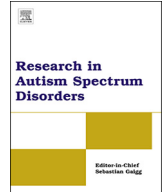




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# Research in Autism Spectrum Disorders

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## Sex differences in Sensory Features between boys and girls with Autism Spectrum Disorder

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### ABSTRACT

**Background:** Girls with Autism Spectrum Disorder (ASD) may exhibit the key diagnostic criteria for ASD differently to boys. One of those key diagnostic criteria is Restricted and Repetitive Behaviours, a subset of which is Sensory Features (SF). The current study aimed to investigate the presence of detailed sex-based differences in SF in samples of boys and girls with ASD.

**Methods:** The comparative SF profiles of an age- and IQ-matched sample of 51 boys and 51 girls aged from 6 years to 18 years with a formal diagnosis of ASD were investigated via the four Quadrants and the 14 subscale scores obtained from the Sensory Profile (SP) completed by the parents of these children.

**Results:** There was a trend for significant sex-based difference on only one of the 18 SP subscales (Sensory Processing Related to Endurance/Tone), and boys had significantly higher scores than girls on only one of the nine items comprising that subscale, which was about upon movement flexibility.

**Conclusions:** These findings suggest that sex-based differences in SF for boys and girls with ASD are yet to be determined and appear to be restricted to a relatively small section of SF behaviours related to movement. Possible explanations for these differences and implications for clinical practice are discussed.

### 1. Introduction

Reflected by its inclusion in the core diagnostic criteria for Autism Spectrum Disorder (ASD) in 2013 (APA, 2013), hyper- or hyporeactivity to sensory input or unusual interests in sensory aspects of the environment has received a good deal of attention in the literature due to the effects that these sensory features (SF) may have upon the functioning of children with ASD. For example, SF in children with an ASD has been linked with difficulties managing daily life (Kern, Trivedi, & Garver, 2006), lower participation in social, physical and related activities (Hochhauser & Engel-Yeger, 2010) and challenging behaviour in school-age (Tseng, Fu, & Cermak, 2011) and preschool age children (O'Donnell, Deitz, & Kartin, 2012). SF in children with an ASD are more intense than those in non-ASD children (Ben-Sasson, Hen, & Fluss, 2009), and may be the cause of severe stress in these children (Reynolds, Lane, & Thacker, 2011; Corbett, Schupp, & Levine, 2009; Sharpley, Bitsika, & Andronicos, 2015). However, although recognised as a major factor in the functioning of these children, SF has not been investigated for the presence of detailed differences between boys and girls with ASD, despite the suggestion that ASD symptomatology may manifest itself differently in boys than in girls (Gould & Ashton-Smith, 2011).

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The current prevalence of Autism Spectrum Disorder (ASD) includes a ratio of between 2:1 and 7:1 across boys and girls (Halliday, Bishop, & Constantino, 2015), with an average ratio of 4:1 (APA, 2013), although a recent meta-analysis of 54 studies including over 13 million participants found that the actual ratio was closer to 3:1 (Loomes, Hull, & Mandy, 2017). There is some conjecture that underlying neurobiological differences between males and females with ASD (Mottron, Duret, & Mueller, 2015) lead to differences in the way that ASD core symptomatology manifests itself in females and males (Gould & Ashton-Smith, 2011; White, Wallace, & Bascom, 2017; Lai, Lerch, & Floris, 2017). Some support for this perspective comes from a meta-analysis of 22 studies (van Wijngaarden-Cremers, van Eeten, & Broen, 2014) which found that, in general, boys showed more evidence of restricted and repetitive behaviours (which include SF) than girls but there were no significant differences in social behaviour and communication. The potential for differences in IQ to confound these results across boys and girls was also mentioned by the authors of that review.

However, other papers have reported mixed findings regarding sex differences in SF, sometimes contradictory. For example, it has been suggested that any sex differences in restricted and repetitive behaviours (including SF) in children with ASD reflect the same kinds of sex differences that may be observed in non-ASD children (Messinger, Young, & Webb, 2015; Hull, Mandy, & Petrides, 2017), and that there are genetic and neuroplasticity bases for boys to exhibit ASD symptoms more frequently and severely than girls (Mottron et al., 2015). A recent study by Frazier and Hardan (2017) found no significant differences between males and females for sensory sensitivities, but females had lower scores on sensory interests, and another study found that adult females had significantly higher 'lifetime' scores on a measure of "Shows unusual sensory responses" based upon three ADI-R (Rutter, LeCouteur, & Lord, 2003) item scores collected from caregivers (Lai, Lombardo, & Pasco, 2011). These are all key findings about the underlying nature of ASD symptom differences across sexes but none of these studies investigated SF in as great detail as is possible, in children, directly from young people with ASD (rather than their caregivers) or at the level often included in clinical assessments, thus reducing the implications of these findings for everyday practice.

In terms of measuring sex differences in SF in ASD, van Wijngaarden-Cremers et al. (2014) reported that the most common instruments used to assess ASD symptoms in sex comparison studies that they reviewed were the ADOS (Lord, Rutter, & DiLavore, 2012) and the ADI-R (Rutter et al., 2003). These are excellent instruments for the purpose of making a diagnosis of ASD, but are restricted in their attention to the specific details of SF compared to scales that are completely devoted to measuring SF. An investigation of the in-depth nature of any differences in SF across males and females with ASD might profitably use an instrument that can provide a more detailed account of the specific sensory-related behaviours of those males and females. One such instrument is the Sensory Profile (SP) (Dunn, 1999), which has been widely used in studies of SF in children with ASD.

Dunn (1999) described SF as the way people respond to sensory events being a combination of their sensory threshold (which may be high or low) and their responding strategy (passive or active). To measure these characteristics, the Sensory Profile (SP) collects data across six categories of Sensory Processing that reflect specific aspects of an individual's SF in everyday life, plus five Modulation subscales that measure the child's regulation of neural messages via inhibition or facilitation of different types of responses, and three Behavioural and Emotional subscales that indicate the behavioural outcomes of sensory processing. Results from these subscales are allocated to form four summary Quadrants of SF, named Low Registration, Sensation Seeking, Sensory Sensitivity, and Sensation Avoiding. Low Registration refers to weak physiological responses to sensory stimulation plus fast habituation to that stimulation; Sensation Seeking refers to weak physiological responses to sensory stimulation plus slow habituation to that stimulation; Sensory Sensitivity describes strong physiological responses to sensation plus slow habituation; and Sensation Avoiding describes strong physiological responses to sensation plus quick habituation (Brown, Tollefson, & Dunn, 2001).

The SP therefore provides a much more comprehensive account of sensory-related behaviours that could constitute the ASD diagnostic criteria of "Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment" (APA, 2013: p. 50) than is obtained from the ADOS-2, ADI-R, and might be valuable in measuring the detailed ways that males and females with ASD differ on their SF.

The hypothesis to be tested arose from the meta-analysis of 22 studies reported by van Wijngaarden-Cremers et al. (2014), who found that RRBs (of which SF is a subset) were more prevalent among males than females, as evidenced by a standardized mean difference of 0.19 (95% CI = .06–.32;  $p = .004$ ) for children aged 6yr to 12yr, and 0.64 (95% CI = .34–.94;  $p < .0001$ ) for those aged between 12yr and 18yr. That hypothesis was refined in this study to state that there would be a significantly higher frequency of SF-related behaviours in males than in females. The possibility of a confound due to IQ or age was reduced by restricting the sample to high-functioning children with ASD and by matching the males and females on IQ and age.

## 2. Methods

### 2.1. Participants

All participants were recruited from a local parent support group and ASD service organizations in the Gold Coast, Queensland, Australia for a study "about ASD". As such, the sample may be described as "community" rather than "clinical". There were 51 males with ASD ( $M$  age = 10.2yr,  $SD = 2.8$ yr, range to 6 to 17yr) and 51 females with ASD ( $M$  age = 10.1yr,  $SD = 2.7$ yr, range to 6 to 17yr). The males and females were formed into age- and IQ-matched pairs on a one-to-one basis so that each boy was matched with a girl whose age was within 6 months of his, and whose WASI-II Full Scale IQ score was within 5 points of his, so that there were no significant differences in either age ( $F(1,101) = .020$ ,  $p = .887$ ) or IQ (males:  $M = 97.9$ ,  $SD = 12.0$ , range = 76–125; females:  $M = 98.2$ ,  $SD = 13.1$ , range = 77–128;  $F(1,101) = .006$ ,  $p = .937$ ) between the boys' and girls' samples on these two variables.

All the children had received their original diagnosis of ASD based upon a 2-h clinical interview with their parents using the relevant DSM criteria for ASD, plus family history. These interviews were conducted by either a registered paediatrician or

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