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Sex differences in the reciprocal behaviour of children with autism

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Abstract

Differences in the social limitations of girls compared to boys on the autism spectrum are still poorly understood. Impaired social-emotional reciprocity is a core diagnostic criterion for an autism spectrum disorder. This study compares sex differences in reciprocal behaviour in children with autism spectrum disorder (32 girls, 114 boys) and in typically developing children (24 girls, 55 boys). While children with autism spectrum disorder showed clear limitations in reciprocal behaviour compared to typically developing children, sex differences were found only in the autism spectrum disorder group: girls with autism spectrum disorder had higher reciprocity scores than boys with autism spectrum disorder. However, compared to typically developing girls, girls with autism spectrum disorder showed subtle differences in reciprocal behaviour. The sex-specific response patterns in autism spectrum disorder can inform and improve the diagnostic assessment of autism in females.

Keywords

autism, diagnostic assessment, gender, reciprocity, sex differences, social skills

Autism spectrum disorders (ASDs) are diagnosed more often among males compared to females, with a ratio of 4–5:1 (Lai et al., 2015; Mandy et al., 2012). There is no consensus on the cause of these disparities across sex, which may be due to biological factors (Wilson et al., 2016), but could also stem from females being underdiagnosed because of milder symptoms (Attwood, 2007; Dworzynski et al., 2012; Head et al., 2014; Kirkovski et al., 2013; Kopp and Gillberg, 1992), or from being overlooked during assessments due to camouflaging behaviour (Lehnhardt et al., 2016; Rynkiewicz et al., 2016). A core diagnostic criterion for an ASD diagnosis is a deficit in social-emotional reciprocity (*Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM-5; American Psychiatric Association (APA), 2013)). Deficits in reciprocity may be less prevalent in girls with ASD because symptoms could be milder, more difficult to detect or camouflaged. To enhance our understanding of sex differences in this core symptom of ASD, we analysed differences in the quality of reciprocal behaviour in girls diagnosed with ASD by comparing them to boys with ASD and to girls and boys without ASD.

Reciprocal behaviour entails the participation of a person in a dynamic process of mutual, equal or complementary social and emotional interaction and sharing with another person (Cole and Teboul, 2004; Gallagher, 2004; Gernsbacher, 2006; Komorita et al., 1992; Trevarthen and Aitken, 2001). Basic reciprocal behaviour can be learned by simply imitating the behaviour of others. At this basic level, reciprocity can be assessed by observing whether a person participates in a mutual activity (e.g. tossing a ball back and forth). At a more advanced level, reciprocal behaviour requires more than just imitating another person. It relies on interpreting the intentions of the other person and adjusting one's own plans accordingly. At this advanced level, reciprocity can be assessed by observing whether a person contributes equally to a common shared goal (e.g. alternately adding blocks while building a tower together with another person). The International Classification of Diseases Tenth Edition (ICD-10) is comprehensive in describing reciprocal impairments of ASD individuals as 'a lack of modulation of behaviour according to social context' and 'an inadequate appreciation of social-emotional

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cues' (World Health Organization (WHO), 1992: 198–199). For the assessment of subtle sex differences in ASD, impairments should ideally be measured at more advanced levels of reciprocity.

In typically developing (TD) individuals, subtle measures are also required to find sex differences in social behaviour. For instance, sex differences in social competence were minimal when based on individual observations or tests (Rose and Rudolph, 2006; Zakriski et al., 2005). However, differences did appear when styles of adaptation to social situations were considered. For instance, styles varied with the gender composition of dyads and groups: in same-sex dyads or groups, girls expressed more agreement with the partner and tended to keep the interaction going, whereas boys more often initiated plans and were more directive to their partners (Maccoby, 2002). Furthermore, males and females seem to adapt differently to social situations. For instance, in investment or dictator games, TD females showed more reciprocal styles of behaviour, whereas TD males acted more competitively (Croson and Gneezy, 2009).

In high-functioning adults with ASD, males were found to show more severe socio-communicative symptoms compared to females. ASD females were more motivated and put more effort into developing skills that help them to appear socially typical. A woman with ASD reported that she frequently imitated the speech patterns, gestures and attitudes of a popular girl in her class at school (Lai et al., 2011; Rynkiewicz et al., 2016; Wilson et al., 2016). The use of imitation in females with ASD often allows them to camouflage or hide their impairments (Attwood, 2007; Kothari et al., 2013; Lai et al., 2012; Wing, 1981). In a recent study, 10 girls with ASD (13–19 years) described sophisticated levels of peer imitation, sometimes pretending to be occupied with an activity (e.g. reading) when they were actually observing peers in order to imitate them (Thierney et al., 2016). These attempts to imitate peers were driven by a strong desire not to stand out as different to them. Copying included facial expressions, postures, tone of voice, topic of conversation or their choice of interests. The breadth of imitation was vast, and the girls went to great lengths to disguise their imitation as they were fearful of being 'caught out'. For instance, a participant told the interviewer: 'I see how other people act first and then copy them in my own way. I change it a little bit so it's not like I'm really copying them' (Thierney et al., 2016: 79).

Even young girls with ASD (age 5–10 years) were found to be better at non-verbal modes of communication (e.g. gestures) compared to boys with ASD (Rynkiewicz et al., 2016; Wilson et al., 2016). In a similar vein, normally intelligent girls with ASD outperformed boys with ASD in social skills such as generating and maintaining friendships (Head et al., 2014; Sedgewick et al., 2016) and navigating social situations (Hiller et al., 2016). Despite the suggestion that the girls with ASD outperform boys with ASD, a systematic review of studies on sex and age differences in the core features of ASD impairments showed no overall sex differences in reciprocity or reciprocity-related behaviour (Van Wijngaarden-Cremers et al., 2013). A possible explanation for the lack of findings is the strong reliance on tests that primarily focus on identifying the *presence* of reciprocal behaviour and not on analysing the *quality* of reciprocal behaviour. This may have reduced the sensitivity of previously used tests to identify more subtle sex differences in ASD.

Using sensitive tests to assess differences in the quality of social behaviour may shed light on the possibility of sex-related differences in reciprocity in ASD. The Interactive Drawing Test (IDT), a new test for reciprocity, was shown to be a valid measure of the quality of reciprocal behaviour and highly sensitive to reciprocity differences between children with and without ASD (Backer van Ommeren et al., 2012, 2015). During the IDT, the participant and the researcher jointly make a drawing. The aim of the IDT is to evaluate reciprocal behaviour; in other words, to assess whether the participant draws objects together with the researcher, in mutual collaboration, or prefers to draw his or her own objects individually. Previous studies have shown a strong preference in ASD participants to focus on their own objects and refrain from reciprocally collaborating with the researcher. In contrast, TD participants are more likely to join the researcher (Backer van Ommeren et al., 2012, 2015). The sensitivity of the IDT is largely due to the absence of explicit guidance during the test. The only verbal instruction is the remark 'we are going to draw together'. No other explanation is given before or during the test, which simply includes the researcher and the participant taking turns in spontaneously drawing new elements on a piece of paper. The IDT objectively assesses four levels (scales) of reciprocal behaviour: turn-taking (pushing and rotating the drawing paper), reciprocal interactions (drawing together), reciprocal interaction in the other's initiative (contributing to objects drawn first by the researcher) and reciprocal flexibility (accepting specific new drawing inputs of the researcher). The latter two scales (reciprocal interaction in the other's initiative and reciprocal flexibility) are considered to reflect more advanced levels of reciprocity and have been shown to be the most sensitive outcomes in previous studies (Backer van Ommeren et al., 2012, 2015). The IDT calculates the scores of all four scales and gives a total score, which reflects the overall level of reciprocal behaviour.

In this study, we examined sex differences in reciprocal behaviour of 225 cognitively able girls and boys between 6 and 18 years of age, with ASD ($n = 146$) or TD ($n = 79$). We expected that (1) girls with ASD would show reciprocal behaviour at all four IDT levels more frequently compared to boys with ASD and (2) the difference between

Table 1. Descriptives for ASD and TD boys and girls.

Child variables	ASD ($n=146$)				Typical development ($n=79$)			
	Boys ($n=114$)		Girls ($n=32$)		Boys ($n=55$)		Girls ($n=24$)	
	M (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range
Age (years)	13.3 (3.0)	6.4–18.7	14.3 (2.7)	6.9–18.4	12.0 (2.9)	6.0–17.1	10.7 (2.9)	6.2–15.0
PPVT (verbal receptive IQ)	105.5 (14.2)	64–132	99.7 (11.2)	83–119	107.7 (12.3)	77–132	104.1 (11.6)	80–125
Total SRS	86.6 (17.2)	60–133	81.3 (24.7)	23–129	35.0 (20.2)	13–111	30 (10.5)	19–43

ASD: autism spectrum disorder; PPVT: Peabody Picture Vocabulary Test; SRS: Social Responsiveness Scale.

girls with ASD or TD would be smaller than the difference between boys with ASD or TD. We specifically expected to find these patterns in the two advanced levels of reciprocity (reciprocal interaction in the other's initiative and reciprocal flexibility).

Methods

Participants

Participants comprised 146 children with ASD and 79 TD children (see Table 1). Children with ASD were recruited from special primary and secondary schools in the Amsterdam region. The TD children were recruited via public primary and secondary schools in the Amsterdam and Gelderland region. The total sample included 56 girls, 32 with ASD and 24 TD, and 169 boys, 114 with ASD and 55 TD. ASD girls ($M=14.3$, standard deviation (SD)$=2.7$) did not differ in age from ASD boys ($M=13.3$, $SD=3.0$), $F(1, 144)=2.94$, $p=0.09$, $\eta_p^2=0.02$, nor did TD girls ($M=10.7$, $SD=2.9$) from TD boys ($M=12.0$, $SD=2.9$), $F(1, 77)=3.41$, $p=0.07$, $\eta_p^2=0.04$. The estimated verbal IQ (VIQ) scores were measured using the Peabody Picture Vocabulary Test (PPVT Dutch version; Dunn and Dunn, 2004). The PPVT (verbal receptive IQ) scores of 12 participants were missing due to their absence from school when the PPVT was administered. ASD girls (VIQ $M=99.7$, $SD=11.2$) showed lower VIQ compared to ASD boys (VIQ $M=105.5$, $SD=14.2$; $F(1, 134)=4.44$, $p\leqslant 0.05$, $\eta_p^2=0.03$). TD girls (VIQ $M=104.1$, $SD=11.2$) did not differ from TD boys (VIQ $M=107.7$, $SD=12.3$) in VIQ ($F(1, 75)=1.51$, $p=0.22$, $\eta_p^2=0.02$).

Independent psychiatrists and/or psychologists, who were not involved in this research project, established the diagnoses of the ASD participants according to DSM-IV-TR criteria (*Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; APA, 2000)) prior to the recruitment. The diagnostic process included parent interviews, psychiatric examinations of the child, school observations and neuropsychological testing. In the ASD group, 19% of the 114 males and 25% of the females were diagnosed with autistic disorder, 12% of the males and 3% of the females with Asperger disorder, 53% of the males and 60% of the females with pervasive developmental disorder-not otherwise specified (PDD-NOS) and 15% of the males and 13% of the females with multiple complex developmental disorder (MCDD).

Measures

The IDT. The IDT (Backer van Ommeren et al., 2012, 2015) is a real-life test examining the reciprocal interaction between a child and a researcher while they draw together on a single piece of paper. The materials include a sheet of drawing paper (A3), markers and a video camera to record the process. The IDT is suited for a wide age range (6–18 years) and lasts approximately 10 min.

The researcher has explicit instructions to elicit reciprocal interactions and to prompt the child non-verbally to contribute meaningful elements to the drawing. The only verbal instruction includes the remark 'We are going to draw together'. Subsequently, the researcher draws a horizontal line on the paper and pushes and turns the paper to the child to indicate that it is his or her turn now. The child is free to add elements to the researcher's drawing or draw his or her own objects. The researcher and the child take turns in adding elements to the drawing, using their own coloured marker. First, the researcher draws two objects (a house and a bow). If the child adds elements to these figures (e.g. adding a door to the house), the instructor, in turn, adds other elements (e.g. adding a window). However, the child may also choose to draw his or her own object. Initially, the researcher may join the child and add elements to the objects drawn by the child. If the child draws a car, the researcher may add wheels, in line with the concept of a car. Halfway through the test, the researcher is instructed to interfere with the child's drawing by adding specific, unusual elements. These elements are designed to have a distinctive impact, for example, adding wings to a car. The researcher adds increasingly interfering elements to objects that were drawn by the child, in order to test how flexible (s)he is in coping with these unexpected turns of events. After finishing the IDT, the participant is asked to rate whether (s)he liked taking part in the drawing task on a 5-point scale (smileys) ranging from *very much* (5 points) to *not at all* (1 point).

Scoring of the IDT. All IDT interactions are videotaped to monitor all performances and to score behaviours. The number of turns is counted and used to calculate the proportion of a specific scale score in relation to the total number of turns. The IDT calculates the scores of all four scales and gives a total score.

1. *Turn-taking*. Points are awarded if the child is active in turn-taking and in copying the researcher's turn-taking behaviour. If the child only pushes the paper back after his or her turn, (s)he is awarded 1 point. If the child also rotates the paper back so the drawing faces the researcher, (s)he gets 2 points. Reciprocal turn-taking behaviour scores are computed as a proportion of the total number of turns, with higher scores reflecting more reciprocal turn-taking behaviour.
2. *Reciprocal interaction.* Each time the child collaborates with the researcher in contributing a meaningful element to a mutual object (e.g. adding a mouth to a face), (s)he scores 1 point. Reciprocal interaction scores are computed as a proportion of the total number of turns, with higher scores indicating more reciprocal interaction.
3. *Reciprocal interaction in the other's initiative*. Each time the child contributes to objects initiated by the researcher, (s)he scores 1 point. Total scores reflect the proportion of reciprocity in other's initiative relative to the total number of turns, with higher scores indicating more reciprocal interaction in the researcher's initiative.
4. *Reciprocal flexibility*. The researcher interferes with the child's drawn objects at increasing impact levels (see for details Backer van Ommeren et al., 2015). Each time the child accepts an interfering input (e.g. adding a water hose to his or her car in response to the researcher drawing a fire ladder on the child's car) (s)he is awarded 1 point. Reciprocal flexibility scores are computed as a proportion of the three specific inputs, with higher scores indicating more reciprocal flexibility.
5. *Total score*. The total reciprocity score is calculated by adding the four reciprocity scale (proportion) scores and reflects the level of reciprocal behaviour in general.

The reliability and validity of the IDT are sound, with excellent inter-rater reliability, based on intra-class correlation coefficients (ICCs) between IDT scores given by two blind, independent raters varying between 0.95 and 1.00 (1.00 for turn-taking, 0.99 for reciprocal drawing, 0.98 for reciprocal interaction in the other's initiative and 0.95 for reciprocal flexibility). Test–retest reliability was moderate to good, and criterion validity was excellent based on child and adolescent data (Backer van Ommeren et al., 2015). Indeed, all IDT scores (each of the scale scores and the total score) were independent of age and receptive vocabulary (measured with the PPVT; Dunn and Dunn, 2004), both in the total sample (age: *r*s between −0.09 and −0.05; PPVT: *r*s between 0.02 and 0.10), as well as in the separate TD (age: *r*s between −0.05 and 0.15; PPVT: *r*s between −0.02 and 0.14) and ASD (age: *r*s between 0.00 and 0.10; PPVT: *r*s between −0.03 and 0.05) samples. In contrast, strong correlations were found for IDT scores and parent-reported Social Responsiveness Scale (SRS) scores, in particular for the total score ($r=-0.42$) and for reciprocal interaction in the other's initiative ($r=-0.49$). More information on the psychometric properties of the IDT is described in a recent article (Backer van Ommeren et al., 2015).

The PPVT

The PPVT is designed as a test of receptive vocabulary achievement and verbal ability. The test consists of a series of pictures and is suitable for a wide age range (2–90 years). The participant has to match an orally given word to a picture. The total score is converted to a VIQ (Dunn and Dunn, 2004). The reliability of the PPVT tested with split–split half and test–retest administration is excellent and the construct and content validity is good (Bucik and Bucik, 2003). The validity of the PPVT is evidenced by strong correlations between PPVT scores and overall intelligence (Bell et al., 2001; Hodapp and Gerken, 1999; Maisel et al., 2014).

The SRS

The SRS measures the severity of ASD symptoms as they occur in natural social settings, with a 65-item questionnaire completed by parent or teacher. In this study, only the parent version was used. The SRS data of 24 participants (10 with ASD and 14 with TD) were missing because their parents did not return the SRS questionnaire. The SRS is widely used and found to be an effective screening instrument for ASD (Charman et al., 2007). The Dutch calibrated version of the SRS was used (Roeyers et al., 2011). Several studies have found evidence for good test–retest reliability, inter-rater reliability, construct validity, convergent validity (with the Autism Diagnostic Observations Schedule (ADOS), Autism Diagnostic Interview-Revised (ADI-R) and Social Communication Questionnaire (SCQ)) and internal consistency of the SRS (Bolte et al., 2008; Wigham et al., 2012).

Results

Evaluation of motivation in participation

The majority of the boys (88%) and girls (98%) liked IDT participation *very much* or *much*, 12% of the boys and 2%

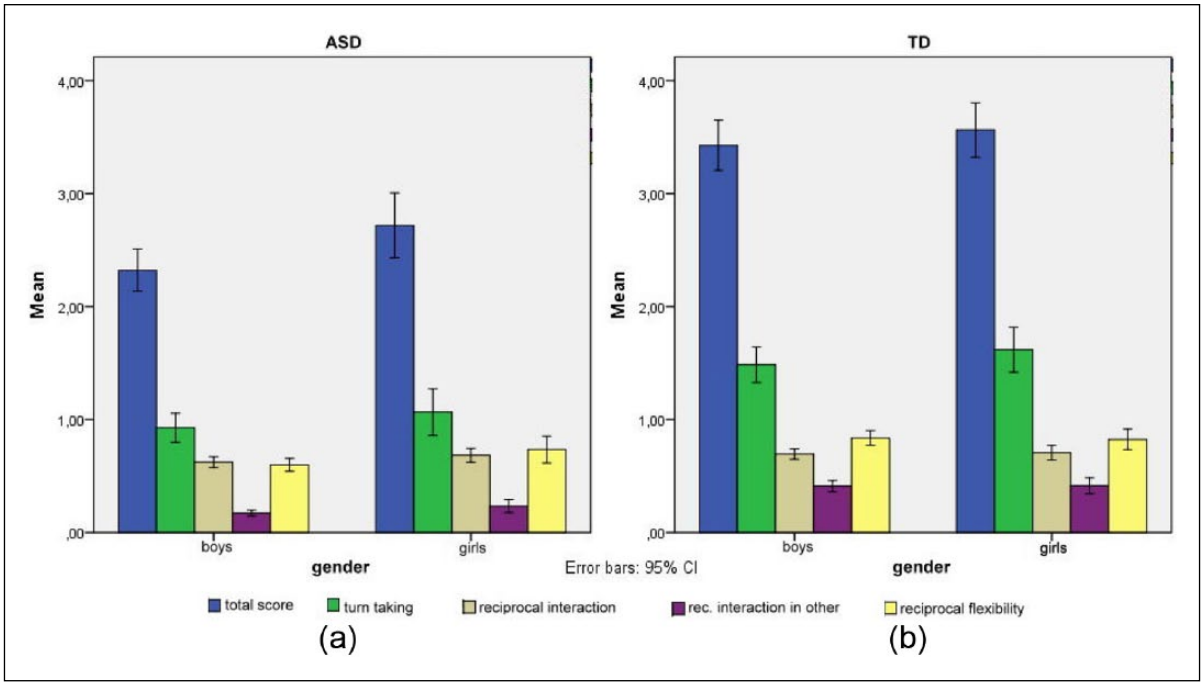

Figure 1. (a) IDT scores for ASD boys and girls separately and (b) IDT scores for TD boys and girls separately.

of the girls rated it as *neutral*, one boy did not like it *very much* and none of the participants rated it *not at all*. No associations were found between the participation ratings and any of the IDT measures.

Differences between girls and boys

As we aimed to specifically study whether girls with ASD showed more reciprocal behaviour compared to boys with ASD, we tested sex differences within each group (ASD, TD) using univariate analyses of covariance (ANCOVAs) controlling for verbal receptive IQ. Due to inadequate videotaping, we were unable to score turn-taking responses of 10 children (6 boys and 4 girls). Consequently, total IDT scores could not be computed in these cases. There were no missing data in the other four IDT scales. Tests were conducted using Bonferroni-adjusted alpha levels of 0.01 per test (0.05/5). As expected, ASD girls had higher total IDT scores, $F(1, 132)=6.46$, $p=0.01$, $\eta_p^2 = 0.05$ than ASD boys, primarily due to higher scores for reciprocal interaction in the other's initiative, $F(1, 133)=6.74$, $p=0.01$, $\eta_p^2 = 0.05$. Girls and boys with ASD scored similarly on the scales of turn-taking, $F(1, 132)=2.35$, $p=0.13$, reciprocal interaction, $F(1, 133)=3.02$, $p=0.08$, and reciprocal flexibility, $F(1, 133)=5.07$, $p=0.02$, $\eta_p^2 = 0.04$, which was not significant after Bonferroni correction. When we analysed sex differences within the separate ASD samples of children with autistic disorder, Asperger's syndrome or PDD-NOS, we found similar patterns of sex differences, with girls outperforming boys on total reciprocity and reciprocity in other's initiative.

As expected, we found no sex differences in the total IDT score in the TD group, $F(1, 66)=0.72$, $p=0.40$, or in any of the four scales: turn-taking, $F(1, 66)=1.26$, $p=0.27$, reciprocal interaction, $F(1, 74)=0.03$, $p=0.87$, reciprocal interaction in the other's initiative, $F(1, 74)=0.16$, $p=0.69$, and reciprocal flexibility, $F(1, 74)=0.02$, $p=0.89$. Adding age to the analyses did not alter the outcomes presented in Figure 1 (not inserted).

Differences within girls and boys

Within sex, group (ASD, TD) differences were tested using univariate ANCOVAs. Because ASD children were older than their TD peers, the analyses were controlled for age. Using Bonferroni correction, ASD girls showed lower total IDT scores compared to TD girls, $F(1, 49)=8.49$, $p=0.005$, $\eta_p^2 = 0.15$. They also scored lower on turn-taking, $F(1, 49)=7.90$, $p=0.007$, $\eta_p^2 = 0.14$, and reciprocal interaction in the other's initiative, $F(1, 53)=13.01$, $p=0.001$, $\eta_p^2 = 0.20$. ASD girls scored similarly to TD girls on reciprocal interaction, $F(1, 53)=0.11$, $p=0.75$, and reciprocal flexibility, $F(1, 53)=0.26$, $p=0.61$.

Compared to TD boys, ASD boys had lower total IDT scores, $F(1, 160)=49.29$, $p<0.001$, $\eta_p^2 = 0.24$. They scored lower on turn-taking, $F(1, 160)=25.97$, $p<0.001$, $\eta_p^2 = 0.14$, reciprocal interaction in the other's initiative, $F(1, 166)=96.10$, $p<0.001$, $\eta_p^2 = 0.37$, and reciprocal flexibility, $F(1, 166)=26.21$, $p<0.001$, $\eta_p^2 = 0.14$. ASD and TD boys scored similarly on reciprocal interaction, $F(1, 166)=4.80$, $p=0.03$, $\eta_p^2 = 0.03$, after Bonferroni correction. Adding verbal receptive IQ to the analyses did not alter the outcomes presented in Table 2 (not inserted).

Table 2. IDT reciprocity scores for ASD and TD, boys and girls separately.

IDT measures	ASD boys ($n = 114$)		ASD girls ($n = 32$)		Sex difference	TD boys ($n = 55$)		TD girls ($n = 24$)		Sex difference
	M (*SD*)	Range	*M* (*SD*)	Range		*M* (*SD*)	Range	*M* (*SD*)	Range	
Turn-taking	0.93 (0.69)	0–2	1.1 (0.56)	0–2	ns	1.5 (0.55)	0–2	1.6 (0.44)	0.56–2.00	ns
Reciprocal interaction	0.62 (0.25)	0–1	0.69 (0.17)	0.27–1	ns	0.71 (0.16)	0.27–1	0.71 (0.14)	0.38–0.96	ns
Reciprocal interaction in other's initiative	0.17 (0.14)	0–0.7	0.23 (0.15)	0–0.53	$p < 0.05$; $\eta_p^2 = 0.05$	0.41 (0.17)	0–0.7	0.42 (0.17)	0.07–0.82	ns
Reciprocal flexibility	0.60 (0.31)	0–1	0.74 (0.32)	0–1	$p < 0.05$; $\eta_p^2 = 0.04$	0.84 (0.22)	0–1	0.83 (0.22)	0–1	ns
Total score	2.32 (1.0)	0.17–4.27	2.72 (0.78)	0.81–3.81	$p < 0.05$; $\eta_p^2 = 0.05$	3.43 (0.77)	0.83–4.42	3.56 (0.53)	2.39–4.41	ns

ASD: autism spectrum disorder; TD: typically developing; IDT: Interactive Drawing Test; SD: standard deviation; ns: not significant.

Figure 2. (a) Drawing by a 13-year-old boy with ASD, who does not join the researcher in drawing the house and (b) drawing by a 13-year-old girl with ASD, who joins the researcher in drawing the house.

Discussion

As expected, girls with ASD showed more reciprocal behaviour than boys with ASD, in particular with respect to the more advanced ability to reciprocate the researcher's drawing actions. Figure 2(b) shows a 13-year-old girl with ASD (using the black marker) joining the researcher (using the red marker) in drawing the house, whereas Figure 2(a) shows a 13-year-old boy with ASD (using the black marker), who does not cooperate with the researcher (using the green marker) in drawing a house, but starts drawing his own objects. Importantly, no sex differences were found in the TD group at all. This indicates that boys and girls with ASD vary in the quality of reciprocal behaviour, a key diagnostic criterion for an ASD diagnosis. Girls with ASD did not differ from boys with ASD on the basic scales of turn-taking and reciprocal interactions. Their better performance at more advanced levels of reciprocity was based on their tendency to follow the researcher's initiatives and on a near-significant higher level to accept the researcher's interfering inputs in their own objects. These findings

indicate that girls with ASD may be more oriented towards responding to the researcher's input compared to boys with ASD. Girls with ASD might be more motivated than boys with ASD to participate in social interactions that include shared goals, an outcome also found in a recent study on sex differences in social motivation and friendship experiences in ASD (Sedgewick et al., 2016).

While outperforming their male ASD counterparts, girls with ASD still performed below the levels of girls with TD. They had lower total reciprocity scores, which was particularly due to less turn-taking behaviour and fewer contributions to objects initiated by the researcher, a mixture of basic and advanced reciprocity. They scored similarly on reciprocal interaction and reciprocal flexibility, indicating that they took part in the reciprocal process much like their TD peers and even showed equal levels of flexibility. Boys with ASD scored below their TD peers at all outcome levels, except on reciprocal interaction, which was not significant after Bonferroni correction. The suggestion of milder social impairments in girls than in boys with ASD (Attwood, 2007; Constantino and Charman, 2012; Kirkovski et al., 2013; Wing, 1981) is thus partly supported in our study. Compared to boys with ASD, girls with ASD showed fewer limitations and sometimes even performed on par with TD boys and girls in some aspects of reciprocal behaviour. This factor could contribute to the fact that ASD is less explicitly visible in females compared to males.

Girls with ASD do not suffer from a severe lack of reciprocity per se, but seem to lack the specific ability to contribute to another person's initiative. To clarify this point, consider the following example. A girl with ASD may start drawing an object (e.g. a tree), and when the researcher joins her by drawing some leaves on the tree, the girl may, in turn, add more leaves, thus adequately reciprocating the researcher in an object that the *girl with ASD* initiated, as she started drawing the tree. However, when the *researcher initiates* an object (e.g. a flower not yet finished), the girl with ASD may be less inclined to add elements to this object. Previous studies with the IDT have indicated that IDT scores show a strong differentiation between children and adolescents with ASD and those without ASD in their ability to reciprocate in another's initiative (Backer van Ommeren et al., 2012, 2015). This finding directs us to the importance of not only analysing a social interaction, but also identifying who initiated the interaction. Extrapolating this finding to other encounters, for example, when observing girls with ASD in social interactions with their peers (e.g. playing hide and seek), it is important to analyse who initiated this particular activity, and to what extent the girl with ASD is also able to join activities that are initiated by others.

This study has some limitations. Groups were not exactly matched in age and VIQ. Girls with ASD were older than those without ASD, and girls had a lower mean VIQ than boys. Although we did not find an effect of age or IQ on IDT performance (Backer van Ommeren et al., 2015), our girl samples were rather small and thus included a limited representation of age and IQ. However, analyses were controlled for IQ and age differences as appropriate. Another limitation was that all our researchers were female, which may have influenced sex differences, although all participants indicated that they equally appreciated the test. In addition, while children were clinically diagnosed independently from this study and the SRS confirmed their diagnosis, using the ADOS (Lord et al., 2000) would have added to the diagnostic information. Finally, interacting with peers is probably even more natural, and using children to act the part of the researcher would enhance the ecological validity of the IDT. In this line, future studies could explore sex differences in reciprocity between peers of the same or different sex.

Thierney et al. (2016) have suggested that girls with ASD are more interactive, flexible and better at imitating the social behaviour of others compared to boys with ASD. The IDT was able to detect subtle impairments of reciprocity in girls. Future studies of reciprocal behaviour with larger girl samples and focusing on interactions with peers are needed to get a full perspective of sex differences in reciprocal impairments and development in individuals with and without ASD. As the IDT does not need verbal exchanges, it is suited for testing non-native speaking children or individuals with verbal impairments and can be used in international studies. To further confirm the predictive accuracy of the IDT, a future study is required in referred samples, which have not yet been diagnosed. The outcomes can then be compared to other standardised diagnostic tests and later diagnostic outcomes, to disentangle whether subtle reciprocal behaviour may indeed provide a lead on undetected autism in girls. This will contribute to advance diagnostic assessment of ASD in girls and provide them with equal access to interventions and training programmes (Head et al., 2014).

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