things he does bother others? Y N

Qualitative impairments in communication as manifested by at least one of the following

Delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)

How many words and gestures does he use? Y N

Does he use words or gestures to indicate his wants (e.g. does he point to indicate wants)? Y N

How does he usually let you know what he wants or when he needs something? Y N

In individuals with adequate speech, marked impairment in the ability to initiate or sustain conversation with others

Can you have a conversation with ____? For example, if you make a comment but don't ask a question, will he say something in response? Y N

Will he start a conversation with you just to talk or chat, not to ask for something? Y N

Can he take turns in a conversation or is it usually one-sided, e.g. does he always want to talk about his favorite subject? Y N

Does he notice when you've lost interest in talking or does he talk on and on? Y N

Does he interpret what you say literally or concretely, e.g. 'what's up' (what are you doing) or 'you must have springs in your shoes' (to jump that high) or 'hop to it' (hurry)? Y N

Stereotyped and repetitive use of language or idiosyncratic language

What word or name does ____ use to refer to himself/herself? Y N

Does he sometimes mix up pronouns, e.g. you for I, he or she for I? Y N

Does he say what you say right after (immediate echolalia)? Y N

Does he repeat the same phrase over and over? Y N

Does he use pat or set phrases, e.g. things you may have said or that s/he heard someone else say, such as from a TV show or movie (delayed echolalia)? Y N

Talk to himself during play, or make nonsense noises or words to himself/herself during play (words that he made up)? Y N

Does he seem to talk too loudly or too softly? Y N

Does he use the same tone of voice each time or have a sing-song pattern to his/her voice? Y N

Lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level

Will he play games such as pat-a-cake or peek-a-boo; make hand gestures to familiar songs such as 'itsy-bitsy-spider'; fill in a word in a familiar song like 'wheels on the bus'? Y N

Does ____ like to 'pretend' or 'make-believe' when playing. For example, will he pretend to talk on a toy phone or pretend to feed or take care of a doll or stuffed animal, will he dress up and 'make believe' he is someone else? Y N

Does he pretend a toy is something else, e.g. a toy banana is a phone, or a block is a sandwich? Y N

Restrictive repetitive and stereotyped patterns of behavior, interests, and activities as manifested by at least one of the following

Encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

What are his favorite toys and activities? Y N

Does he always play with toys in the same way, e.g. by lining up toy cars or sorting toys by color? Y N

Does he have a special (all encompassing) interest in one toy, activity or subject (e.g. trains or flags) or an interest in unusual objects or topics (e.g. sprinkler systems, astrophysics)? Y N

How does he react if you try to change a favorite activity or topic of conversation? Y N

Does he have an unusually good memory for the details of special interests, family activities or vacations? Y N

Apparently inflexible adherence to specific, non-functional routines or rituals

Does ____ have rigid rituals or routines? For example, are there things he has to do in a particular way or in an exact order every time at mealtime, bedtime or during play? Y N

- How does he react if his routine is interrupted or he can't complete it (e.g. a toy is broken or missing, he has to sleep at a motel when on vacation, you drive a different way home)? Y N
- How does he react to changes in his schedule(e.g. school assembly canceled) or changes in his environment (e.g. how the furniture is arranged at home or classroom, where he sits at the dinner table)? Y N
- Does he repeat certain activities over and over, for example: with objects (dropping or rolling, always carrying a specific object); cleaning (washing) hands; use of toilet paper; checking (appliances off, doors closed); counting (toys, money); or ordering (toys, clothes, towels in bathroom)? Do these activities interfere with day-to-day function? Y N
- Stereotyped and repetitive motor mannerisms (e.g. hand and finger flapping or twisting, or complex whole-body movements)*
- Does he have any mannerisms or odd ways of moving his hands or his body that look the same each time, e.g. flapping hands when excited, walking on his toes, flicking his fingers, spinning or rocking his body, running in a circle? Y N
- Persistent preoccupation with parts of objects*
- Does he mostly play with objects that light up or make sounds, objects that move or spin, e.g. wheels, fans, running water? Y N
- Does he pay attention only to part of the toy, e.g. spinning the wheels of the car rather than driving it around on a 'make-believe' road? Y N
- Does he use toys or objects in unusual ways, e.g. repeatedly opens and closes doors of toy cars, touches most toys to his lips or mouths toys, holds toys very close to his eyes or looks out of the 'side' of his eyes at toys? Y N
- Does he have an attachment to unusual objects, e.g. string? Y N

Table 1

Characteristics of the 417 older children referred to the autism clinic

	ASD n = 116	No ASD n = 301
High functionality (IQ > 70) (n)	62	230
complete data	55	203
ASD diagnosis (n)		
Autistic disorder	19	–
PDD-NOS	14	–
Asperger's disorder	22	–
Psychiatric disorder diagnosis (n)*		
none	44	55
Anxiety disorder	5	26
ADHD	–	30
Depressive disorder	4	32
Mood disorder NOS	0	15
Conduct disorder	2	52
Psychotic disorder	0	3
Learning disorder (n)	3	65
yes	3	65
no	52	138
Language disorder (n)		
yes	8	68
no	47	135

Eleven children in the No ASD group were diagnosed with more than one psychiatric disorder diagnosis. This included three children with a diagnosis of both ADHD and anxiety disorder. These three children were excluded from further analyses.

Table 2

Subject characteristics of participants in the high-functioning ASD, ADHD anxiety disorder groups

	High- functioning ASD n = 55	ADHD n = 27	Anxiety disorder n = 23
Age in years (mean, SD)	10.43 (3.18)	9.16 (2.48)	9.43 (2.48)
Gender (n)			
Female	9	1	6
Male	46	26	17
Ethnicity (n)			
Caucasian	40	18	17
African-American	1	0	0
Hispanic	2	1	0
Asian/Pacific Islander	2	1	0
Other	5	3	2
Unreported	5	3	4
Full-scale IQ (mean, SD)	102.67 (15.41)	101.92 (9.23)	100.77 (11.00)
Adaptive behaviour composite (mean, SD)	65.58 (11.76)	68.00 (10.18)	69.56 (15.16)
OWLS listening (mean, SD)	94.09 (14.77)	97.24 (13.69)	97.16 (14.29)
OWLS expression (mean, SD)	94.41 (17.53)	93.00 (12.44)	94.76 (14.40)
Language disorder Dx (n)	8	5	1
Learning disorder Dx (n)	3	5	2
Comorbid psychiatric Dx (n)	11	1	3
Depressive disorder	4	1	3
Anxiety disorder	5	0	–
Conduct disorder	2	0	0

Table 3

Specificity and number of children receiving an ADOS-G score below versus at or above the cutoff for a classification of ASD

ADOS-G domain	ADHD		Anxiety disorder	
	Below	At or above	Below	At or above
Communication	23	4	16	7
Social interaction	19	8	18	5
Combined (communication + social interaction)	23	4 ^a	20	3 ^b
			Specificity	Specificity
			85.19%	69.57%
			70.37%	78.26%
			85.19%	86.96%

^a = Endorsement of DSM-IV TR criteria in the parent-interview ranged from 4 to 9 for these participants.

^b = Endorsement of DSM-IV TR criteria in the parent-interview ranged from 3 to 7 for these participants.

Part of the inclusion criteria for children in the high-functioning ASD group was that they received scores at or above the the cutoff for ASD in all ADOS-G domains, and thus specificity was not calculated.

Table 4

Percentage of positive endorsement and chi-square results for DSM-IV TR criteria comparisons for the high-functioning ASD versus ADHD group

	High-functioning ASD		ADHD		Sensitivity	Specificity	Chi-square	Phi
	Present	Absent	Present	Absent				
Social relatedness								
Non-verbal behavior	33	22	9	18	60.00%	66.67%	5.15*	.25
Failure to develop peer relationships	39	16	12	15	70.90%	55.56%	5.39*	.26
Lack of seeking to share	18	37	6	21	32.73%	77.78%	0.97	.11
Lack of social/emotional reciprocity	27	28	11	16	49.09%	59.26%	0.75	.10
Communication								
Delay/lack of speech	19	36	4	23	34.55%	85.19%	3.49***	.21
Impaired conversational ability	32	23	14	13	58.18%	48.15%	0.30	.06
Stereotyped/repetitive/idiosyncratic language	27	28	5	22	49.09%	81.48%	7.90***	.31
Lack of make-believe/imaginative play	23	32	3	24	41.82%	88.89%	7.89***	.31
Restricted/repetitive/stereotyped patterns								
Stereotyped/restricted pattern of interest	32	23	10	17	56.36%	62.96%	0.32	.05
Non-functional routine or ritual	35	20	8	19	63.64%	70.37%	0.37	.07
Stereotyped or repetitive motor mannerisms	33	22	7	20	60.00%	74.07%	1.57	.14
Preoccupation with parts of objects	7	48	3	24	12.73%	88.89%	0.04	.02

** $p < .01$;

* $p < .05$;

*** $p < .07$

Table 5

Percentage of positive endorsement and chi-square results for DSM-IV TR criteria comparisons for the high-functioning ASD versus anxiety disorder groups

	High-functioning ASD		Anxiety disorder		Sensitivity	Specificity	Chi-square	Phi
	Present	Absent	Present	Absent				
Social relatedness								
Non-verbal behavior	33	22	7	16	60.00%	69.57%	5.67*	.27
Failure to develop peer relationships	39	16	11	12	70.90%	52.17%	3.76†	.22
Lack of seeking to share	18	37	1	22	32.73%	95.65%	7.09**	.30
Lack of social/emotional reciprocity	27	28	7	16	49.09%	69.57%	2.75	.19
Communication								
Delay/lack of speech	19	36	2	21	34.55%	91.30%	5.51*	.27
Impaired conversational ability	32	23	6	17	58.18%	73.91%	6.69**	.29
Stereotyped/repetitive/idiosyncratic language	27	28	4	19	49.09%	82.61%	7.53**	.31
Lack of make-believe/imaginative play	23	32	4	19	41.82%	82.61%	4.28*	.23
Restricted/repetitive/stereotyped patterns								
Stereotyped/restricted pattern of interest	32	23	6	17	56.36%	73.91%	1.87	.17
Non-functional routine or ritual	35	20	11	12	63.64%	52.17%	0.89	.11
Stereotyped or repetitive motor mannerisms	33	22	7	16	60.00%	69.57%	0.64	.09
Preoccupation with parts of objects	7	48	2	21	12.73%	91.30%	0.26	.06

** $p < .01$;

* $p < .05$;

*** $p < .07$