



Citation for published version:

Hiller, RM, Young, R & Weber, N 2014, 'Sex Differences in Autism Spectrum Disorder based on DSM-5 Criteria: Evidence from Clinician and Teacher Reporting', *Journal of Abnormal Child Psychology*, vol. 42, no. 8, pp. 1381 - 1393. <https://doi.org/10.1007/s10802-014-9881-x>

DOI:

[10.1007/s10802-014-9881-x](https://doi.org/10.1007/s10802-014-9881-x)

Publication date:

2014

Document Version

Peer reviewed version

[Link to publication](#)

The final publication is available at Springer via <http://dx.doi.org/10.1007/s10802-014-9881-x>

University of Bath

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Journal of Abnormal Child Psychology

© Springer Science+Business Media New York 2014

10.1007/s10802-014-9881-x

**Sex Differences in Autism Spectrum Disorder based on DSM-5 Criteria: Evidence
from Clinician and Teacher Reporting**

Accepted version

Rachel M. Hiller^{1,2}, Robyn L. Young¹ and Nathan Weber¹

(1)Flinders University, School of Psychology, Adelaide, Australia

(2)University of Bath, Department of Psychology, Bath, UK

Rachel M. Hiller (Corresponding author)

Email: R.Hiller@bath.ac.uk

Published online: 3 June 2014

Acknowledgments

The authors wish to sincerely thank Tomoko Nishizawa for her assistance with inter-rater reliability, as well as all of the parents and children who volunteered their information for this research.

Author Notes

This research was supported by the Apex Trust for Autism PhD Research Grant. This research was conducted while the first author was at Flinders University, Australia. Over the course of the review process the first author relocated to the University of Bath, United Kingdom.

Conflict of Interest. The authors declare that they have no conflict of interest.

Abstract

In the absence of intellectual impairment autism spectrum disorder (ASD) is diagnosed both less and later in females. This study used clinician and teacher report to explore sex differences in the behavioural presentation of 69 girls and 69 boys all diagnosed with high-functioning ASD. Evidence from DSM-IV-TR and DSM-5 are presented. Sex differences in teacher concerns were also explored. While no sex differences were found in the broad social criteria presented in the DSM-IV-TR or DSM-5, numerous differences were evident in how boys and girls came to meet each criterion. For example, girls were more likely to show an ability to integrate non-verbal and verbal behaviours, maintain a reciprocal conversation, and be able to initiate, but not maintain friendships. Moreover, girls presented with both less and different restricted interests. Teachers also reported substantially fewer concerns for girls than boys, including for externalising behaviours and social skills. Results suggest girls with ASD may present with a surface-level ‘look’ different from the ‘classic’ presentation of ASD, and present as less impaired when in a school setting. Consequently, results provide insight in to why the disorder may be more difficult to detect in cognitively-able girls.

Keywords

Autism spectrum disorder; Sex differences; Gender; Behaviour presentation; Teacher report

Introduction

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder, characterised by developmental delays in social-communication ability and the presence of restricted and repetitive behaviours (American Psychiatric Association [2013](#)). In 2013 the fifth edition of the diagnostic statistical manual was released (DSM-5), and combined Asperger's disorder, autistic disorder, childhood disintegrative disorder and pervasive developmental disorder not otherwise specified (PDD-NOS), into the umbrella term Autism Spectrum Disorder. While previously thought of as a triad of impairments (American Psychiatric Association [2000](#)) ASD is now categorised by two broad criteria: social and communication impairment and restricted/repetitive behaviours (American Psychiatric Association [2013](#)).

ASD is diagnosed four times more frequently in boys than girls (Rivet and Matson [2011](#)). In the absence of intellectual impairment, the male: female ratio increases to approximately 10:1, reflecting evidence that clinically identified girls with ASD are more likely to present with intellectual impairment (Fombonne [2009](#); Rivet and Matson [2011](#)). In the absence of intellectual impairment the disorder may be referred to as high-functioning ASD. Further to being diagnosed less, girls with high-functioning ASD are, on average, also diagnosed later than boys. This is despite no difference in the number of professionals visited and the child's age when the parent first expressed concern (Begeer et al. [2012](#); Siklos and Kerns [2007](#)). This suggests, while certain biological factors may protect girls from developing ASD as readily as boys (Baron-Cohen [2002](#); Werling and Geschwind [2013](#)), the current magnitude of the sex discrepancy is also potentially the result of the under-identification of ASD in cognitively-able girls.

Currently, we know little about why such a large sex discrepancy exists for cognitively-able children with ASD. Research on sex differences in the core symptoms of

ASD presents inconsistent results. The most consistent finding is that girls are less likely than boys to present with restricted interests (Hartley and Sikora [2009](#); Lord et al. [1982](#); Mandy et al. [2012](#); Szatmari et al. [2012](#)), with Szatmari and colleagues ([2012](#)) suggesting this may be due to girls' higher genetic liability. However, it has also been suggested that restricted interests may manifest differently in girls, and thus be under-identified (Attwood et al. [2006](#)). Consequently, a major contribution of this research is the investigation of sex differences in the types of restricted interests displayed by girls and boys.

Evidence of sex differences in the social and communication domain have remained inconsistent. The literature shows evidence of no difference in the social-communication impairments of girls and boys (Andersson et al. [2013](#); Mandy, et al. [2012](#)). This includes evidence from a large sample of girls, all diagnosed with high-functioning ASD (Mandy, et al. [2012](#)). However, there is also evidence of more severe (Hartley and Sikora [2009](#); McLennan et al. [1993](#)) and less severe (Lai et al. [2011](#)) social impairment in females, compared to males with ASD. Our ability to draw conclusions across studies has thus far been affected by methodological issues including small samples (particularly of females), the reliance on retrospective reporting after long time lapses (in some cases up to 40 years; Lai et al. [2011](#)), and the inclusion of children with comorbid intellectual impairment, making it difficult to determine what factors, unique to cognitively-able girls, may make ASD more difficult to detect. In this study we have aimed to overcome these limitations with a larger sample of girls with ASD, a focus on the child's state of functioning at the time of the diagnosis, and the inclusion of only children with no comorbid intellectual disability.

While it is certainly worthwhile to explore sex differences in the broader ASD criteria provided by the diagnostic manual, it is perhaps not surprising that few sex differences are often reported. This is because the samples have included individuals who have already been diagnosed with the disorder, and thus met criteria. However, within each broad criterion there

is a range of different behaviours a diagnostic clinician may draw on to decide whether a child does or does not meet a particular criterion. For example, to meet impairment in nonverbal communicative behaviour children may present with impairments in their integration of verbal and nonverbal behaviours, or impairments in eye contact or social smiling, or impairment in their understanding of nonverbal cues. An individual may present with one, some, or all of these behaviours to meet the particular criterion. However, the literature fails to provide insight into how girls and boys come to meet each criterion, as outlined in either DSM-IV-TR or DSM-5. Explaining this could provide insight into why the diagnosis may be more difficult to detect in girls, particularly by professionals not trained in making a diagnosis, yet likely to be the first source of information relied on by a parent (e.g., family doctor, teachers). Consequently, a key aim of this study was to move beyond examination of the broad criteria to explore whether there were sex differences in the way boys and girls came to meet each of the criterion for ASD.

It has also been proposed that ASD may be particularly difficult to identify in girls due to impairments not presenting consistently across settings (Attwood et al. [2006](#); Dworzynski et al. [2012](#); Mandy, et al. [2012](#)). In particular it has been suggested that girls' underlying social impairment would be even less salient in a school environment (Attwood, et al. [2006](#)). This hypothesis was supported in recent studies by Mandy et al. ([2012](#)) and Dworzynski et al. ([2012](#)), who both found that teachers rated girls with ASD as having better social skills (e.g., better prosocial behaviour), despite no significant difference in parent ratings (Dworzynski et al. [2012](#)), or indeed greater parental concern for girls (Mandy, et al. [2012](#)). In the more comprehensive study by Mandy and colleagues, teachers reported that boys with ASD were more problematic than girls overall, and had more problems with hyperactivity, prosocial behaviour, and peer relationships. This was in contrast to parent report of more concern for the emotional symptoms of girls. These findings suggest that girls

are somehow able to hide emotional symptoms, and social impairments (whether consciously or unconsciously), when in a school environment. Girls' potential ability to manage their behaviours in large social settings (i.e., school), despite impairments, provides important insight in to why the disorder may be more difficult to detect in this population. However, this is an area where further research is necessary. Consequently, an additional aim of this study was to further explore teacher reporting on the presentation of boys and girls.

In sum, this study was designed to investigate sex differences in the presentation of children and adolescents with ASD, based on both DSM-IV-TR and DSM-5 criteria. In particular, this study investigated whether sex differences in the diagnostic rates may be, at least in part, due to girls presenting with different overt behaviours, leading to the under-detection of the disorder. To explore this we examined the diagnostic assessments and reports of children and adolescents who had all been diagnosed with high-functioning ASD. The inclusion of both DSM criteria also allowed for the investigation of the impact of the DSM-5 criteria on the diagnosis of girls. Within the DSM-5 framework this study moved beyond the examination of sex differences in the broader diagnostic categories of ASD, and allowed us to examine whether there were sex differences in what specific impairments, within each criterion, resulted in the clinician determining that the child met criteria for ASD. This information, along with differences in the home versus school-presentation of girls and boys with ASD, allowed for the further exploration of how ASD may present differently in girls and boys, and, importantly, how these differences may manifest across different settings.

Method

Participants

Information was gathered from the diagnostic assessments and resulting reports of 69 girls and 69 boys all diagnosed with high-functioning ASD. There was no significant difference in the age of the girls ($M = 8.06$ years, $SD = 4.03$) and boys

($M = 8.76$ years, $SD = 3.91$), $t(136) = 1.03$, $p = 0.31$, $d = 0.17$. The participants were clients from a large private practice specialising in diagnostic assessments for Pervasive Developmental Disorders (PDDs). All clinicians had specialised training, were experienced in PDD assessment, and were recognised diagnosticians with the local Autism organisation. Informed consent was provided by the parent (and child where appropriate) for use of their diagnostic data for research purposes, as part of the standard process of the practice. This research was granted ethical approval by the Flinders University Social and Behavioural Research Ethics Committee. A total of five clinicians contributed participant information to the current study (four psychologists and one speech pathologist). Assessments included both dual assessments (by a psychologist and a speech pathologist) and single assessments (by a sole practitioner), depending on the need of the client.

Diagnostic process. For 114 participants (81 %), the diagnostic clinician referred to both the DSM-IV-TR (American Psychiatric Association [2000](#)) and DSM-5 (American Psychiatric Association [2013](#)) criteria in the resulting diagnostic report, as was the standard practice of the clinic due to a transition period between the two criteria. See Fig. [1](#) for information on how many boys and girls had information from the primary sources from which data was collected. Due to the timing of the assessments the DSM-IV-TR was used to make the official diagnosis.

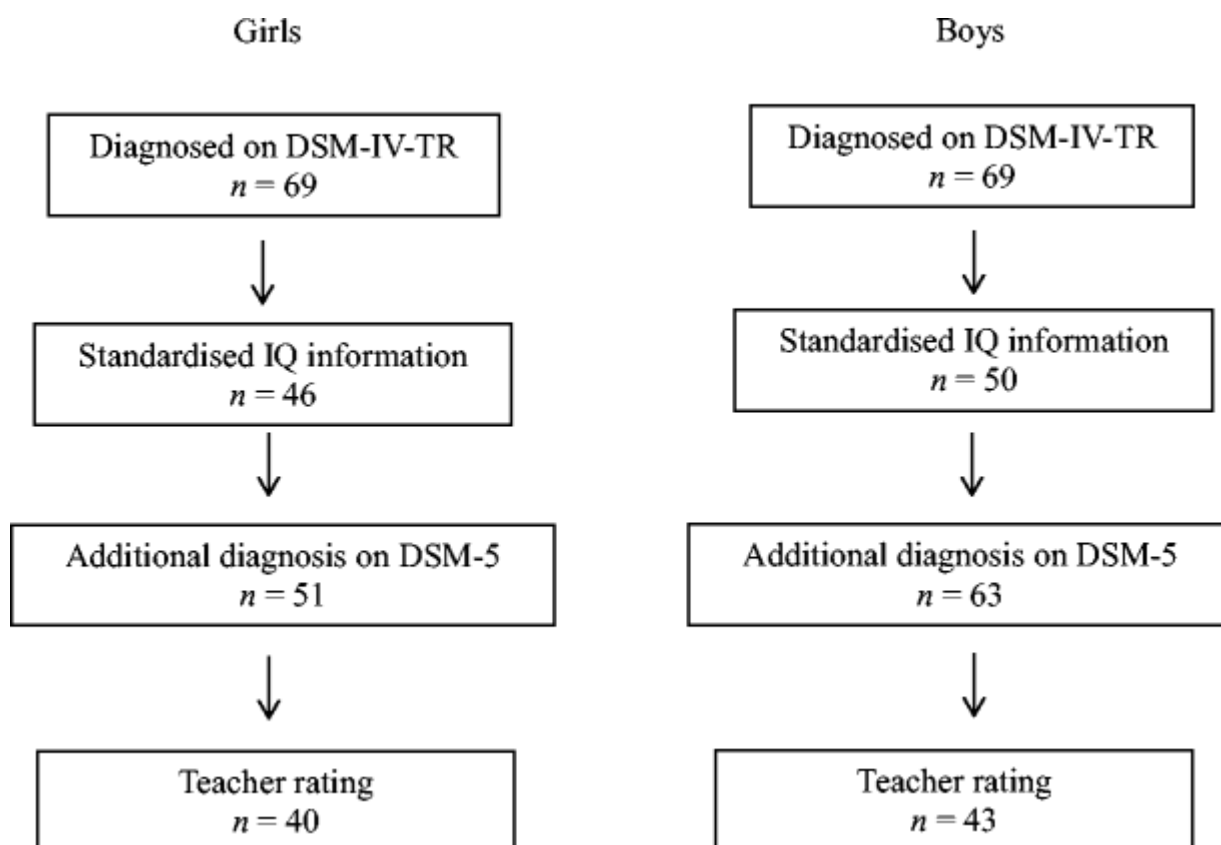


Fig. 1

Number of girls and boys who had information from the various primary sources

In conjunction with the DSM-IV-TR criteria, a variety of standardised assessments were used to determine diagnosis. On the DSM-IV-TR and DSM-5 criteria, participants were rated by the diagnostic clinician as either meeting the criterion (*Yes*), partially meeting the criterion (*Somewhat*), or not meeting the criterion (*No*). For the purpose of the final diagnostic decision, ratings of somewhat meeting a criterion meant the criterion was not actually met, but that the clinician had identified some atypicality. Consequently, the clinician's use of these three rating levels gave insight into when a clinician identified an impairment as atypical, but not at a level to constitute meeting the criterion (i.e., not at a level they may typically see in a child with ASD). All clinicians followed a standard report structure where each diagnostic criterion was referred to, with a breakdown of what

behaviours the child presented with (and what impairments were not, or only partially present), within each criterion. Available information from the diagnostic file was also used (e.g., questionnaires) to ensure information in the report was consistent with information collected during the diagnostic assessment. As information was collected from the assessments of five independent clinicians, and a broad range of ages of clients, different standardised assessment tools were used. However, all assessments comprised a formal diagnostic interview with the child and parent, which followed a standard procedure, as per the clinic's protocol. Other measures used included the Autism Detection in Early Childhood (ADEC; Young [2007](#)), the Childhood Autism Rating Scale (CARS; Schopler et al. [1986](#)), the Autism Diagnostic Interview-Revised (ADI-R; Lord et al. [1994](#)), and the Autism Detection Observation Schedule (ADOS; Lord et al. [1989](#)). As a variety of different assessment tools were used, based on clinician preference and the child's age, the specific scores on these tools were not analysed in this paper.

Diagnoses. Chi square analysis showed no significant difference (with small effect size) in the diagnostic categories met by the girls and boys, $\chi^2(3) = 2.48$, $p = 0.48$, $\phi_c = 0.13$. The most common category was Asperger's disorder (based on DSM-IV-TR), with 73.9 % ($n = 51$) of girls and 78.3 % ($n = 54$) boys meeting this criterion. Ten girls (14.5 %) and nine boys (13.0 %) were diagnosed with autistic disorder or autism spectrum disorder, while the remaining eight girls (11.6 %) and six boys (8.7 %) met criteria for pervasive developmental disorder (not otherwise specified; PDD-NOS).

IQ information. Standardised IQ data from the Wechsler Intelligence Scale for Children (Wechsler [2003](#)), or the Wechsler Preschool and Primary Scale of Intelligence (Wechsler [2002](#)), were available for 97 children (69 %). There was no significant difference in the full scale IQ (girls: $M = 97.76 \pm 15.31$; boys: $M = 100.31 \pm 13.27$, $t(67) = 0.74$, $p = 0.46$, $d = 0.18$), verbal IQ

(Girls: $M = 96.91 \pm 11.99$; boys: $M = 100.89 \pm 12.71$, $t(91) = 1.55$, $p = 0.12$, $d = 0.32$), or performance IQ (girls: $M = 100.19 \pm 13.38$; boys: 103.30 ± 15.64 , $t(91) = 1.02$, $p = 0.31$, $d = 0.21$) of the boys and girls. All participants for whom IQ data were available had either performance or verbal IQ in the average range (or above). No participant's full-, verbal-, or performance-IQ was below the standard score of 70. It was assumed that the participants for whom IQ data were not available did not have an intellectual disability as all were functioning academically in a mainstream school or had previously scored in the competent range for cognition using the Bayley Scales of Infant and Toddler Development (Bayley [2006](#)).

Previous diagnosis. Eighty-three participants had a reported previous diagnosis, prior to the ASD assessment (43 boys and 40 girls). Chi square analysis showed a significant sex difference in previous diagnoses, $\chi^2(3) = 22.16$, $p < 0.001$, $\phi c = 0.46$. For boys, the most common previous diagnosis was ADHD or significant behaviour problems (74.4 %, $n = 32$), with only 25.0 % of girls ($n = 10$) having previously received this diagnosis. Thirteen of the girls (32.5 %, $n = 13$) had a previous anxiety disorder diagnosis, compared to only 7 % of the boys ($n = 3$). The other categories were sensory or language disorders (girls: 27.5 %, $n = 11$; boys: 16.3 %, $n = 7$), and a previous diagnosis of PDD-NOS (girls: 15 %, $n = 6$; boys: 2.3 %, $n = 1$).

Family history. Information on family history of ASD was available for 61 girls and 57 boys. Chi square analysis showed no significant sex difference in family history, $\chi^2 = 4.46$, $p = 0.10$, $\phi c = 0.19$. Approximately half of all children had no family member with a known diagnosis of ASD (girls: 45.9 %, $n = 28$; boys: 59.6 %, $n = 34$). Forty one percent of girls ($n = 25$) had an immediate family member (parent or sibling) with an ASD diagnosis, compared to 22.8 % of boys ($n = 13$). The remaining 13.1 % of girls ($n = 8$)

and 17.5 % of boys ($n = 10$) had another family member with an ASD diagnosis (e.g., uncle or cousin).

Procedure

The primary author and a research assistant examined the diagnostic assessment information and resulting diagnostic reports for all children. Clinician rated information was collected on the DSM-IV-TR and DSM-5 criteria. Additional information provided in the report and diagnostic interview was collected verbatim and applied to the various behaviours of interest. The full list of the behaviours is listed in Table [1](#), with odds ratios and 95 % confidence intervals. The odds ratios refer to the likelihood the behaviour predicts the child is a girl versus boy. These behaviours were extrapolated from the various behaviours outlined within the DSM-5 criteria (American Psychiatric Association [2013](#)). Each impairment was coded as either (0) *no impairment*, (1) *partially or somewhat impaired*, or (2) *impaired*. The specific presentations that constituted somewhat impaired versus impairment or not impaired will be discussed in the results section, where variables are described in more detail.

Importantly, it was not presumed that the absence of a comment on any behaviour reflected the behaviour not being impaired. Consequently, if a behaviour was not explicitly referred to, the data point was treated as missing. Missing data never exceeded 15 % for a given variable, with no difference in the amount of data missing for boys and girls. The only exception to this was references to body language (a potential impairment from the nonverbal behaviour category), which was rarely referred to in reports and has thus not been included in the analysis. Information that was recorded verbatim was coded at a later date by the first author. An independent rater, blind to the child's sex and the research aims then completed interrater reliability on 30 % of the data. Adequate interrater reliability was established across all variables based on Cohen's kappa scores between 0.75 and 0.92.

School presentation was taken from two sources. First, as part of the clinic's standard pre-diagnostic assessment questionnaire, parents reported on what concerns were expressed to them by a teacher, when their child was in pre-school. Second, the child's current teacher reported on a range of behaviours, based on a structured questionnaire provided to teachers as part of the clinic's standard procedure. Information was collected verbatim from the reports, including reference to the child's social functioning, externalising behaviours, friendships, restricted interests, and atypical movements. Results were coded as either zero (*not problematic*), one (*somewhat problematic*), or two (*problematic*). This information was again coded by the primary researcher, as well as the independent rater (for 30 % of the sample). Adequate interrater reliability was established across the variables based on Cohen's kappa scores between 0.80 and 0.93.

Statistical Analyses

For the major analyses logistic regressions were used, with sex as the outcome variable. Age was controlled for in all major analyses. These analyses address the key research question: How strongly is a given predictor indicative of a child being a girl (or boy)? Consequently, these analyses provide more useful information than simply examining sex differences in proportions or means of predictor variables. We used the logistic regression equations to calculate the predicted log odds for each level of all significant predictors. Odds ratios are asymmetrical around 1, meaning it is difficult to compare odds ratios favouring girls (> 1) with those favouring boys (< 1). For ease of interpretation, we transformed all odds ratios to > 1 and have noted whether the ratio favours girls or boys. Consequently, a larger odds ratio is indicative of a stronger association between sex and the predictor variable.

Results

Sex Differences Based on DSM-IV-TR Criteria

Table 1 presents the list of behaviours, based on DSM-5, of interest to this study. Regarding the broad criteria, as the majority of the sample met criteria for Asperger's Disorder, we investigated sex differences based on the diagnostic criteria for this disorder (i.e., the social and ritualistic domains only; American Psychiatric Association [2000](#)). All DSM ratings were made by the diagnostic clinician.

Table 1

Results of logistic regression analyses, controlling for age, for the behaviour predicting sex

Criterion	Behaviour	Chi-square (df)		ExpB [95 % CI]	
		Overall	Criteria Not Met	Criteria Somewhat Met	Criteria Met (constant)
Social-emotional reciprocity	Social approach**	6.64(2)	6.93 [0.76,62.90]	2.45** [1.06, 5.70]	1.16 [0.45, 2.97]
	Reciprocal conversation*	23.90(2)	25.54* [3.05, 214.11]	6.79* [2.83,16.32]	0.55 [0.18, 1.68]
	Sharing of interests*	9.70(2)	4.66* [1.70,12.81]	1.23 [0.53, 2.84]	0.82 [0.29, 2.34]
	Emotion and affect	9.33(2)	- ^a	0.68 [0.39, 2.22]	1.21 [0.47, 3.10]
	Initiation of interaction	5.43(2)	- ^b	3.29** [1.21, 8.93]	1.87 [0.75, 4.71]
Non-verbal communicative behaviour	Integration of verbal/nonverbal behaviour*	9.14(2)	4.94* [1.67,14.61]	1.05 [0.43, 2.55]	0.84 [0.28, 2.48]
	Eye contact	4.14(2)	2.55** [1.02, 6.39]	1.14 [0.50, 2.59]	1.14 [0.45, 2.86]
	Facial expressions	1.88(2)	1.67 [0.52, 5.31]	1.69 [0.72, 3.93]	1.08 [0.43, 2.69]

	Nonverbal understanding	0.31(2)	- ^c	1.40 [0.43, 4.53]	0.81 [0.29, 2.27]
Developing and maintaining friendships	Adjusting behaviour for situation*	16.22(2)	17.17* [2.08, 141.99]	12.57* [2.62, 59.48]	0.53 [0.23, 1.93]
	Sharing behaviour	5.18(2)	4.85** [1.24, 18.88]	1.22 [0.54, 2.73]	1.13 [0.46, 2.77]
	Imagination*	17.13(2)	6.10* [2.42, 15.39]	4.23* [1.64, 11.23]	0.60 [0.21, 1.68]
	Making friends*	9.40(2)	4.03 [0.90, 18.02]	3.10* [1.42, 6.74]	1.11 [0.47, 2.66]
	Interest in people**	8.74(1)	3.13** [1.44, 6.76]	–	0.60* [0.37, 0.96]
Stereotyped/repetitive behaviour	Speech	2.45(2)	2.01 [0.79, 5.11]	1.10 [0.48, 2.52]	1.02 [0.37, 2.83]
	Movement	4.14(2)	2.53 [0.99, 6.45]	1.79 [0.81, 3.93]	0.80 [0.30, 2.10]
	Use of objects*	9.68(2)	6.38* [1.90, 21.41]	0.96 [0.42, 2.17]	1.36 [0.57, 3.25]
Excessive routine adherence	Routine adherence	3.29(2)	0.23 [0.05, 1.13]	0.96 [0.42, 2.19]	1.49 [0.63, 3.53]
	Managing change	1.93(2)	0.47 [0.11, 2.06]	1.43 [0.61, 3.37]	1.52 [0.62, 3.71]
Restricted/fixated interest ^d	Type of interest	–	–	–	–
Sensory sensitivity		2.17(2)	3.04 [0.69, 13.38]	1.18 [0.49, 2.84]	1.38 [0.55, 3.46]

Note. 0.95 % CI for *ExpB* calculated from *B(SE)* and converted for ease of interpretation

^a Only six children failed to meet criterion on emotion/affect category (all of whom were girls). ^b Only four children (all girls) failed to meet criterion on initiation category. ^c Six children (all girls) failed to meet criterion for nonverbal understanding. ^d For restricted/fixated interests data was coded by type or category of impairment (results in Table 3)

*Overall model and levels which significantly predicted sex based on $p \leq 0.01$; ** $p < 0.05$

Social domain. Results of logistic regressions for DSM-IV-TR criteria, controlling for age, are presented in Table 2. In the social domain, there was no evidence of an overall significant sex difference on the nonverbal behaviours and sharing of interests criteria. Examination of the various levels of impairment (criterion met, somewhat, not met) showed that being significantly impaired on either of these criteria (i.e., criterion met) did not significantly predict sex. However, only partially or somewhat meeting criterion on the ‘nonverbal impairment’ category and not meeting criterion on the ‘sharing of interests’ category, both significantly predicted the child was a girl. That is, girls were more likely than boys to show only partial impairment in nonverbal skills and no impairment in their apparent sharing of interests. On the peer relationships and social/emotional reciprocity criteria, the overall logistic regression model showed level of impairment was not predictive of sex.

Table 2

Results of logistic regressions for dsm-iv-tr and dsm-5 categories predicting sex, after controlling for age

Category	Predicted Odds	Wald (df)	<i>p</i>	ExpB [95 % CI]
DSM-IV-TR				
Nonverbal impairment		5.33(2)	0.07	
Criteria not met	1.65	1.11(1)	0.29	1.94 [0.56, 6.07]
Somewhat**	2.07	4.98(1)	0.03	2.43 [1.11, 5.30]
Criteria met (constant)	1.17	0.13(1)	0.72	.85 [0.34, 2.08]
Failure to develop peer relations		2.15(2)	0.34	
Criteria not met	1.37	0.04(1)	0.84	1.22 [0.17, 9.06]
Somewhat	2.20	2.14(1)	0.14	1.97 [0.79, 4.91]
Criteria met (constant)	1.12	0.08(1)	0.79	1.12 [0.49, 2.56]

Impairment in sharing of interests		5.44(2)	0.07	
Criteria not met**	1.86	5.03(1)	0.03	2.52 [1.13, 5.74]
Somewhat	1.05	0.31(1)	0.58	1.29 [0.52, 3.20]
Criteria met (constant)	1.35	0.36(1)	0.55	0.74 [0.26, 2.01]
Lack of social and emotional reciprocity		0.01(2)	0.99	
Criteria not met ^a	–	0.00(1)	1.00	–
Somewhat	1.33	0.01(1)	0.94	0.97 [0.37, 2.54]
Criteria met (constant)	1.38	0.55(1)	0.46	1.38 [0.59, 3.22]
Restricted interest*		20.85(2)	<0.001	
Criteria not met*	8.32	9.65(1)	<0.01	29.72 [3.50, 252.71]
Somewhat*	2.30	14.48(1)	<0.001	8.20 [2.77, 24.23]
Criteria met (constant)	3.57	5.20(1)	0.02	0.28 [0.09, 0.84]
Inflexible routine adherence		2.69(2)	0.26	
Criteria not met	1.08	0.87(1)	0.35	0.59 [0.19, 1.80]
Somewhat	1.23	2.23(1)	0.14	0.52 [0.22, 1.23]
Criteria met (constant)	1.56	1.11(1)	0.29	1.56 [0.68, 3.56]
Stereotyped motor mannerisms		2.15(2)	0.34	
Criteria not met	2.00	0.63(1)	0.43	1.43 [0.59, 3.50]
Somewhat	1.01	0.67(1)	0.41	0.72 [0.33, 1.59]
Criteria met (constant)	1.40	0.61(1)	0.44	1.40 [0.60, 3.22]
Persistent preoccupation with parts		4.88(2)	0.09	
Criteria not met	2.18	2.23(1)	0.14	1.79 [0.83, 3.86]
Somewhat	1.39	1.08(1)	0.30	0.59 [0.22, 1.59]
Criteria met (constant)	1.22	0.20(1)	0.65	1.22 [0.52, 2.86]
DSM-5				
Deficits in social-emotional		0.01(2)	0.99	

reciprocity				
Not met ^b	–	0.00(1)	1.00	–
Somewhat met	1.55	0.01(1)	0.93	1.09 [0.14, 8.34]
Met (constant)	1.43	0.58(1)	0.45	1.43 [0.57, 3.63]
Deficits in nonverbal communicative behaviour		2.03(2)	0.36	
Not met	5.66	1.13(1)	0.29	3.52 [0.35, 35.94]
Somewhat met	3.06	1.07(1)	0.30	1.90 [0.56, 6.41]
Met (constant)	1.61	0.09(1)	0.77	1.61 [0.44, 3.10]
Deficits in relationships		0.08(2)	0.96	
Not met	1.68	0.002(1)	0.96	1.07 [0.07, 17.61]
Somewhat met	1.32	0.08(1)	0.78	0.84 [0.25, 2.86]
Met (constant)	1.57	0.86(1)	0.35	1.57 [0.61, 4.06]
Stereotyped/repetitive behaviour		4.64(2)	0.10	
Not met	3.54	2.87(1)	0.09	2.61 [0.86, 7.90]
Somewhat met	3.26	3.05(1)	0.08	2.40 [0.90, 6.42]
Met (constant)	1.36	0.43(1)	0.51	1.36 [0.54, 3.46]
Excessive adherence to routines		4.38(2)	0.11	
Not met	1.96	2.71(1)	0.10	0.31 [0.08, 1.25]
Somewhat met	1.21	2.40(1)	0.12	0.49 [0.20, 1.21]
Met (constant)	1.68	1.15(1)	0.28	1.68 [0.65, 4.35]
Restricted/fixated interest*		11.37(2)	0.003	
Not met	4.64	5.07(1)	0.02	6.63 [1.28, 34.42]
Somewhat met*	3.42	7.71(1)	0.01	4.89 [1.60, 14.97]
Met (constant)	1.42	0.49(1)	0.50	0.70 [0.24, 1.99]
Sensory sensitivity		2.17(2)	0.34	
Not met	4.20	2.16(1)	0.14	3.04 [0.69, 13.38]
Somewhat met	1.63	0.14(1)	0.71	1.18 [0.49, 2.84]

Met (constant)	1.38	0.47(1)	0.49	1.38 [0.55, 3.46]
----------------	-------------	---------	------	-------------------

Note. CI = confidence interval, bolded predicted odds ratios represent odds predictive of being a girl with ASD

^a Only one child failed to meet impairment in social and emotional reciprocity based on DSM-IV-TR criteria. ^bOnly one child failed to meet this impairment of DSM-5

* $p < 0.01$; ** $p < 0.05$

Repetitive/Restricted Interests Domain

On this domain, the only category to significantly predict sex was the presence of restricted or fixated interests (see Table 2). If a child failed to meet this criterion, the predicted odds ratio showed the child was 10 times more likely to be a girl than boy. As such, not meeting criterion was significantly predictive of being a girl. Routine adherence, stereotyped movement, and preoccupation with parts of objects all failed to significantly predict sex.

Sex Differences Based on DSM-5 Criteria

Sixty-three boys (91 %) and 51 girls (74 %) had clinician-rated information on DSM-5 criteria. Logistic regressions, controlling for age, were also used to assess which broad categories on this new criteria significantly predicted sex. Table 2 shows results of the logistic regression analyses. From the results of the regressions, the only diagnostic category to predict sex was the restricted interest domain. As on the DSM-5, not meeting or only somewhat meeting criterion for the restricted interest category was predictive of being female.

Sex Differences in Behaviour Presentation

Sex differences in readily observable characteristics on DSM-5. To meet each criterion on either the DSM-IV-TR or DSM-5, the child may present with one (or more) of a number of behaviours of concern. We were interested in whether sex differences may be evident in how boys and girls came to meet each criterion (i.e., what impairments within the

criterion were present or absent). Regardless of whether the child had clinician-rated information on the broad DSM-5 criteria, information was collected for all participants on these specific behaviours mentioned within each criterion (listed in Table [1](#) with odds ratios). Participants had all met criteria for high-functioning ASD under the DSM-IV-TR. Results showed numerous areas where girls presented differently to boys, particularly in their more readily observable, overt behaviours. Below we discuss in more detail those variables which most strongly predicted sex, based on significance testing ($p \leq 0.01$) and effect sizes.

Social and emotional reciprocity. Only one child failed to show any impairment on the DSM-5 social-emotional reciprocity criterion. However, results suggest the impairments that led boys and girls to meet this criterion differed. Girls appeared to present with a greater ability to engage in reciprocal conversation and sharing of interests. If a child/adolescent was able to engage in typical reciprocal conversation they were almost 14 times more likely to be a girl than boy. However, these apparent typical reciprocal conversation skills were only evident for the minority (17 %) of girls (and only one boy), explaining the large confidence interval (see Table [1](#)). Consequently, it was still only the minority of girls with ASD who were able to maintain seemingly typical conversation. If the child appeared to have *some* ability to engage in conversation they were almost three times more likely to be a girl rather than boy. This category was met by 50 % of the girls in the sample (compared to 18 % of boys). This ‘somewhat’ criterion represents those participants who were able to engage in reciprocal conversation but it was primarily on a topic of their own interest, or it was thought social scripts played a key role. Sharing of interests and achievements was also significantly predictive of being a girl. If this impairment was not met (i.e., sharing of interests was seen as typical) the participant was almost four times more likely to be a girl, with 38 % of girls (and only 13 % of boys) having no apparent impairment in their willingness to share their interests.

Nonverbal communicative behaviour. A key example of sex differences in overt behaviour presentation was found in the nonverbal behaviour category. Here, preserved skills in the ability to integrate nonverbal and verbal gestures was significantly predictive of being female. From predicted odds ratios if a child presented at the diagnostic assessment with no abnormality in nonverbal communication abilities they were four times more likely to be a girl than boy. Over one-third of the girls (34.5 %) in the sample were rated as having no impairment in their ability to integrate nonverbal and verbal communicative behaviours (compared to 9 % of boys).

Interestingly, while girls presented with better use of social gestures, the ability to understand and interpret nonverbal behaviours was not predictive of sex. This was considered significantly impaired for 75 % of girls and 89 % of boys. Consequently, the sex difference in the behaviour presentation (i.e., the ability to use social gestures) was not reflective of the child's underlying understanding. No impairment in the child's ability to interpret others' nonverbal cues was evident for only 10 % of girls and no boys.

Friendships and public appearance. Results also suggested girls reportedly present with better imagination (at least on face value) and a different manifestation of friendship problems (see Table 1). For imagination, typical imaginative play or some imaginative play were both predictive of being a girl, with 75 % of girls falling in to these categories (45 % with no impairment and 30 % with some impairment). In contrast, only 18 % of boys were rated as having no impairment in imagination, and a further 18 % rated as having somewhat impaired imagination. From predicted odds ratios, if the child could engage in imaginative play considered typical for their developmental level, they were 3.5 times more likely to be a girl than a boy. If the child 'somewhat' demonstrated imaginative play they were 2.5 times more likely to be a girl than boy. Here, the 'somewhat' category represents those children

who demonstrated some imaginary play, however, the clinician made reference to it potentially being based on scripts.

Only nine children in the sample were thought to have no impairments in their ability to make friends. However, while both sexes had difficulties with friendships, these problems tended to manifest differently in boys and girls. Specifically, girls were more likely to be able to initiate friendships but then have trouble maintaining them (coded as 'somewhat'). Fifty per cent of girls met this criterion compared to 31 % of boys. This difficulty maintaining friendships primarily stemmed from the need for control over play. Consequently, if the child presented with the ability to initiate but not maintain friendships they were 3.5 times more likely to be a girl than a boy. In contrast, 65 % of boys compared to 40 % of girls had trouble both initiating and maintain friendships. This suggests a higher number of boys with ASD have more pervasive friendship problems, potentially making the impairment more salient.

Additionally, it has been hypothesised that ASD may be more difficult to identify in girls, in part, due to girls presenting as more quiet and introverted when in public (Attwood et al. [2006](#)). Partial support was found for this, with girls reportedly better able to regulate their behaviour in different situations. While having no issue with adjusting behaviour for the situation meant the child was nine times more likely to be a girl, this was only the case for 18 % of girls (compared to only one boy). Based on the predicted odds ratio, having some (albeit inconsistent) management of behaviour across situations (coded as 'somewhat') meant the child was over six times more likely to be a girl than boy. In contrast, having substantial impairments in the ability to adjust behaviour across situations meant the child was almost twice as likely to be a boy. That said, this was reported as a significant concern for 60 % of girls (compared to 95 % of boys). Overall, girls were more likely to show some ability to manage their behaviour in public, including monitoring volume of voice, and avoiding

socially inappropriate comments or externalising behaviours (e.g., ‘meltdowns’). However, based on parent report this was still an issue for the majority of girls in the sample.

Restricted, Repetitive Behaviour Domain

Differences were also apparent in the stereotyped use of objects (see Table [1](#)). Specifically, girls were substantially less likely to present with stereotyped use of objects (i.e., lining up or sorting behaviour). Twenty-seven per cent of girls did not meet criterion for this impairment compared to 6 % of boys. Twenty-two percent of girls and 31 % of boys somewhat met criterion, meaning the behaviour was sometimes, but infrequently, present. If the child did not meet this criterion the predicted odds ratio showed they were over eight times more likely to be a girl than boy.

Types of restricted interests. Besides proposing differences in overt behaviour presentation in the social domain, it has also been suggested that girls would present with different restricted interests to boys (Attwood et al. [2006](#)). These interests may then be more difficult to identify as a sign of ASD (or indeed as atypical). Here, logistic regression analysis again showed significant sex differences, $Wald(4) = 18.81, p < 0.001$. Age was not controlled for in this analysis, but will be discussed later. Results are presented in Table [3](#). Girls were most commonly rated as having restricted interests in the ‘seemingly random’ category (60 % girls, 29 % boys). Consequently, being rated as having a seemingly random restricted interest (e.g., rocks, stickers, pens) significantly predicted the child was a girl. The category to most strongly predict being a boy was fixations with screen time. Screen time fixations were predominantly obsessive gaming, however also included obsessions with iPads or other such screen technology. Thirty eight percent of boys reportedly showed obsessional interests in screens, compared to very few girls (9 %). In relation to the constant (screens), obsessional interests around toys and a specific television program or character, were also significantly associated with sex. However, the descriptive statistics and predicted odds ratios around one

(equal likelihood of being a girl or boy) reveal, at best, weak sex differences. Seventeen percent of girls were reported to demonstrate obsessional behaviour primarily around a specific program or character, compared to 10 % of boys. Moreover, only 8 % of girls and 5 % of boys were reported to demonstrate obsessional behaviour towards a toy. Given the age range in the sample, we also investigated whether sex differences in the type of restricted interests manifested by boys and girls, may differ depending on age. Consequently, we also examined the types of restricted interests displayed by younger (<7 years old) and older (>7 years old) boys and girls (see Fig. 2). Results showed a large percentage of younger boys' interests revolved around wheeled toys, while the largest percentage of older boys were fixated with screens (e.g., gaming). The largest percentage of girls' restricted interests remained in the category of 'random', regardless of age group.

The Role of School Presentation

The final aim of this research was to provide a comprehensive investigation of the school presentation of boys and girls with ASD. To explore this, information on school presentation was collected from two sources (parent report on the pre-school years and school report on current functioning).

Parent report on the pre-school years. Parents reported on concerns that had been expressed to them during the child's pre-school years. Chi square analysis showed significant sex differences in early concerns, $\chi^2(4) = 26.75, p < 0.001, \phi c = 0.55$. The largest difference was in reporting that no teacher expressed concern during the pre-school years. This was reported for 48 % of girls ($n = 20$) and only 11 % of boys ($n = 5$). Likewise, 49 % of parents of boys reported concern was expressed regarding the externalising behaviours of their son ($n = 22$), with this concern reported for only 10 % of girls ($n = 4$). Remaining concerns were with general learning (girls: 12 %, $n = 5$; boys: 4 %, $n = 2$), social development (girls:

26 %, $n = 11$; boys: 18 %, $n = 8$), and specific querying of ASD (girls: 5 %, $n = 2$; boys: 18 %, $n = 8$).

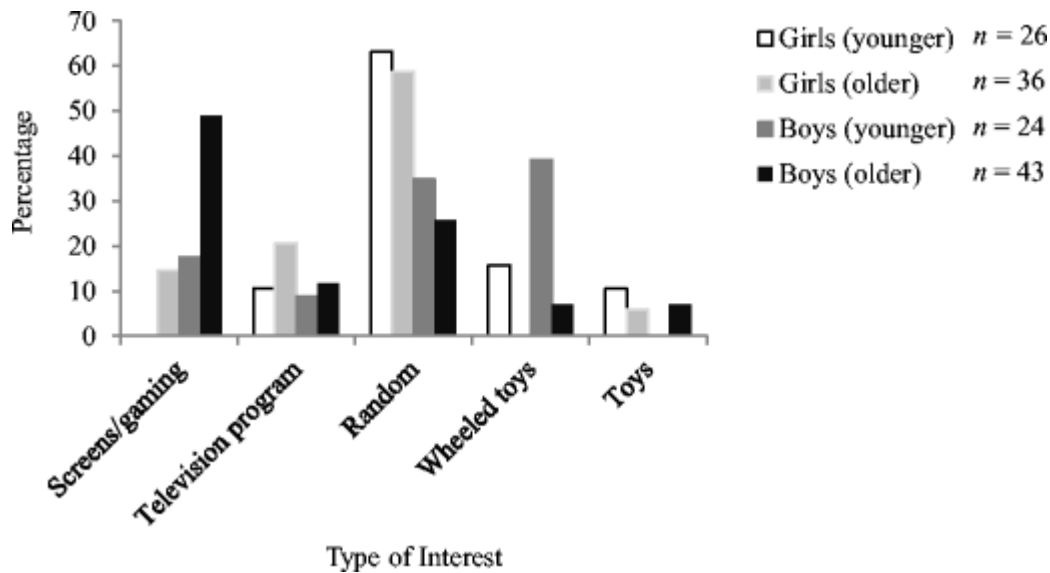
Teacher reporting. Teacher-reported information was available for 43 boys and 40 girls. Logistic regression analyses, controlling for age, showed significant differences were evident across a range of teacher concerns. Results of each regression are presented in Table 4. Of note, significant concern with externalising behaviours was reported for 50 % of boys and only 13 % of girls. For 70 % of girls, teachers reported no concern regarding externalising behaviours (compared to only 21 % of boys). Moreover, for 37 % of girls no concern was reported with their social skills (with some concern reported for 40 % of girls), compared to 5 % of boys (and 23 % having some concern reported). Across the majority of impairments, teachers reported significant concerns for far fewer girls than boys. Indeed, the only areas where no sex differences were evident (restricted interests and atypical movements) were areas where teachers had fewer concerns for either sex, most likely because of difficulty identifying those behaviours in a classroom context. Results support the idea that girls with ASD present at school with substantially fewer behaviour and general problems than boys.

Table 3

Results of logistic regression for type of restricted interest predicting sex

Interest Type	Predicted Odds	Wald (1)	<i>p</i>	ExpB [95 % CI]
Specific program/character	1.29	7.01	0.01	6.43 [1.62, 25.49]
Seemingly random(e.g., animals, rocks)	1.68	14.02	<0.001	8.42 [2.76, 25.69]
Wheeled vehicles (e.g., cars)	4.00	0.08	0.78	1.25 [0.26, 6.12]
Toys (e.g., teddy-bear)	1.33	4.37	0.04	6.67 [1.13,39.47]
Screens (e.g.,videogames) constant	5.00	10.79	0.001	0.20 [0.06, 0.52]

Note. Bolded predicted odds represent those types predictive of being a girl

**Fig. 2**

Percentage of younger (<7 years old) and older (>7 years old) boys and girls who displayed particular type of restricted interest, based on clinician report

Table 4

Results of logistic regressions on teacher-rated items predicting sex, after controlling for age

Category	Predicted Odds	Wald (df)	<i>p</i>	ExpB [95 % CI]
Externalising*		18.64(2)	<0.001	
No concern*	7.34	17.13(1)	<0.001	14.68 [4.11, 52.37]
Somewhat	1.31	1.91(1)	0.17	2.62 [0.67, 10.29]
Significant concern (constant)	2.00	0.78(1)	0.37	0.50 [0.11, 2.33]
Social Skills*		18.86(2)	<0.001	
No concern*	14.10	14.90(1)	<0.001	26.60 [5.02, 140.66]
Somewhat*	3.01	9.64(1)	<0.01	5.68 [1.90, 16.98]
Significant concern (constant)	1.89	0.68(1)	0.41	0.53 [0.12, 2.36]
Friendships*		9.01(1)	0.01	
No concern	10.96	5.53(1)	0.02	5.35 [1.32, 21.63]
Some concern*	10.09	6.65(1)	0.01	4.92 [1.47, 16.49]
No friends (constant)	2.05	0.82(1)	0.37	2.05 [0.43, 9.68]
Conversation Skills		6.38(2)	0.04	
No concern	2.83	5.76(1)	0.02	4.64 [1.33, 16.24]
Somewhat	1.12	0.79(1)	0.37	1.84 [0.48, 7.10]
Significant concern (constant)	1.64	0.32(1)	0.57	0.61 [0.11, 3.32]
Routine dependence*		9.01(1)	0.01	
No concern*	9.67	8.41(1)	0.004	8.41 [1.99, 35.44]
Somewhat	4.03	3.15(1)	0.08	3.50 [0.88, 13.93]
Significant concern (constant)	1.15	0.03(1)	0.87	1.15 [0.24, 5.51]
Restricted Interest		0.15(2)	0.93	
No concern	1.59	0.03(1)	0.87	1.09 [0.37, 3.20]

Somewhat	1.99	0.15(1)	0.70	1.36 [0.29, 6.30]
Significant concern (constant)	1.46	0.25(1)	0.62	1.46 [0.34, 6.36]
Atypical Movement		2.60(2)	0.27	
No concern	2.74	2.23(1)	0.14	2.38 [0.76, 7.43]
Somewhat	1.03	0.02(1)	0.90	0.84 [0.06, 11.16]
Significant concern (constant)	1.15	0.03(1)	0.88	1.15 [0.22, 6.43]
Academic Performance		2.63(2)	0.27	
Age appropriate	1.32	0.42(1)	0.52	1.46 [0.46, 4.61]
Behind in specific class	1.73	2.58(1)	0.11	3.32 [0.77, 14.37]
Behind across curriculum	1.92	0.59(1)	0.44	0.52 [0.09, 2.74]

Note. Bolded predicted odds ratios represent those variable levels predictive of being a girl

* $p < 0.01$

DSM-IV-TR versus DSM-5

Given evidence that girls present with a variety of behaviour differences to boys, we were also interested in whether this would impact girls' ability to meet criteria on the DSM-5. Sixty-three boys and 51 girls had clinician rated information on both DSM-IV-TR and DSM-5 criteria. Chi-square analysis showed no significant difference in the percentage of boys and girls who failed to meet criteria on the DSM-5 (after meeting criteria on DSM-IV-TR), $\chi^2(3) = 7.41, p = 0.06, \phi c = 0.26$. However, the effect size suggests this may be a power issue, with 31.4 % of girls ($n = 16$) and 17.5 % of boys ($n = 11$) failing to meet DSM-5 criteria. For all cases, the failure to meet DSM-5 criteria was due to failing to meet at least one of the three criteria in the social domain. For boys, this was spread across all three social categories. For girls who failed to meet DSM-5 criteria, 69 % ($n = 11$) failed to fully meet criterion for impairment in nonverbal communication (where we found overt behaviour

differences yet no difference in underlying understanding). Failing to meet criteria on DSM-5 was primarily an issue for those children with a diagnosis of PDD-NOS. Four out of eight girls (50 %) and two out of six boys (33 %) with an original PDD-NOS diagnosis failed to meet DSM-5 criteria. Eleven girls and nine boys had an original diagnosis of Asperger's disorder, while one girl had an original diagnosis of autistic disorder.

Discussion

This study investigated how ASD may present differently in girls versus boys, within the framework of both the DSM-IV-TR and DSM-5. Results suggested some key areas that may make ASD more difficult to identify in cognitively-able girls. There was evidence of sex differences in many readily observable impairments, including nonverbal behaviours and conversation skills. Moreover, girls also presented with different types of obsessive interests that may be more difficult to identify as atypical. Finally, teachers expressed substantially fewer concerns for girls than for boys. Taken together, results suggest girls present with some key differences in their overt behaviours, likely making the behavioural presentation of the disorder different to what we may expect to see in cognitively-able boys with ASD.

Results showed no overall significant differences across the broad social criteria, for both DSM-IV-TR and DSM-5, supporting recent findings by Mandy, et al. ([2012](#)), who engaged a similar sample. Evidence of no significant difference is perhaps unsurprising, given all children sampled had already met DSM-IV-TR criteria for ASD. What we were more interested in, was whether sex differences would be evident in what specific behaviour impairments were (and were not) present within each criterion. These were the behaviours proposed to create an individual's overt behavioural presentation, which may impact on clinical judgement (e.g., by a medical professional or clinical psychologist) regarding whether an impairment is indeed a sign of ASD. Importantly, boys and girls reportedly suffered equally from a lack of social understanding (e.g., the ability to interpret nonverbal

cues), however the overt behaviour impairments which may influence a decision to explore a potential ASD diagnosis manifested quite differently between the sexes. Examples included girls being better able to use nonverbal gestures and engage in reciprocal conversations. Of note, for many behaviours (e.g., friendships, conversation skills, adjusting behaviour across situations) girls were more likely to fall in to the ‘somewhat’ category. As such, it was not that there was no impairment present, but that the behaviour was not as impaired as the clinician would expect for a ‘typical’ ASD impairment. Given the more ambiguous presentation of these impairments in girls, as evident in the reports of clinician’s specifically trained in making ASD diagnoses, it is likely that identifying these behaviours as signs of ASD would be even more problematic when parents express concern to general practitioners, other medical professionals, or other clinicians (e.g., clinical psychologists), not specifically trained in the diagnosis of ASD.

Results also supported the finding that, compared to boys, fewer girls with ASD presented with restricted interests and less lining up or sorting behaviours (Hartley and Sikora [2009](#); Mandy, et al. [2012](#)). In conjunction with the above discussed differences in overt social presentation, fewer restricted interests also likely play a role in making ASD more difficult to identify in girls. A major contribution of this work is its exploration of the specific types of restricted interests displayed by boys and girls. For the 89 % of boys and 58 % of girls who did present with a fixated interest, our results showed girls and boys presented with quite different types of fixations. Specifically, compared to girls, boys were more likely to demonstrate fixated interests with televisions or video games, while girls were more likely to demonstrate interests around random objects. This included animals, rocks, shells, or books. Interestingly, when the sample was split in to older and younger children, these seemingly random fixations held by many girls, remained the most common category.

There are numerous reasons why girls' restricted interests may be more difficult to identify as a sign of ASD. The idiosyncrasy of the interests of girls may indicate that the behaviour is less likely to emerge as an obvious fixation and, therefore, as an indicator of ASD (especially to a non-expert diagnostician). Further, these seemingly more random obsessions are potentially more difficult to identify as atypical (or as a sign of ASD), particularly when the girl is younger. An alternate explanation is that girls' interests are less intense or are less impairing on the daytime functioning of the girl (and their family) than boys obsessions with gaming, and are thus less likely to be expressed by parents as a concern. Consequently, there are numerous important areas for future research to explore, including whether sex differences in the intensity of obsessional interests may explain why girls' interests are more difficult to identify as atypical. Exploring whether sex differences may reflect typical sex differences in interests and exploring how these differences may impact clinical judgment also remain important areas of future investigation. In sum, while the sex ratio in the presence of restricted interests may, in part, reflect biological differences (Szatmari, et al. [2012](#)), our results suggest that at least part of this difference may be due to the current under-identification of how restricted interests manifest in girls.

Teacher Reporting

Supporting results of Mandy et al. ([2012](#)) teachers reported substantially fewer concerns with girls' behaviour than with boys. Relative to boys, girls were reported to more commonly demonstrate appropriate classroom behaviour (with less concern for their social skills and externalising behaviour). In contrast, for a high proportion of boys, externalising behaviours were a significant concern. This finding couples with evidence that boys were also more likely to have a previous ADHD diagnosis. Results add to evidence that boys with ASD present as more disruptive in a school environment, potentially making impairments more salient to teachers. Teachers were also less likely to report concerns with girls' general

social skills, conversation skills, and ability to deal with change in the classroom, compared to teachers of boys. While some of these sex differences were reflected in clinician reporting (e.g., girls being better able to engage in reciprocal conversation), the difference was of a far greater magnitude in teacher report. For example, while 17 % of girls were rated by clinicians as having seemingly typical conversation skills, for 50 % of girls teachers reported no concern with conversation skills. Given the growing body of evidence that girls with ASD present differently to boys when at school, it will now be important for research to explore why and how girls seem to be able to better manage their behaviour in this environment.

Strengths and Limitations

Data from this study were extracted from diagnostic assessments. A strength of this method is access to reports from a variety of sources (i.e., parents, clinicians and teachers), as well as access to a larger sample of cognitively-able girls with ASD. However, it is possible that some behaviours were not reported in the final report and available information, despite potentially being present. To minimise this issue, no mention of the particular behaviour was coded as missing data. As such, the behaviour was only coded if explicit reference was made to it either being present or absent. Also, we cannot rule out that reporting may have been affected by clinician expectations of what ASD should look like in girls (e.g., that they should ‘camouflage’). That said, reports were taken from extensively trained and experienced diagnostic clinicians, and included multiple sources of information (i.e., teacher, parent, clinician). Nevertheless, we would recommend that future research continues to explore the presence and absence of these behaviours through direct observational or testing methods. In particular, it will be important for researchers to begin directly assessing the underlying social and cognitive impairments in cognitively-able girls versus boys with ASD. This will assist in determining whether differences in overt behaviours are present despite girls and boys experiencing the same underlying impairments, or if girls are actually less impaired or

present with a different variant of the disorder. Moreover, further investigation of sex differences in typical development would assist in exploring whether differences from the ASD field may reflect typical sex differences, or indeed, sex differences in how girls and boys are socialised (e.g., see Escudero et al. [2013](#)).

Finally, we have argued that a particular challenge for girls with ASD may be their under-identification through the community diagnostic path, prior to the official diagnostic assessment. Specifically, we hypothesise that ASD may be less recognised when the parent presents with concerns to their family doctor, or other clinician, where resources may not be available to provide an extensive examination of underlying impairments, thus relying on behaviour presentation (where we have shown girls to be different). However, this is an avenue where further research is necessary, particularly to examine the role of clinical judgments of what ASD ‘looks-like’ and how it is identified as a potential diagnosis, long before the child undergoes a formal diagnostic assessment.

Summary

Sex differences in the overt behaviour presentation, restricted interests and school presentation of girls versus boys with ASD provides insight into why the disorder may be more difficult to detect in girls. Consequently, this research assists in beginning to form a framework for how clinician’s and researcher’s identify ASD in girls. Results have demonstrated the importance of both the understanding that girls with ASD are likely to present with less concerning behaviours in the school-environment, and that underlying impairments in social understanding may not manifest in behaviours considered typical of the male-centric presentation of ASD.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, revised* (4th ed.). Washington: Author.
- American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington: Author.
- Andersson, G. W., Gillberg, C., & Miniscalco, C. (2013). Pre-school children with suspected autism spectrum disorders: Do girls and boys have the same profiles? *Research in Developmental Disabilities, 34*, 413–422.
- Attwood, T., Grandin, T., Bolick, T., Faherty, C., Iland, L., Myers, J. M., & Wroble, M. (2006). *Asperger's and girls*. Texas: Future Horizons.
- Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in Cognitive Science, 6*, 248–254.
- Bayley, N. (2006). *Bayley scales of infant and toddler development® 3rd edition (Bayley-III®)*. San Antonio: The Psychological Corporation.
- Begeer, S., Mandell, D., Wijnker-Holmes, B., Venderbosch, S., Rem, D., Stekelenburg, F., & Koot, H. M. (2012). Sex differences in the timing of identification among children and adults with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*, 1–6.
- Dworzynski, K., Ronald, A., Bolton, P., & Happé, F. (2012). How different are girls and boys above and below the diagnostic threshold for autism spectrum disorders? *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 788–797.
- Escudero, P., Robbins, R. A., & Johnson, S. P. (2013). Sex-related preferences for real and doll faces versus real and toy objects in young infants and adults. *Journal of Experimental Child Psychology, 116*, 367–379.
- Fombonne, E. (2009). Epidemiology of pervasive developmental disorders. *Pediatric*

Research, 65, 591–598.

- Hartley, S. L., & Sikora, D. M. (2009). Sex differences in autism spectrum disorder: An examination of developmental functioning, autistic symptoms, and coexisting behavior problems in toddlers. *Journal of Autism and Developmental Disorders*, 39(12), 1715–1722.
- Lai, M. C., Lombardo, M. V., Pasco, G., Ruigrok, A. N., Wheelwright, S. J., Sadek, S. A., & Baron-Cohen, S. (2011). A behavioral comparison of male and female adults with high functioning autism spectrum conditions. *PloS One*, 6, 1–10.
- Lord, C., Schopler, E., & Revicki, D. (1982). Sex differences in autism. *Journal of Autism and Developmental Disorders*, 12, 317–330.
- Lord, C., Rutter, M., Goode, S., Heemsbergen, J., Jordan, H., & Mawhood, L. (1989). Autism diagnostic observation schedule: a standardized observation of communicative and social behavior. *Journal of Autism and Developmental Disorders*, 19, 185–212.
- Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, 24, 659–685.
- Mandy, W., Chilvers, R., Chowdhury, U., Salter, G., Seigal, A., & Skuse, D. (2012). Sex differences in autism spectrum disorder: Evidence from a large sample of children and adolescents. *Journal of Autism and Developmental Disorders*, 42, 1304–1313.
- McLennan, J. D., Lord, C., & Schopler, E. (1993). Sex differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders*, 23, 217–227.
- Rivet, T. T., & Matson, J. L. (2011). Review of gender differences in core symptomatology in autism spectrum disorders. *Research in Autism Spectrum Disorders*, 5, 957–976.
- Schopler, E., Reichler, R. J., & Renner, B. R. (1986). *The childhood autism rating scale*

- (CARS). Irvington: For diagnostic screening and classification of autism.
- Siklos, S., & Kerns, K. A. (2007). Assessing the diagnostic experiences of a small sample of parents of children with autism spectrum disorders. *Research in Developmental Disabilities, 28*, 9–22.
- Szatmari, P., Liu, X. Q., Goldberg, J., Zwaigenbaum, L., Paterson, A. D., Woodbury-Smith, M., & Thompson, A. (2012). Sex differences in repetitive stereotyped behaviors in autism: implications for genetic liability. *American Journal of Medical Genetics. Part B, Neuropsychiatric Genetics, 159*, 5–12.
- Wechsler, D. (2002). *Wechsler preschool and primary scale of intelligence™ third edition (WPPSI™-III)*: Sydney, NSW: Pearson.
- Wechsler, D. (2003). *Wechsler intelligence scale for children—fourth edition (WISC-IV)*. San Antonio: The Psychological Corporation.
- Werling, D. M., & Geschwind, D. H. (2013). Sex differences in autism spectrum disorders. *Current Opinion in Neurology, 26*, 146–153.
- Young, R. L. (2007). *Autism detection in early childhood (ADEC) manual*: ACER Press.