J Autism Dev Disord (2018) 48:389–403
DOI 10.1007/s10803-017-3324-9

ORIGINAL PAPER

Profiling Autism Symptomatology: An Exploration of the Q-ASC Parental Report Scale in Capturing Sex Differences in Autism

Sarah Mae Simcoe[1,2] · Charlotte Brownlow[1] · Michelle Sarah Garnett[2] · Agnieszka Rynkiewicz[3,4,5] · Tony Attwood[2]

Published online: 20 October 2017

Abstract The Questionnaire for Autism Spectrum Conditions (Q-ASC) was developed by Attwood et al. (2011) to identify gender-sensitive profiles of autism symptomatology; prioritise and adjust the direction of clinical interventions; and support positive psychosocial outcomes and prognosis into adulthood. The current research piloted the Q-ASC with parents of 238 children with a clinical diagnosis of ASD-Level 1 (without intellectual or language impairment). Data analysis revealed eight interpretable and reliable components of the Q-ASC using Principle components analysis. Comparisons across age and gender groups found statistically significant mean differences of parent-reported characteristics. The findings from this study aim to identify improvements in the Q-ASC towards the future assessment of the sensitivity and diversity of presentations of autism among female children and adolescents.

Keywords Asperger's syndrome · Autism spectrum disorder · Symptomatology · Gender · Females · Girls · Autism spectrum conditions

✉ Charlotte Brownlow
Charlotte.Brownlow@usq.edu.au

[1] School of Psychology and Counselling, University of Southern Queensland, Toowoomba, Australia

[2] Specialist Clinic for Autism Spectrum Conditions, Minds & Hearts: A Clinic for Autism Spectrum Conditions, Brisbane, Australia

[3] Center for Diagnosis, Therapy and Education SPECTRUM ASC-MED, Gdansk, Poland

[4] Center for Diagnosis, Therapy and Education SPECTRUM ASC-MED, Rzeszow, Poland

[5] Neurodevelopmental Disorders Research Lab, Faculty of Medicine, University of Rzeszow, Rzeszow, Poland

Introduction

Autism spectrum conditions (ASC)/disorder (ASD) (henceforth 'autism') has traditionally been considered a male-dominated diagnosis, with observations of male populations primarily informing empirical research, diagnostic tools and clinical assessment protocols (Goddard et al. 2014; Taylor et al. 2016). One of the most consistent findings in the literature investigating autism is its observed occurrence four and a half times more often in males than in females (Australian Bureau of Statistics 2014; Cheslack-Postava and Jordan-Young 2012; Gould and Ashton-Smith 2011). However, there is now an emerging awareness that autism may manifest itself differently, and in some ways more subtly, in females (Dworzynski et al. 2012), and while researchers continue to question the epidemiology, prevalence, and presentation of autism (Andersson et al. 2013; Cheslack-Postava and Jordan-Young 2012; Giarelli et al. 2010), there is a growing clinical recognition that the condition may, in fact, be more common among females than previously accepted, spurring international researchers to investigate the unique and emerging female presentation of autism (Glidden et al. 2016; Rynkiewicz and Łucka 2015; Rynkiewicz et al. 2016; Zwaigenbaum et al. 2012). Increasingly, clinical perspectives have noted sex differences in patterns of autism behaviour, broadly identifying a more socially acceptable presentation in females, which may contribute to females being overlooked in a diagnostic setting (Kirkovski et al. 2013; Lai et al. 2015; Rynkiewicz et al. 2016). Although recent studies have identified differences in behavioural characteristics (Kopp and Gillberg 2011; Rynkiewicz and Łucka 2015), the research to date is yet to define or provide a systematic understanding of the female presentation (Dworzynski et al. 2012; Lai et al. 2015).

What is currently known about the female presentation of autism is largely based on qualitative studies (Bargiela et al. 2016; Cridland et al. 2014; Tierney et al. 2016), anecdotal accounts (Simone 2010; Willey 2015), and clinical observations (Attwood 2007; Chawarska et al. 2016; Dworzynski et al. 2012; Garnett et al. 2013), and these have indicated sex differences in behavioural characteristics. However, Skuse et al. (2004) have observed that characteristics such as shyness and over-sensitivity, deemed common in individuals with autism, are sometimes considered typical traits for females more generally, thus this presentation may be overlooked as clinically relevant in females with autism. Gould and Ashton-Smith (2011) further add that the general aptitude for communication and social competence noted in females on the autism spectrum may aid in masking the social impairment of their condition. Gould and Ashton-Smith also describe how, during diagnostic assessment, it was found females, rather than males, often realise their difference and carefully conceal it by deliberately mimicking the speech, mannerisms and dress of other females without a quality of feeling associated, which is common among neuro-typical non-spectrum girls. Similarly, Lai et al. (2016) found that while both men and women with autism were found to camouflage their social challenges at times, this tendency was particularly high within the female group, with significant differences reported between the men and women in the extent of camouflage use.

Using the Autism Diagnostic Observation Schedule—Revised (ADOS-2), one of the most widely-available, standardised, and empirically supported diagnostic test used to assess characteristics and assist in the diagnosis of autism (DiLavore et al. 1995), Rynkiewicz and Łucka (2015) suggested adolescent females showed a greater self-awareness and determination to learn social nuances, with additional effort made to conceal their functional deficits, in contrast to males. Additionally, by analysing behaviour from two demonstration activities in the computerized ADOS-2, Rynkiewicz et al. (2016) found that girls with autism used gestures more vividly than boys with autism and suspected this to be one component of enhanced camouflaging in females, which may pose risk of underdiagnosis or not receiving the appropriate diagnosis for this population (p. 6).

Comparatively, females reported abnormalities in sensory profile and variation in clinically co-occurring conditions (e.g., increased risk of anxiety and depression related symptoms) when compared to adolescent males with autism (Rynkiewicz and Łucka 2015). Specifically, this research reported a higher risk for adolescent females to receive an alternative diagnosis as directed by the ADOS-2 procedure, in spite of clinical presentations and developmental history suggesting autism.

To further illustrate this increased potential capacity in girls to cope with and camouflage their social confusion, several autobiographical, clinical, and research accounts have reported that girls with autism tend to observe from the periphery of play and social settings (Attwood 2007; Goddard et al. 2014; Simone 2010; Willey 2015). In particular, girls appear to analyse nuances of people's actions, emotional atmosphere, and social conventions, and imitate the most adaptive and popular individuals, including celebrities and fictional characters (Attwood 2007; Bulhak-Paterson 2015), using borrowed phrases and absorption of speech qualities (e.g., use of accents; Attwood and Grandin 2006). Calculated mimicry of these successful representations of what is considered socially acceptable helps mask their social confusion (Kopp and Gillberg 2011; Lai et al. 2015; Tierney et al. 2016). This demonstrated ability in reciprocity for girls with autism is a learned, rather than an innate process (Attwood and Grandin 2006). Female children with autism have also been shown to demonstrate an ability to decode social situations or rehearse prospective interactions during solitary play (e.g., using dolls and toys as representative objects or using their own hands to represent figures) to inform and enhance their understanding of others (Attwood and Grandin 2006; Attwood 2007; Bauminger et al. 2004). Dean et al. (2016) propose that the specific social behaviours that are associated with particular sexes result in girls with autism more effectively masking their symptoms, ultimately leading to girls on the autism spectrum being under-identified, and consequently under-supported.

Although there is consensus among clinical researchers that male and female children with autism present with shared social characteristics (Azeem et al. 2016), there is a noted sex difference in the ability to respond to the reactions of others, especially relating to a perceived impact of their communication on others. Specifically, females have been shown to apologise to recover any signs their actions may have caused offense to others, and to appease during social situations, which may contrast with their actual emotional response (Bulhak-Paterson 2015; Garnett et al. 2013). This may differentiate females with autism from current male-dominated diagnostic indicators, as parental reports are likely to interpret an apology and appeasement as socially appropriate or overlook any social inadequacies (Bargiela et al. 2016). Indeed, research by Tierney et al. (2016) found through interviews with female adolescents with autism that motivations to maintain social relationships remained high, but adolescence posed new challenges to this. One strategy identified by Tierney et al. that was used by the girls in their study was an increased use of masking and imitation in order to manage and facilitate social relationships. These researchers call for further development of gender specific assessment and support techniques.

Females with autism have also been shown to differ from males in particular diagnostic behavioural characteristics, such as special interests (Attwood 2012; Supekar and

Menon 2015). According to Attwood and Grandin (2006), unusual proficiency across talents and interests in language, music, drama, and singing may be representative of a natural ability in females with autism. Additionally, the broader research literature indicates an association between ASD and talents in a range of abilities, including music and languages (Baron-Cohen et al. 2009, 2007; Bonnel et al. 2003; O'Connor et al. 1994; Pring et al. 1995). These may serve to provide comfort and a means for social inclusion, as a function of imitation of another persona or a fake facade enacted through an established script and character profile (Ingersoll 2008). Additionally, Lai et al. (2015) report that females with autism tend to have intense interests that involve animals and people, rather than the restrictive interests on objects or specialised topics more traditionally associated with autism as derived from male samples.

Similarly, researchers have identified that girls with autism have a greater awareness of the need and desire for social interactions (Wilkinson 2008). Consistent with Wilkinson, research conducted by Rynkiewicz and Łucka (2015) found adolescent females with autism reported lower autism-related impairments in communication and gesture characteristics compared to adolescent males with autism. This suggests that detection of characteristics relating to communication and gesture deficits with autism differ between the sexes. Moreover, these findings suggest adolescent females with autism have a greater perception of self and increased ability in understanding social norms and conventions than adolescent males with autism (Rynkiewicz and Łucka 2015).

Sex Differences in Diagnostic Protocol

The early identification and accuracy in screening and diagnostic protocols of autism is a clinical priority requiring empirical attention (Attwood 2012; Chawarska et al. 2016). Increasing evidence linking early treatment to improved outcomes for children with developmental concerns emphasises the importance of accurate and timely evaluation and referral to healthcare providers (Lai et al. 2015). Qualitative differences in patterns of behaviours between males and females may not be identified in instruments lacking empirical sensitivity in capturing female characteristics of autism (Lai et al. 2015; Rynkiewicz et al. 2016), which may lead to indistinct or alternate diagnoses such as anxiety, depression, and obsessive–compulsive disorder (Giarelli et al. 2010; Gould and Ashton-Smith 2011).

The diversity of presenting symptoms in children and adolescents with autism requires psychometrically valid and reliable measures that profile autism symptomatology for females (Azeem et al. 2016; Cheslack-Postava and Jordan-Young 2012). It is expected that an increase in clinical and empirical knowledge, which recognises specific female presentations would lead to positive outcomes for females with autism (Giarelli et al. 2010; Gould and Ashton-Smith 2011). However, several studies indicate females receive a diagnosis at later ages compared to males (Andersson et al. 2013; Dworzynski et al. 2012; Giarelli et al. 2010). According to Rynkiewicz and Łucka (2015), females present clinically 3.5 years after males and receive a diagnosis of autism, on average, 5 years later than males. Similarly, Wilkinson (2010) supports previous findings and asserts that later diagnosis and misdiagnosis of autism in females leads to educational, psychological, and physical health problems during adolescence and into adulthood. To determine the detrimental impact of misdiagnosis of females with autism, recent research has detailed manifestations of exhaustion, distress, emotional instability, being teased or bullied, vulnerability during adolescence in sexual partnerships, and missing flirtatious signals leading to unsolicited physical abuse and exploitation (Cridland et al. 2014).

Of the existing and multidimensional measures used to assist in the diagnostic process for autism, the provision of an exclusive and systematic empirical measurement relating to the female presentation of autism is yet to be developed (Garnett et al. 2013; Lai et al. 2015). Currently, the first adaptations of existing diagnostic measures and screening tools are being piloted and undergoing development to fill this gap. Recently, a reliable and valid screening tool assessing a broader range of neuropsychiatric disorders, namely, the Autism Spectrum Screening Questionnaire *(*ASSQ-REV), has been revised to include an 18-item subscale (ASSQ-GIRLS), to capture features consistent with, and sensitive to, the presentation of neuropsychiatric disorders, which include autism, in females (Kopp and Gillberg 2011). Similarly, Attwood, Garnett, and Rynkiewicz (2011) have developed the Questionnaire for Autism Spectrum Conditions (Q-ASC) to address the fundamental knowledge gap in being able to identify and provide early symptom measurement for females with autism. Initially designed as the Girl's Questionnaire for Autism Spectrum Conditions (GQ-ASC), the Q-ASC is a revised version that provides the potential to identify differential autism profiles in males and females. The Q-ASC is a comprehensive 57-item parent-reported screening and clinical symptoms measure intended to identify autism behaviours and abilities in children and adolescents of both sexes, ranging in age from five to 19 years. This measure extends the use of conventional items to also include potential characteristics that are unique to the female presentation across dimensions of *Play, Friendships and Social Situations, Abilities and Interests, and Sensory Profile*. It further captures details concerning medical history to detect the presence of co-occurring conditions consistent with features of anxiety, depression, panic attacks and eating disorders. The Q-ASC has two aims: to assess the dimensions and severity of symptomatology of autism; and to

refine understandings of the female presentation of autism, enabling earlier screening and greater accuracy in symptom measurement (Attwood et al. 2011). To specifically and reliably assess the presentation of autism in females, the initial stages and item development have been constructed and generated from the extensive clinical expertise of the authors (Attwood et al. 2011), as diagnosticians, and supported by research literature and formal diagnostic criteria.

This study firstly aims to provide an exploratory and preliminary investigation of the interpretable components and confirm the internal consistency of the initial 57 items of the Q-ASC. Its aim is not to undertake a stringent validation in this first stage of research, but rather to provide a better understanding of the profiles of males and females on the autism spectrum. The second aim of this study is to assess the sensitivity and diversity of presentation for females with autism using this scale. It is hypothesised that statistically significant differences will be reported between male and female children and adolescents, with greater levels of characteristics for girls across items, as reported by parents, indicating a different pattern of reported autism symptomology between males and females.

Method

Participants

Data of anonymous parent-completed Q-ASC comprised 236 parent participants reporting on 138 boys and 98 girls, with a core clinical diagnosis of Autism Spectrum Disorder, Level 1 (ASD; $n=54$), Asperger's Syndrome (AS; $n=164$), Autism (High-Functioning[1]; $n=5$), or Pervasive Developmental Disorder (PDDNOS; $n=13$). All of the participants had children who attended a specialist clinic for autism in Australia and all had therefore received a diagnosis from either a clinical psychologist or paediatrician, reflecting current best practice standards in Australia. The ages of participants ranged from 5 to 19 years and were classified either as children (aged 5–12 years) or adolescents (aged 13–19 years). To meet eligibility for inclusion in the study, participants' parents confirmed that their child or adolescent had received a clinical diagnosis as described, and that they did not also have either a language or intellectual impairment, and were in the selected age range. In addition, children had to be attending, or have attended, a mainstream school, which in Australia, indicated that the child had not been diagnosed with an intellectual impairment. Diagnostic protocol and conferment of the current sample was deemed clinically appropriate at the expert discretion of the third and fifth authors. Data for the current study was collected via online survey software at a time after the diagnostic process was complete.

[1] The term 'high functioning' refers to an individual with autism who is verbally fluent, with average or above average intelligence.

Table 1 Participant demographic characteristics

Gender	Age group		Total
	Child	Adolescent	
Male	67	71	138
Female	48	50	98
Total	115	121	236

Table 2 Participant diagnostic data according to gender ($N=236$)

	Males ($n=138$)		Females ($n=98$)	
	n	%	*n*	%
Primary diagnosis				
Asperger's syndrome (AS)	90	65.1	74	75.1
Autism spectrum disorder (ASD)	37	26.8	17	17.3
Autism (high functioning)	4	2.9	1	1
Pervasive developmental disorder not otherwise specified (PDDNOS)	7	5.1	6	6.1
Co-occurring diagnosis[a]	138	58.47	98	41.53
Yes[b]	54	39.1	42	42.9
No	84	60.9	56	57.1

[a] $n=236$

[b] $n=$ Alternative diagnostic labels included: depression, attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), anxiety, obsessive, eating disorder (Anorexia, Bulimia) compulsive disorder (OCD)

Socio-Demographic Information

As shown in Table 1, parents completed sociodemographic information, which included participants' age (in years) and sex identification. Clinical information included additional diagnostic status (see Table 2) and special education attendance. Any children nominated as attending such a school were excluded from the study due to their co-morbid diagnosis of intellectual impairment.

Materials

Questionnaire for Autism Spectrum Conditions (Q-ASC)

The Questionnaire for Autism Spectrum Conditions (Q-ASC) is a comprehensive 57-item screening

questionnaire designed to assess parent/caregiver perceptions of behaviours and abilities in young people, aged 5–19 years, that could be associated with the characteristics of autism. In addition, the Q-ASC includes items conceptualising characteristics of the female presentation of ASD-Level 1 without language or intellectual impairment. Parents rated their level of agreement to questions and statements on a four-point response scale, ranging from 1 (*definitely disagree*) to 4 (*definitely agree*). Higher composite scores (i.e., level of agreement) on the sub-scales within the Q-ASC are indicative of greater levels of autism symptomatology. The sub-scales are conceptualised across the dimensions of *Play* (8 items; e.g., "Does or did s/he dominate when playing or talking with others"), *Friendships and Social Situations* (21 items; e.g., "Is s/he shy in social situations?"), *Abilities and Interests*, (20 items; e.g., "Is s/he interested in fiction?"), and *Sensory Profile* (8 items; e.g., "Does s/he have poor endurance and tire easily?"). The final section of the Q-ASC contained a dichotomous response format and asked parents to answer either *yes* or *no* questions related to their child's *Medical History* (4 items; e.g., "Has s/he ever presented symptoms typical for depression?"). The Q-ASC was completed as a function of an initial intake interview or sent to participating parents via an email invitation containing a weblink directing them to the secure online survey software, Survey Monkey. Participants provided informed consent by signing the research terms stated in the Minds and Hearts Information and Consent form and tacitly when completing the online survey, to indicate their understanding of details outlined on the Participant Information Sheet. The information detailed the purpose of the study, inclusion criteria, the expected time to complete the questionnaire (approximately 10 min), details of voluntary, confidential, and anonymous participation, and ability to withdraw at any time without penalty. Participants were then required to click the online survey prompt to proceed to the questionnaire. Ethics approval was additionally sought from, and granted by, the University of Southern Queensland (USQ) Human Research Ethics Committee.

Analytic Strategy

All statistical analyses were conducted in IBM SPSS Statistics Version 23. A Principle Component Analysis (PCA) and Parallel Analysis were conducted to address the first research question and investigate the interpretable and reliable factors of the 57 items in the parent-reported Q-ASC. The second research question was addressed via preliminary analysis using Analysis of Variance (ANOVA), which was conducted to examine differences between sex (male and female) and age (children aged 5–12 years and adolescents aged 13–19 years) profiles/presentations within each of the statistically interpreted components identified through the PCA.

Consistent with the recommendations of Cattell (1966), Guadagnoli and Velicer (1988), and Kline (1994), findings from the methods of PCA and exploratory factor analysis (EFA) were compared using orthogonal and oblique rotation, and generally yielded similar results. Given the likelihood in correlation among the psychological constructs investigated, an oblique rotation (Promax) method was selected to allow for this and render a more accurate component solution. For interpretability of results, the default Kappa (4) value was used (Tabachnick et al. 2001). PCA was selected as the most appropriate data reduction method due to the exploratory and preliminary nature of this investigation. Items 3, 27, and 29 were excluded from analysis due to the supplementary ordinal response 'not applicable' being a response option inconsistent with the requirements of PCA.

Comparisons of Symptomatology as a Function of Co-occurring Diagnosis

A series of 2×2 cross-tabulations and Pearson's Chi square analyses were used to analyse the medical history items to evaluate whether males and females with autism reported similar instances of anxiety, depression, panic attacks and eating disorder/s. No statistically significant associations were found between sex and typical symptomatology relating to depression (χ^2 (1, $N = 236$) = 2.15, $p = .14$), anxiety (χ^2 (1, $N = 236$) = 2.90, $p = .09$), or panic attacks (χ^2 (1, $N = 236$) = 1.17, $p = .29$). The Chi square test reported a statistical significance between sex and typical symptomatology relating to eating disorders (χ^2 (1, $N = 236$) = 10.21, $p = .001$), although the association was quite small ($\Phi = .04$, $p = .0.02$ Fisher's exact test). Thus, these areas of co-occurring symptomatology were considered equivalent and it was not necessary to include these factors as covariates in subsequent analyses.

Results

Principle Component Analysis

Data screening revealed no out of range values from the initial sample, however missing data was detected across 10 items with five participants removed due to incomplete questionnaire responses. Given the systematic nature of the remaining missing data (i.e., not missing at random with the same item on multiple participants missing), there was no requirement for imputation (Tabachnick et al. 2001). No cases were detected as residual outliers or identified as multivariate outliers, determined by Mahaloanobis' distance not exceeding critical χ^2 for $df = 56$ (at $\alpha = .001$) of 95.75.

Table 3 Summary of questionnaire items failing to meet minimum item criteria for principle components analysis

Questionnaire items		Item analysis criteria[a]
3	Does or did s/he play with the family pet/s?	Insufficient n/a response option
11	Does s/he prefer to play with younger children?	Cross-loaded > .10
12	Does s/he prefer single, close friendships?	Communalities > .30
15	Does s/he enjoy playing with the same gender?	Avoid duplication/redundancy
17	Is s/he attracted to girls or boys with strong personalities who tell him/her what to do?	Component loading < .4
24	Does s/he say they know what to do in a social situation when s/he is actually confused?	Cross-loaded > .10
27	Does s/he socialise quite well for a while, but subsequently feels exhausted?	Insufficient n/a response option
29	If age appropriate, does s/he understand the art of flirting and dating?	Insufficient n/a response option
32	Is s/he talented in art?	Cross-loaded > .10
33	Is s/he talented in mathematics?	Cross-loaded > .10
35	Does s/he write fiction?	Avoid duplication/redundancy
40	Does s/he stand out as different from peers in terms of clothing?	Component loading < .4
41	Are his/her interests advanced for their age (e.g. opera)?	Component loading < .4
42	Are his/her interests immature for their age?	Component loading < .4
43	Is s/he interested in nature?	Communalities > .30
45	Does s/he have a special interest/s related to food?	Cross-loaded > .10
46	Does s/he have an immature voice?	Component loading < .4
49	Is s/he confused about his/her sexual orientation?	Avoid redundancy/filtering for age appropriateness
55	Does s/he avoid certain sensations (e.g. distressed when his/her feet leave the ground, fear of heights, dislikes activities where his/her head is upside down)?	Communalities > .30

[a]Item analysis criteria employed (a) minimum communalities > .30 (i.e., proportion of item variance accounted for by the component); (b) minimum component loadings > .40 on any component structure, and; (c) no item loadings > .10 across two or more components (i.e., cross-loading)

Prior to running the PCA, a visual inspection of the histograms indicated that each variable appeared to be mostly normally distributed, however given the sample was derived from a clinical population, some violations of normality within reasonably acceptable limits were expected. Examination of skewness and kurtosis measures reported item 49 "Is s/he confused about his/her sexual orientation?" to be greater than the accepted ± 1.0, which deemed the normal univariate distribution for this item unacceptable, and hence it was excluded from analysis (Tabachnick et al. 2001). All other items were mostly normally distributed and within the accepted range. Given the robust nature of PCA to minor violations of normality, deviations were not considered problematic (Field 2014).

Data collected from the resultant 231 participants with the remaining pool of 53 items was subsequently examined via PCA and oblique rotation (Promax) with Kaiser normalisation. The following item analysis criteria was employed (Costello and Osborne 2005; Field 2014; Guadagnoli and Velicer 1988): (a) minimum communalities > .30 (i.e., proportion of item variance accounted for by the component); (b) minimum component loadings > .40 on any component structure, and; (c) no item loadings > .10 across two or more components (i.e., cross-loading). Several iterations were conducted with gradual removal of problematic items revealing initial PCA results with three items failing to meet the minimal criteria for the range of accepted communalities. Moreover, component loading patterns of seven items failed to meet the minimum criteria to load onto a component structure. Additionally, five items cross-loaded with less than the recommended .10 difference between two or more components. A total of 15 items were excluded from the final analysis, which resulted in a total of 38 items retained for final analysis (see Table 3).

Horn's (1965) Parallel Analysis was conducted to determine the number of components to extract, indicating an eight-component solution (Henson and Roberts 2006; Ledesma and Valero-Mora 2007; Zwick and Vellicer 1986). Table 4 displays eight components and eigenvalues greater than one reported for each, with shared common variance amongst items. Prior to rotation, communalities were reported above .3 for each item and ranged between medium (.36) to large (.71). Overall, the above indicators deemed PCA to be suitable with all 38 items (Guadagnoli and Velicer 1988).

The overall Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was .73 and above the commonly recommended value of .6 (Field 2014). Bartlett's test of sphericity was significant (χ^2 (703) = 2902.244, $p < .001$), revealing a compact pattern of correlations necessary for distinct and reliable factors to be generated.

Table 4 Summary of Eigenvalues and percentage of variance from principle components[a] for 38 items

Factor	Initial eigenvalues		
	Total	Variance (%)	Cumulative (%)
1	5.14	13.53	13.53
2	3.40	8.94	22.47
3	3.15	8.30	30.77
4	2.60	6.83	37.61
5	2.03	5.33	42.94
6	1.65	4.34	47.28
7	1.53	4.04	51.32
8	1.34	3.52	54.84

[a]Prior to rotation

After oblique rotation (Promax) was employed, suppressing values less than |.40| to aid interpretability, the resultant eight-component solution explaining 54.84% of the total variance was retained.

To further assess the relative importance of each component, examination of the scree plot depicted in Fig. 1, revealed the point of inflexion visible at component nine. According to Graham, Guthrie and Thompson (2003), this further supports a prospective cut-off for retaining factors one through eight only.

Table 5 displays the corresponding factor loadings of variables for each component and related item content. Variables were labelled according to their loading strength relative to various aspects of behaviours and abilities associated with characteristics of autism. Internal consistency for each factor was examined using Cronbach's alpha coefficients, which revealed high to low reliability ranging between α = .86 to α = .55. Component one comprised five items that represented parental perceptions of their child's characteristics and expression relating to gender incongruent behaviours. This component was labelled *Gendered Behaviour* (α = .86). The six items related to component two represented parental perceptions of their child's sensory awareness and the degree of outwardly responding to this sensory sensitivity. This component was labelled *Sensory Sensitivity* (α = .72). The five items of component three represented aspects related to parental perceptions of compliant behaviours demonstrated by their child across different contexts. This component was labelled *Compliant Behaviour* (α = .72). The five items related to component four represented parental perceptions of the degree to which their child engages in play and communication with others with an observed enjoyment and interest for friendships. This component was labelled *Friendships and Play* (α = .76). Component five comprised five items that represented parental perceptions of their child's level of masking emotional responses and expressions during social interactions. This component was labelled *Social Masking* (α = .61). The five items related to component six represented parental perceptions of their child's ability to engage in imaginative play and general interest and enjoyment for fantasy and fiction. This component was labelled *Imagination* (α = .67). The five items of component seven represented aspects related to parental perceptions of the degree to which their child exhibits imitation skills in social settings. This component was labelled *Imitation* (α = .62). The final two items included in component eight represented parental perceptions of their child's talents

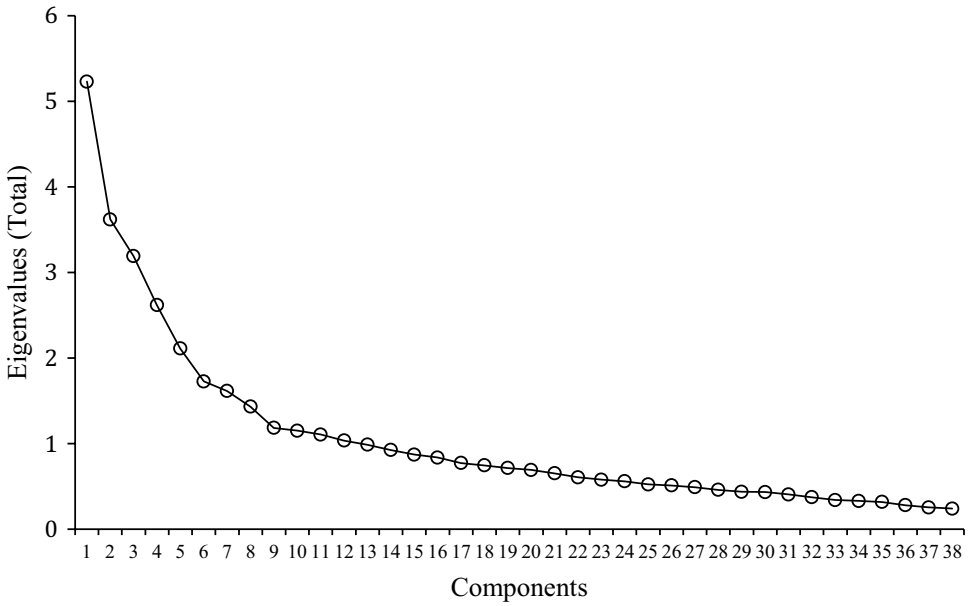

Fig. 1 Scree plot indicating extracted components and corresponding eigenvalues (*N* = 231)

Table 5 Summary of principle components analysis with oblique (Promax) rotation for 38-items

Questionnaire items		Pattern coefficient	Communalities
Component 1: gendered behaviour (5 items, α = .86)			
37	Is s/he interested in looking feminine?	.84	.72
2	Does or did s/he prefer to play with boys' toys?	.83	.69
38	Is s/he interested in looking masculine?	.81	.67
1	Does or did s/he prefer to play with girls' toys?	.80	.65
57	Does s/he like to carry an object (e.g. a favourite toy, a piece of cloth) which s/he touches or rubs to calm themselves	.69	.62
Component 2: sensory sensitivity (6 items, α = .72)			
51	Is s/he bothered by bright lights or certain kind of lights (e.g. fluorescent light)?	.74	.56
53	Does s/he have poor endurance and tire easily?	.72	.47
52	Is s/he distressed by certain smells or avoidant of certain tastes that are a part of a typical diet?	.69	.52
50	Does s/he express distress during grooming (e.g. fights or cries during fingernail cutting, haircutting, combing) or when s/he is touched (e.g. someone touches his/her feet)?	.68	.55
56	Is s/he easily distracted and cannot focus his or her attention if there is a lot of noise around?	.53	.42
54	Does s/he seek certain sensations (e.g. jumps, swings, spins, cannot sit still, fidgets, masturbates, leaves clothing twisted on body)?	.45	.47
Component 3: compliant behaviour (5 items, α = .72)			
47	Does s/he avoid complying with requests from an adult?	.79	.64
22	Is s/he well-behaved at home?	.77	.62
23	Does s/he apologise when s/he makes a social error?	.64	.49
21	Is s/he well-behaved at school?	.62	.55
48	Is s/he emotional and her reactions out of proportion?	.45	.51
Component 4: friendships & play (5 items, α = .76)			
13	Does s/he enjoy playing with others?	.78	.68
16	Does s/he enjoy playing or talking with the opposite gender?	.78	.64
44	Does or did s/he have a special interest in friendship?	.72	.60
14	Does s/he enjoy talking with others?	.62	.69
10	Does s/he have many friends?	.54	.43
Component 5: social masking (5 Items, α = .61)			
26	Do some social situations make him or her mute?	.72	.58
9	Is s/he shy in social situations?	.68	.52
25	Does s/he have a facial 'mask' that hides his/her social confusion?	.52	.49
28	Does his/her facial expression sometimes not match his/her mood, or the situation?	.47	.48
7	Does or did s/he dominate when playing or talking with others?	.46	.47
Component 6: imagination (5 items, α = .67)			
30	Did or does s/he enjoy fantasy worlds?	.78	.61
31	Is s/he interested in fiction?	.67	.54
5	Was or is his/her play as imaginative as other children's?	.66	.52
4	Does or did s/he have imaginary friends or imaginary animals?	.59	.38
6	Does or did s/he create his/her own complex 'setups' with toys?	.52	.37
Component 7: imitation (5 items, α = .62)			
19	Does s/he copy or clone him/herself on others?	.74	.60
20	Does s/he adopt a different persona in different situations?	.69	.56
18	Does s/he avidly observe others playing or socialising?	.66	.51
39	Is s/he interested in looking gender neutral?	.52	.36
8	Does or did s/he role-play the teacher or other adults in his/her solitary games?	.49	.44
Component 8: talents and interests (2 items, α = .55)			
34	Is s/he talented in music?	.83	.68

Table 5 (continued)

Questionnaire items	Pattern coefficient	Communalities
36 Is s/he talented in languages?	.70	.57

Communalities are unrotated

Table 6 Component correlations matrix using principle components and oblique (promax) rotation with Kaiser normalization

Component	1	2	3	4	5	6	7	8
1 Gender identity	1.00							
2 Sensory sensitivity	0.3	1.00						
3 Compliant behaviour	− 0.15	− 0.31	1.00					
4 Friendships & play	0.01	− 0.19	0.15	1.00				
5 Social masking	− 0.01	0.09	0.09	− 0.14	1.00			
6 Imagination	0.05	0.18	− 0.07	0.13	− 0.09	1.00		
7 Imitation	0.13	0.32	− 0.13	− 0.01	0.03	0.21	1.00	
8 Talents	0.02	0.05	− 0.02	0.11	0.13	0.13	0.11	1.00

$N = 231$

and interests. This component was labelled *Talents and Interests* ($\alpha = .55$).

Table 6 reports the correlation coefficients between each pair of the eight extracted components. No evidence of multicollinearity was shown, as weak to moderate bivariate correlations ranged between .01 and .32.

Assessing Group Differences

A 2 × 2 between groups analysis of variance (ANOVA) was used to compare the average parental responses of items within each of the eight interpreted components for males and females across age ranges 5–12 years (children) and 13–19 years (adolescents; see Table 7). Item-scores were combined into total scores for each component to examine sex and age differences within each of the clinically relevant domains. A priori power analysis was conducted using G*Power software, which showed a minimal sample size of 112 was needed for a moderate effect size ($\eta p^2 = .4$), with an alpha level of .05 and power of .95, which revealed the current sample size of 236 to be adequate (Field 2014). Data screening identified two out of range values for age from the initial sample, which were removed from analysis. Systematically missing data (i.e., not missing at random) was detected with no requirement for imputation; however, to ensure minimal loss of subjects, isolated cases with missing values were omitted from subsequent analysis, which explains the difference in total number of subjects within each of the eight components (Tabachnick et al. 2001). No residual or multivariate outliers were detected. Prior to ANOVA interpretation, Shapiro–Wilk and Levene's tests were examined to evaluate the assumptions of normality and homogeneity of variance, respectively. The Shapiro–Wilk test was significant ($p < .05$) suggesting the assumption of normality had been violated for the weighted item-scores within each component, with the exception of children within the *Social Masking* component ($p = .06$). However, visual inspection of histograms indicated each variable appeared to be mostly normally distributed, and skewness and kurtosis statistics for the distribution of scores in each component were within the accepted ± 1.0 and also appeared to be approximately normally distributed (Field 2014). As ANOVA is robust to minor violations of normality, deviations were not considered problematic (Field 2014). Further, given the exploratory function of results of the present study, generalisability is not intended and assumptions of normality and linearity may therefore be overlooked (Tabachnick et al. 2001). Standard errors are represented in the figure by the error bars attached to each value point (+ SE) in order to provide further understanding of variability within the data.

As shown in Fig. 2, *Gendered Behaviour* reported a statistically significant main effect for sex $F(1, 227) = 67.77$, $p < .001$, $\eta p^2 = .23$, with parents indicating a greater level of gendered behaviour issues for females than males. Similarly, a significant main effect was reported for age $F(1, 227) = 7.65$, $p = .006$, $\eta p^2 = .03$, with children aged 5–12 years demonstrating greater misperceptions and incongruous behaviour regarding gender than adolescents aged 13–19 years. No interaction effect was reported between age and sex $F(1, 227) = 1.831$, $p = .18$.

Sensory Sensitivity identified a statistically significant main effect for sex $F(1, 229) = 11.725$, $p < .001$, $\eta^2 = .05$,

Table 7 Means and standard deviations across age and gender groups within each component

	Male		Female	
	n	M (SD)	n	M (SD)
Gendered behaviour[a]				
5–12 years	64	11.56 (3.59)	50	16.06 (3.85)
13–19 years	70	10.90 (2.77)	47	14.13 (4.01)
Total	134	11.22 (3.20)	97	15.12 (4.02)
Sensory sensitivity[b]				
5–12 years	64	17.11 (4.24)	50	18.98 (4.05)
13–19 years	71	16.90 (3.92)	48	18.67 (3.70)
Total	135	17.00 (4.06)	98	18.83 (3.87)
Compliant behaviour[c]				
5–12 years	65	11.89 (3.40)	50	12.18 (3.01)
13–19 years	72	13.51 (3.73)	48	12.27 (3.27)
Total	137	12.74 (3.66)	98	12.22 (3.12)
Friendships & play[d]				
5–12 years	65	14.12 (3.21)	50	13.92 (2.81)
13–19 years	72	12.35 (3.38)	48	12.02 (3.13)
Total	137	13.19 (3.41)	98	12.99 (3.10)
Social masking[e]				
5–12 years	66	10.41 (3.03)	50	12.24 (2.80)
13–19 years	72	11.60 (2.75)	48	12.96 (2.89)
Total	138	11.03 (2.94)	98	12.59 (2.85)
Imagination[f]				
5–12 years	65	13.86 (3.51)	50	15.12 (3.49)
13–19 years	72	13.76 (3.66)	48	14.52 (3.49)
Total	137	13.81 (3.57)	98	14.83 (3.48)
Imitation[g]				
5–12 years	66	10.02 (3.49)	49	13.00 (2.60)
13–19 years	71	10.15 (2.94)	47	13.36 (3.07)
Total	137	10.09 (3.20)	96	13.18 (2.83)
Talents and interests[h]				
5–12 years	65	4.94 (1.49)	50	5.58 (1.60)
13–19 years	72	4.63 (1.96)	48	5.17 (2.19)
Total	137	4.77 (1.75)	98	5.38 (1.91)

[a]$N=231$, [b]$N=233$, [c]$N=235$, [d]$N=235$, [e]$N=235$, [f]$N=235$, [g]$N=233$, [h]$N=235$

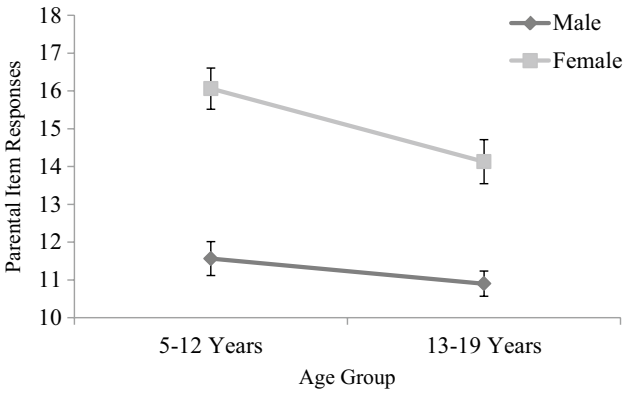

Fig. 2 Mean differences across age and gender groups within the gendered behaviour component ranging ≥ 5 ≤ 20, $N=233$

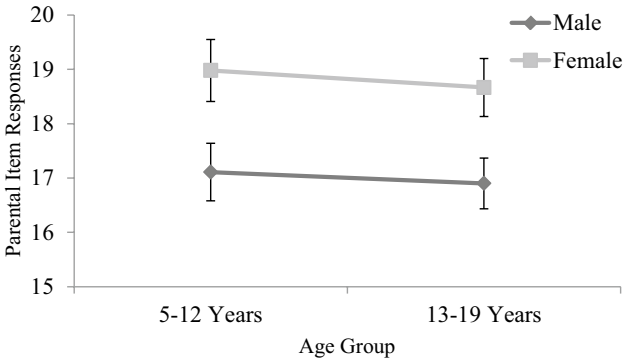

Fig. 3 Mean differences across age and gender groups within the sensory sensitivity component ranging ≥ 6 ≤ 24, $N=233$

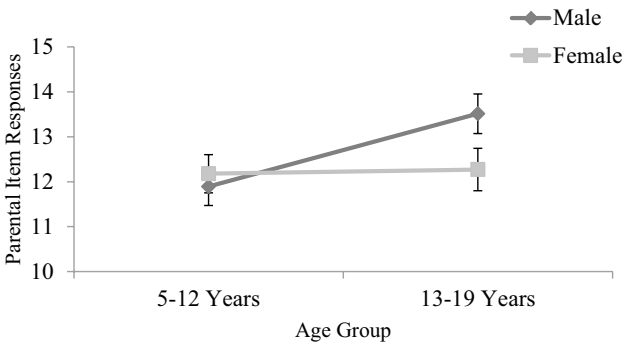

Fig. 4 Mean differences across age and gender groups within the compliant behaviour component ranging ≥ 5 ≤ 20, $N=235$

with parents indicating a greater level of sensory sensitivity characteristics for females than males. No statistically significant main effect was reported for age $F(1, 229)=.241$, $p=.62$, with consistency across children and adolescent age groups (See Fig. 3), and no interaction effect was reported between age and sex $F(1, 229)=.01$, $p=.92$.

As illustrated in Fig. 4, *Compliant Behaviour* found no statistically significant main effect for sex $F(1, 231)=1.12$, $p=.29$ or age $F(1, 231)=3.61$, $p=.06$, with parents indicating consistency in their reported level of compliant and specific behavioural characteristics observed for males and females across children and adolescent age groups. Further, no statistically significant interaction effect was reported between age and sex $F(1, 231)=2.886$, $p=.09$.

Friendships and Play identified a statistically significant main effect for age $F(1, 231)=19.20$, $p<.001$, $\eta^2=.08$, with parents reporting a lower level of demonstrated friendship and play characteristics for adolescents

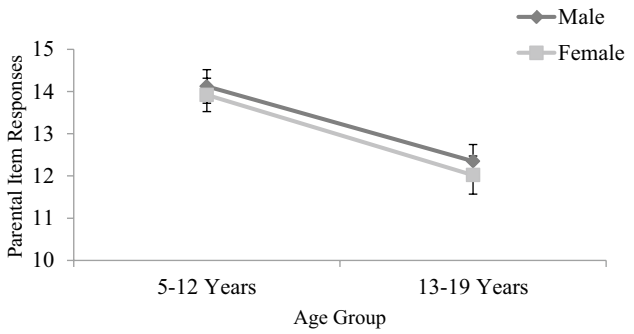

Fig. 5 Mean differences across age and gender groups within the friendships and play component ranging ≥ 5 ≤ 20, $N = 235$

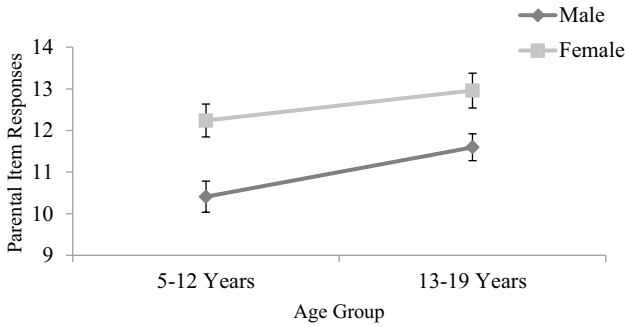

Fig. 6 Mean differences across age and gender groups within the social masking component ranging ≥ 5 ≤ 20, $N = 236$

than children. No statistically significant main effect was reported for sex $F(1, 231) = .02$, $p = .53$ with similarly reported levels of *Friendships and Play* characteristics for females and males irrespective of age (See Fig. 5). No interaction effect was reported between age and sex $F(1, 231) = .02$, $p = .88$.

As shown in Fig. 6, *Social Masking* identified a statistically significant main effect for sex $F(1, 232) = 17.70$, $p < .001$, $\eta^2 = .07$ and age $F(1, 232) = 6.32$, $p = .01$, with parents indicating a greater level of social masking characteristics for females compared to males. Additionally, statistically significant differences were noted with parents of adolescents reporting higher levels of social masking for adolescents than children. No interaction effect was reported between age and sex $F(1, 232) = .38$, $p = .54$.

As illustrated in Fig. 7, *Imagination* indicated a statistically significant main effect for sex $F(1,226) = 4.61$, $p = .03$, $\eta^2 = .02$, with parents indicating a greater level of interest in the use of imagination characteristics for females compared to males. No statistically significant main effect was reported for age $F(1,226) = .55$, $p = .46$, with consistency of interest in imagination across children and adolescent age groups. Further, no interaction effect was reported between age and sex $F(1, 226) = .29$, $p = .59$.

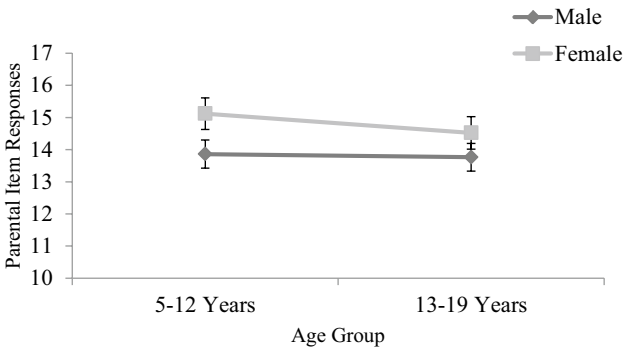

Fig. 7 Mean differences across age and gender groups within the imagination component ranging ≥ 5 ≤ 20, $N = 235$

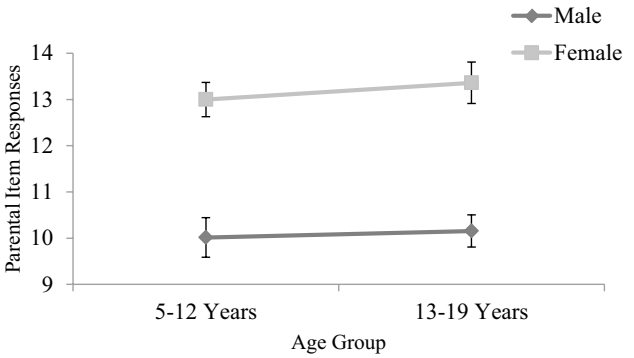

Fig. 8 Mean differences across age and gender groups within the imitation component ranging ≥ 5 ≤ 20, $N = 233$

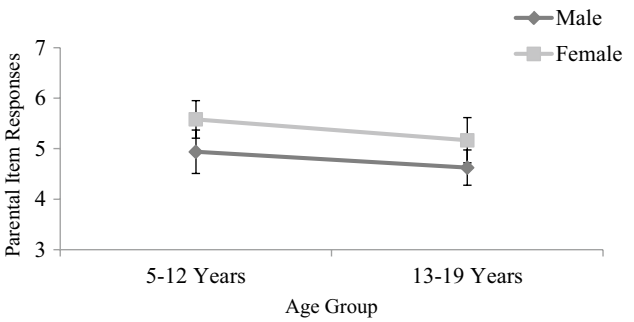

Fig. 9 Mean differences across age and gender groups within the talents and interests component ranging ≥ 2 ≤ 8, $N = 233$

Imitation indicated a statistically significant main effect for sex $F(1, 227) = 57.49$, $p < .001$, $\eta^2 = .20$, with parents indicating a greater level of demonstrated characteristics involving imitation for females than males. No statistically significant main effect was reported for age $F(1, 226) = .377$, $p = .54$, with imitation reported consistently across children and adolescent age groups (See Fig. 8). Further, no interaction effect was reported between age and sex $F(1, 226) = .07$, $p = .79$.

As shown in Fig. 9, *Talents and Interests* indicated a statistically significant main effect for sex $F(1, 231) = 6.026$, $p = .02$, $\eta p^2 = .03$, with parents indicating a greater level of appeal for certain talents and interests in females compared to males. No statistically significant main effect was reported for age $F(1, 231) = 2.274$, $p = .13$, with consistency reported across children and adolescent age groups. No interaction effect was reported between age and sex $F(1, 231) = .04$, $p = .84$.

Discussion

Given the evidence that there is increasing acceptance that autism may present differently in females than in males (Attwood and Grandin 2006; Chawarska et al. 2016; Cridland et al. 2014; Dworzynski et al. 2012; Garnett et al. 2013; Wilkinson 2008), the aim of this study was to conduct an exploratory investigation of presenting autism characteristics within a clinical setting, with a focus on refining a preliminary profile for female children and adolescents with autism. The first research question aimed to investigate the interpretable components and confirm the internal consistency of the 57-items comprising the parent-report questionnaire intended to identify behaviours and abilities that are characteristic of autism in children and adolescents, ranging in age from 5 to 19 years. This was examined through PCA and for the current research the eight-component solution was retained comprising *gendered behaviour, sensory sensitivity, compliant behaviour, friendships and play, social masking, imagination, imitation*, and *talents and interests*. The resultant components varied and extended from the original four Q-ASC conceptual constructs of *play, friendships and social situations, abilities and interests*, and *sensory profile*. The magnitude of the eigenvalues for *imagination, imitation* and *talents and interests* failed to explain sufficient variance for them to be considered useful components in measuring behavioural characteristics for children and adolescents with autism in this study. Although *talents and interests* showed high loading patterns, it comprised only two items and reported a moderate internal consistency, indicating this component fails to reliably reflect the talent and interest characteristics of autism for this clinical population. This indicates the need for further item refinement or redevelopment for this component. In addition, the item "Does or did s/he dominate when playing or talking with others?" on *social masking* did not contribute meaningfully to internal consistency and due to the semantic difference of the item's wording, away from other items describing *social masking* behaviours, it is recommended to either discard the extracted item from future analyses or restructure the wording to remain consistent in framing with other items. This would reduce the *social masking* component to four items.

Finally, in the interest of improving the utility of the current measure, it is recommended that a greater number of items be developed to equally represent, and adequately measure, associated characteristics in children and adolescents with autism. In particular, within *talents and interests*, further assessment of the measurement and meaningful contribution of talents characteristic of children and adolescents with autism is warranted. Such further validation would then necessarily draw on assessing the ability of the scale to accurately discriminate between the behaviours of an autistic and non-autistic sample in order to build upon the findings of this exploratory study.

The second research question investigated parent-reported differences in male and female children and adolescents across the eight interpretable components. Although no interaction effects were evident for age and sex across any of the eight variables, results supported the hypothesis that significant sex differences were found within the majority of clinically relevant domains and noted differences identified across children and adolescent age groups. Specifically, parents reported a greater level of observed characteristics associated with *gendered behavior* issues, *sensory sensitivity, social masking*, use of *imagination, imitation* characteristics, and appeal of certain *talents and interests* in females compared to males. This is consistent with the previous findings of Rynkiewicz and Łucka (2015) and McLennan et al. (1993), demonstrating females with autism reported lower levels of social communication deficits compared to males with autism. This study also supports previous findings by Knickmeyer et al. (2008) and Williams et al. (2008) that imply greater effort and ability in social communication is present for females with autism, while still acknowledging the challenges females with autism experience in social settings compared to males with autism and non-spectrum neurotypical females.

Further, results demonstrated differences in age ranges with parents reporting a greater level of observed incongruence in gendered behaviour for their children aged 5–12 years, than adolescents aged 13–19 years. Consistent with Glidden et al. (2016) findings imply individualised expression may be more accepted among adolescents than child groups, with an increased expectation of stereotyped gender congruence in early years (Glidden et al. 2016). In contrast, parents in the current study reported lower levels of *friendships and play* characteristics for adolescents in comparison to the younger age group. These results are consistent with previous findings that suggest as individuals with autism enter high school, they tend to become more aware of social differences and accommodate towards fewer friendship-based activities, enhanced focus on special interests, and avoidance of potential peer-related maltreatment (Cridland et al. 2013).

There is also a greater complexity and subtlety in friendship and interactions that cannot easily be observed and analysed (Attwood 2007; Bargiela et al. 2016). These results show consistency of parent reports with previous findings by Hartley and Sikora (2009) reporting increased difficulties during adolescence for females with autism, specifically relating to peer relationships. Parents indicated a consistency in the level of *compliance behaviours* for both males and females across child and adolescent age groups, which suggests, on average, expressions of behaviours at home and school, apologising with social errors, complying with requests from adults and emotional reactivity are similar for both sexes. This is an unexpected finding, as previous clinical accounts suggest a variance in presentations, with greater externalised behaviours seen in females with autism at home, compared to school (Bulhak-Paterson 2015; Willey 2015).

Strengths, Limitations and Future Directions

This study drew on parent perspectives of their child's presentation of autism; however, additional perspectives may also be needed to further strengthen the work drawing on the perspectives of other significant individuals such as educators, doctors, extended family members, and direct accounts from individuals with autism. To improve the sensitivity and accuracy in identifying clinically relevant patterns and profiles of strengths and weaknesses across behavioural domains, it is suggested that future research expose items to the scrutiny and perspective of parents, caregivers and individuals with autism, via qualitative investigation to provide a mixed-methods investigation, and future longitudinal research is recommended to provide a greater sensitivity and accuracy, and retrospective accounts of female presentation across adolescents from adulthood, and from a variety of community and clinical settings.

Future research directions include the refinement of the item wordings and response formats, for example the use of the word 'play' in items that describe the behaviours of both children and adolescents may require some clarification. As social and contextual environments implicate behavioural presentation for females with autism, it is suggested item development include a brief example to prime and guide the respondent (e.g., a birthday party, classroom, at home). Finally, we would recommend that the instrument be further compared between autistic and neurotypical individuals, capturing a broader range of demographic variables, such as SES and ethnicity, to ensure that the effects of normative gender differences are accounted for.

Despite these limitations the Q-ASC will be of considerable value to diagnosticians in terms of exploring the way autism can be expressed differently in girls. For example, discovering the use of imitation, social masking, and/or use of imagination at the outset of a diagnostic assessment will encourage the diagnostician to assess social capacity at deeper levels than the persona presented in the clinic room or at school. Deeper enquiry will lead to greater confidence in confirming the diagnosis and access to appropriate understanding and support. Discovering and assessing gendered behavior earlier will be of assistance in providing support to both the girl and her family to foster a positive sense of self identity. Further refining the scale would therefore enable a fuller understanding of specific challenges for females on the autism spectrum in order to better profile and more sensitively capture characteristics which may be specific to this population. We would anticipate that this would lead to greater specificity in clinical interventions and consequent outcomes.

Conclusion

In summary, the current results present preliminary evidence and support for the use of an instrument, such as the Q-ASC, to discriminate across subtle sex differences in socio-behavioural characteristics. It is important to note that the current study did not aim to psychometrically validate the Q-ASC as either a screening or diagnostic tool. Instead, this study represents an exploratory and systematic review of potential sex differences in children and adolescents diagnosed with ASD-Level 1, with meaningful differences noted. The results of this study support previous autobiographical, anecdotal, and clinical observations to suggest important practical and clinical significance in understanding the difference in autism characteristics between boys and girls. Specifically, the parental observations of autism characteristics in the current study provide empirical and preliminary evidence to suggest specific behavioural domains for a female presentation of autism. Further investigation and refinement of the Q-ASC is warranted to better understand the subtler complexity of presentation and specific needs of girls with autism for the purpose of both accurate detection and targeted intervention. For example, understanding that females on the autism spectrum tend to use social masking, imitation and imagination more than males on the spectrum points to specific cognitive strategies and compensatory mechanisms that can be further enhanced and understood in therapy.

Author Contributions SMS, MG, TA, and CB designed the study. MG, TA and AR designed the original measure. MG and TA collected the data. SMS and CB analysed the data, and initially drafted the manuscript. All authors revised, developed, read and approved the final manuscript.

Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

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*(1), 413–422. doi:10.1016/j.ridd.2012.08.025.

Attwood, T. (2007). *The complete guide to Asperger's syndrome*. London: Jessica Kingsley Publishers.

Attwood, T. (2012). Girls and women who have Asperger's syndrome. In *Safety skills for Asperger women: How to save a perfectly good female life*. London: Jessica Kingsley Publishers.

Attwood, T., Garnett, M. S., & Rynkiewicz, A. (2011). *Questionnaire for Autism Spectrum Conditions (Q-ASC)* [Measurement instrument].

Attwood, T., & Grandin, T. (2006). *Asperger's and girls: World-renowned experts join those with asperger's syndrome to resolve issues that girls and women face every day!* Arlington, TX: Future Horizons.

Australian Bureau of Statistics. (2014). Autism in Australia 2012, Canberra: Australian Bureau of Statistics.

Azeem, M. W., Imran, N., & Khawaja, I. S. (2016). Autism spectrum disorder: An update. *Psychiatric Annals, 46*(1), 58–62. doi:10.3928/00485713-20151202-01.

Bargiela, S., Steward, R., & Mandy, W. (2016). The experiences of late-diagnosed women with autism spectrum conditions: An investigation of the female autism phenotype. *Journal of Autism and Developmental Disorders, 46*(10), 3281–3294. doi:10.1007/s10803-016-2872-8.

Baron-Cohen, S., Ashwin, E., Ashwin, C., Tavassoli, T., & Chakrabarti, B. (2009). Talent in autism: Hyper-systemizing, hyper-attention to detail and sensory hypersensitivity. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1522), 1377–1383.

Baron-Cohen, S., Wheelwright, S., Burtenshaw, A., & Hobson, E. (2007). Mathematical talent is linked to autism. *Human Nature, 18*(2), 125–131.

Bauminger, N., Shulman, C., & Agam, G. (2004). The link between perceptions of self and of social relationships in high-functioning children with autism. *Journal of Developmental and Physical Disabilities, 16*(2), 193–214. doi:10.1023/B:JODD.0000026616.24896.c8.

Bonnel, A., Mottron, L., Peretz, I., Trudel, M., Gallun, E., & Bonnel, A. M. (2003). Enhanced pitch sensitivity in individuals with autism: A signal detection analysis. *Journal of Cognitive Neuroscience, 15*(2), 226–235.

Bulhak-Paterson, D. (2015). *I am an Aspie girl: A book for young girls with autism spectrum conditions*. London: Jessica Kingsley Publishers.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*(2), 245–276.

Chawarska, K., Macari, S., Powell, K., DiNicola, L., & Shic, F. (2016). Enhanced social attention in female infant siblings at risk for autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 55*(3), 188–195. Retrieved from https://www-clinicalkey-comau.ezproxy.usq.edu.au.

Cheslack-Postava, K., & Jordan-Young, R. M. (2012). Autism spectrum disorders: Toward a gendered embodiment model. *Social Science & Medicine, 74*(11), 1667–1674. doi:10.1016/j.socscimed.2011.06.013.

Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analyses: Four recommendations for getting the most from your analysis. *Practical Assessment, Research & Evaluation, 10*(7), 173–178.

Cridland, E. K., Jones, S. C., Caputi, P., & Magee, C. A. (2014). Being a girl in a boys' world: Investigating the experiences of girls with autism spectrum disorders during adolescence. *Journal of Autism and Developmental Disorders, 44*(6), 1261–1274. doi:10.1007/s10803-013-1985-6.

Dean, M., Harwood, R., & Kasari, C. (2016). The art of camouflage: Gender differences in the social behaviors of girls and boys with autism spectrum disorder. *Autism: The International Journal of Research and Practice*. doi:10.1177/1362361316671845.

DiLavore, P. C., Lord, C., & Rutter, M. (1995). The pre-linguistic autism diagnostic observation schedule. *Journal of Autism and Developmental Disorders, 25*(4), 355–379. Retrieved from http://ezproxy.usq.edu.au.

Dworzynski, K., Ronald, A., Bolton, P., & Happe, 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 and Adolescent Psychiatry, 51*(8), 788–797. Retrieved from https://www-clinicalkey-com-au.ezproxy.usq.edu.au.

Field, A. (2014). *Discovering statistics using IBM SPSS statistics* (4th ed.). London: Sage.

Garnett, M. S., Attwood, T., Peterson, C., & Kelly, A. B. (2013). Autism spectrum conditions among children and adolescents: A new profiling tool. *Australian Journal of Psychology, 65*(4), 206–213. doi:10.1111/ajpy.12022.

Giarelli, E., Wiggins, L. D., Rice, C. E., Levy, S. E., Kirby, R. S., Pinto-Martin, J., & Mandell, D. (2010). Sex differences in the evaluation and diagnosis of autism spectrum disorders among children. *Disability and Health Journal, 3*(2), 107–116. doi:10.1016/j.dhjo.2009.07.001.

Glidden, D., Bouman, W. P., Jones, B. A., & Arcelus, J. (2016). Gender dysphoria and autism spectrum disorder: A systematic review of the literature. *Sexual Medicine Reviews, 4*(1), 3–14. doi:10.1016/j.sxmr.2015.10.003.

Goddard, L., Dritschel, B., & Howlin, P. (2014). A preliminary study of gender differences in autobiographical memory in children with an autism spectrum disorder. *Journal of Autism and Developmental Disorders, 44*(9), 2087–2095. doi:10.1007/s10803-014-2109-7.

Gould, J., & Ashton-Smith, J. (2011). Missed diagnosis or misdiagnosis? Girls and women on the autism spectrum. *Good Autism Practice (GAP), 12*(1), 34–41.

Graham, J. M., Guthrie, A. C., & Thompson, B. (2003). Consequences of not interpreting structure coefficients in published CFA research: A reminder. *Structural Equation Modeling, 10*(1), 142–153. doi:10.1207/S15328007SEM1001_7.

Guadagnoli, E., & Velicer, W. F. (1988). Relation to sample size to the stability of component patterns. *Psychological Bulletin, 103*(2), 265–275. doi:10.1037//0033-2909.103.2.26.

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. doi:10.1007/s10803-009-0810-8.

Henson, R. K., & Roberts, J. K. (2006). Use of exploratory factor analysis in published research common errors and some comment on improved practice. *Educational and Psychological Measurement, 66*(3), 393–416. doi:10.1177/0013164405282485.

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 30*(2), 179–185. doi:10.1007/BF02289447.

Ingersoll, B. (2008). The social role of imitation in autism: Implications for the treatment of imitation deficits. *Infants & Young Children, 21*(2), 107–119. doi:10.1097/01.IYC.0000314482.24087.14.

Kirkovski, M., Fitzgerald, P., & Enticott, P. (2013). A review of the role of female gender in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 43*(11), 2584–2603. doi:10.1007/s10803-013-1811-1.

Kline, P. (1994). An easy guide to factor analysis. New York: Routledge.

Knickmeyer, R. C., Wheelwright, S., & Baron-Cohen, S. B. (2008). Sex-typical play: Masculinization/defeminization in girls with an autism spectrum condition. *Journal of autism and developmental disorders, 38*(6), 1028–1035. doi:10.1093/brain/awt216.

Kopp, S., & Gillberg, C. (2011). The autism spectrum screening questionnaire (ASSQ)-Revised Extended Version (ASSQ-REV): An instrument for better capturing the autism phenotype in girls? A preliminary study involving 191 clinical cases and community controls. *Research in Developmental Disabilities, 32*(6), 2875–2888. doi:10.1016/j.ridd.2011.05.017.

Lai, M. C., Lombardo, M. V., Auyeung, B., Chakrabarti, B., & Baron-Cohen, S. (2015). Sex/gender differences and autism: Setting the scene for future research. *Journal of the American Academy of Child & Adolescent Psychiatry, 54*(1), 11–24. Retrieved from https://www-clinicalkey-com-au.ezproxy.usq.edu.au.

Lai, M. C., Lombardo, M. V., Ruigrok, A. N., Chakrabarti, B., Auyeung, B., Szatmari, P., Happe, F., & Baron-Cohen, S. (2016). Quantifying and exploring camouflaging in men and women with autism. *Autism: The International Journal of Research and Practice*. doi:10.1177/1362361316671012.

Ledesma, R. D., & Valero-Mora, P. (2007). Determining the number of factors to retain in EFA: An easy-to-use computer program for carrying out parallel analysis. *Practical Assessment, Research & Evaluation, 12*(2), 1–11. Retrieved from http://pareonline.net/getvn.asp?v=12&n=2.

McLennan, J. D., Lord, C., & Schopler, E. (1993). Sex differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders, 23*(2), 217–227. doi:10.1007/BF01046216.

O'Connor, N., Smith, N., Frith, C., & Tsimpli, I. M. (1994). Neuropsychology and linguistic talent. *Journal of Neurolinguistics, 8*(2), 95–107.

Pring, L., Hermelin, B., & Heavey, L. (1995). Savants, Segments, Art and Autism. *Journal of Child Psychology and Psychiatry, 36*(6), 1065–1076. doi:10.1111/j.1469-7610.1995.tb01351.x.

Rynkiewicz, A., & Łucka, I. (2015). Autism spectrum disorder (ASD) in girls. Co-occurring psychopathology. Sex differences in clinical manifestation. *Psychiatria Polska ONLINE FIRST*. doi:10.12740/PP/OnlineFirst/58837.

Rynkiewicz, A., Schuller, B., Marchi, E., Piana, S., Camurri, A., Lassalle, A., & Baron-Cohen, S. (2016). An investigation of the 'female camouflage effect' in autism using a computerized ADOS-2, and a test of sex/gender differences. *Molecular Autism, 7*(1), 10. doi:10.1186/s13229-016-0073-0.

Simone, R. (2010). *Aspergirls: Empowering females with Asperger syndrome*. London: Jessica Kingsley Publishers.

Skuse, D., Warrington, R., Bishop, D., Chowdhury, U., Lau, J., Mandy, W., & Place, M. (2004). The developmental, dimensional and diagnostic interview: A novel computerized assessment for autism spectrum disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 43*(5), 548–558. doi:10.1097/01.chi.0000117041.35450.2d.

Supekar, K., & Menon, V. (2015). Sex differences in structural organization of motor systems and their dissociable links with repetitive/restricted behaviors in children with autism. *Molecular Autism, 6*(1), 1. doi:10.1186/s13229-015-0042.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). *Using multivariate statistics* (6th ed.). Boston: Pearson.

Taylor, L., Brown, P., Eapen, V., Midford, S., Paynter, J., Quarmby, L., …, Whitehouse, A. (2016). *Autism spectrum disorder diagnosis in Australia: Are we meeting best practice standards*. Brisbane: Autism Co-operative Research Centre.

Tierney, S., Burns, J., & Kilbey, E. (2016). Looking behind the mask: Social coping strategies of girls on the autistic spectrum. *Research in Autism Spectrum Disorders, 23*, 73–83.

Wilkinson, L. A. (2008). The gender gap in asperger syndrome: Where are the girls? *Teaching Exceptional Children Plus, 4*(4), 2–9. Retrieved from:http://escholarship.bc.edu/education/tecplus.

Willey, L. H. (2015). *Pretending to be normal: Living with Asperger's syndrome (autism spectrum disorder) expanded edition*. London: Jessica Kingsley Publishers.

Zwaigenbaum, L., Bryson, S. E., Szatmari, P., Brian, J., Smith, I. M., Roberts, W., … & Roncadin, C. (2012). Sex differences in children with autism spectrum disorder identified within a high-risk infant cohort. *Journal of Autism and Developmental Disorders, 42*(12), 2585–2596. doi:10.1007/s10803-012-1515-y.

Zwick, W. R., & Velicer, W. F. (1986). Comparison of five rules for determining the number of components to retain. *Psychological Bulletin, 99*(3), 432. doi:10.1037/0033-2909.99.3.432.