EXPLORING THE RELATIONSHIP BETWEEN ANXIETY AND SOCIAL FUNCTIONING IN YOUTH WITH AUTISM SPECTRUM DISORDER

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Abstract

Recent systematic reviews and meta-analyses reveal that psychiatric comorbidities are highly prevalent in youth with Autism Spectrum Disorder (ASD), particularly anxiety disorders. Given the high prevalence of anxiety among this population, recent research has focused on investigating potential mechanisms underpinning anxiety. The purpose of the current study was to examine the relationship between anxiety and social functioning in youth with ASD as well as the moderating influence of sex, age, and IQ. The current study involved secondary data analysis, using data from the Simons Simplex Collection (SSC) dataset of the Simons Foundation for Autism Research Initiative (SFARI). The sample included 2,856 individuals aged 4 to 18. Overall, anxiety rates were around 38% in this population and similar across parent and teacher reports. Based on both parent and teacher data, social functioning accounted for a substantial portion of the variance in anxiety, controlling for age, sex, and IQ (17% for parent report and 15% for teacher report). The addition of social functioning domains (social awareness, social cognition, social communication, social motivation, and restricted interests and repetitive behaviours) to the hierarchical regression models accounted for more of the variance in anxiety, controlling for age, sex, and IQ (24% for parent report and 27% for teacher report). All five social functioning domains were significant predictors of anxiety. For parent data, IQ was found to moderate the relationship between anxiety and social functioning, suggesting that when social functioning is low, youth without Intellectual Disability (ID) show higher anxiety than youth with ID. Limitations and future directions for the research are discussed. It is hoped that these results will assist in identifying at-risk youth and developing preventive therapeutic and school-based interventions.

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Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder typically diagnosed in early childhood, characterized by social communication and social reciprocity deficits and repetitive or stereotyped behaviours (American Psychological Association [APA], 2013). The most recent estimate of the prevalence of ASD is 1 in 68 children or approximately 1.5% of children (Baio, 2014; Ofner et al., 2018). The diversity among youth with ASD poses a challenge for clinicians when making decisions regarding diagnoses and intervention options. The wide range of IQ and the presence of physical and psychiatric comorbidities in ASD also contributes to diagnostic difficulties (Bellini, 2004). Recent systematic reviews and meta-analyses reveal that psychiatric comorbidities, such as anxiety, are highly prevalent in youth with ASD (Lai et al., 2019; van Steensel et al., 2011; van Steensel & Heeman, 2017).

Prevalence of Anxiety in ASD

According to Gjevik et al. (2011), approximately 72% of youth with ASD have at least one comorbid psychiatric disorder and 30% have two or more. Among the most prevalent psychiatric comorbidities are anxiety disorders. Lai et al. (2019) conducted a meta-analysis to determine “best estimates” of various psychiatric comorbidities in ASD and found that the prevalence of anxiety disorders was 23%, which is relatively high compared to prevalence estimates in the general population (ranging from 3-18%). Further, van Steensel et al. (2011) conducted a meta-analysis to estimate the prevalence of anxiety disorders specifically in youth with ASD. Across the 31 studies that included 2,121 youth with ASD, 39.6% had at least one comorbid anxiety disorder. This prevalence rate is substantially higher than the reported 27% among typically developing children (van Steensel et al., 2011).

Reported prevalence rates of anxiety in youth with ASD vary greatly. There are a number of reasons that may account for the observed prevalence variation in the literature (Lai et al., 2019; van Steensel et al., 2011; van Steensel & Heeman, 2017; Vasa & Mazurek, 2015). First, the prevalence variation may result from the difficulty distinguishing anxiety symptoms from ASD symptoms. For example, obsessive behaviours associated with Obsessive-Compulsive Disorder may be difficult to distinguish from repetitive behaviours associated with ASD (Keen et al., 2019). Also, "diagnostic overshadowing" may result in anxiety symptoms being overlooked or misattributed to the ASD.

Second, the prevalence variation may result from sample heterogeneity. There is variation in the samples studied, particularly in terms of age, sex, and IQ. For example, some studies examining the comorbidity of ASD and anxiety exclude individuals with lower IQ scores, children under 6 years old, and adolescents over 15 years old (van Steensel & Heeman, 2017). ASD is more prevalent in males and therefore, many studies do not have a large sample of females. Given the observed variation in prevalence rates of anxiety in ASD, an objective of the present study is to report on the percentage of clinically significant anxiety symptoms among a large heterogenous sample of youth with ASD and subgroups within the sample based on age, sex, and IQ.

Finally, the fluctuation in prevalence rates almost certainly reflects the different assessment methods used for anxiety. Some prevalence studies include structured diagnostic interviews measuring anxiety disorders (i.e., more stringent), whereas other studies include questionnaires, completed by parents or teachers, tapping anxiety-related behaviours or symptoms. Different assessment methods may explain the prevalence variation in the two aforementioned meta-analyses. Lai et al. (2019), who reported a 23% rate, used more stringent

criteria for assessing anxiety disorders with diagnoses based on DSM-IV, DSM-5 and/or ICD-9/10 criteria and confirmed by clinical assessment. On the other hand, van Steensel et al. (2011) used semi-structured interviews or questionnaires assessing anxiety that provide cutoff scores for clinically significant levels of anxiety symptoms, and reported a 40% rate of anxiety. Therefore, the various assessment methods used for anxiety are measuring either anxiety *disorders* (e.g., structured diagnostic interviews) or anxiety *symptoms/behaviours* (e.g., parent, teacher, or self-report questionnaires).

Anxiety symptoms are defined as observable behaviours and/or reported subjective experiences whereas anxiety disorders are defined as "a constellation of Diagnostic and Statistical Manual of Mental Disorders (DSM) or International Classification of Diseases (ICD) disorders" (Gotham et al., 2013, p. 33), which involve a certain number of symptoms, over a certain time period, and often in different environments. Using anxiety symptoms results in a broader measure of anxiety, which is more sensitive to the presence of fewer and/or less severe symptoms. Identifying youth with ASD experiencing anxiety symptoms, even though they may not be severe enough to warrant an anxiety diagnosis, is important as it can lead to preventative measures against further impairment. In addition, anxiety disorders are often difficult to diagnose, especially among youth with ASD if they have low IQ and/or young age, due to diagnostic overshadowing and difficulty communicating anxious symptomology. Therefore, anxiety symptoms deserve particular attention in this population (Vasa et al., 2018). In the present study, anxiety was operationalized in terms of anxiety symptoms and the term anxiety was used to refer to the presence of anxiety symptoms and not necessarily a formal anxiety diagnosis.

Manifestation and Mechanisms of Anxiety in ASD

For youth with ASD, anxiety often emerges in early childhood with far-reaching and lifelong implications (Spain et al., 2018). A child's ability to function in home, school, and community activities is greatly hampered in the presence of anxiety (Reaven, 2009; Russell & Sofronoff, 2005). Co-occurring anxiety in youth with ASD can interfere with education, reduce quality of life, contribute to irritability and behavioural problems, decrease independence, and limit employment options (South et al., 2017; Vasa et al., 2018). The debilitating nature of anxiety in ASD can adversely impact functioning at school and within peer and family relationships (Bellini, 2004; Greig & MacKay, 2005; Reaven, 2009; Sze & Wood, 2007).

Given the consequences of anxiety, an important research priority is identifying and understanding psychological mechanisms underpinning anxiety and how they promote and maintain anxiety in this population (Vasa et al., 2018). The proposed mechanisms discussed in the literature include: intolerance of uncertainty (Boulter et al., 2014), repetitive behaviours (Magiati et al., 2016; Postorino et al., 2017), emotional dysregulation (Mazefsky et al., 2014), cognitive rigidity (South & Rodgers, 2017), restricted interests (Spiker et al., 2012), and sensory over-responsivity (Green & Ben-Sasson, 2010). Numerous studies have revealed positive correlations between anxiety and these mechanisms (i.e., anxiety increases as measures of these variables increase).

Further, there are other correlates of anxiety in ASD that have been reported in the literature, however, the directionality of the associations is inconsistent. These include age (i.e., some studies indicate higher anxiety in older youth whereas other studies indicate higher anxiety in younger children), sex (i.e., some studies indicate anxiety is higher among females whereas other studies indicate it is lower), and cognitive functioning (i.e., some studies indicate there is a

positive correlation between anxiety and IQ whereas other studies indicate there is a negative correlation) (Vasa et al., 2018). These discrepancies may be attributed to the same methodological issues described above in reference to the prevalence studies. As noted above, and to further complicate matters, the strength and/or direction of association between anxiety and ASD may also differ based on age, sex, and level of cognitive functioning. Therefore, it is important to control for age, sex, and IQ when examining the role of other variables in understanding anxiety in this population.

Social Functioning and Anxiety in ASD

The focus of the present study was on whether social functioning is a mechanism for the development of anxiety in youth with ASD. The extent to which social functioning deficits, which are characteristic of ASD (although they vary in nature and severity), explain the association between anxiety and ASD is unknown (Gotham et al., 2013). There are two models that address the development of anxiety among typically developing youth through a social functioning lens (Rubin & Burgess, 2001; Spence et al., 1999). Spence et al. (1999) proposed a developmental model in which poor social functioning can result in negative expectations in social situations, which increases anxiety and avoidance (Fisher et al., 2004). As a result of increased social withdrawal, there are fewer opportunities to improve social functioning (Fisher et al., 2004). Studies that support the model (Beidel et al., 1999; Spence et al., 1999) show typically developing youth with anxiety have poor social functioning (Fisher et al., 2004). Similarly, Rubin and Burgess (2011) proposed a developmental model whereby social withdrawal opens the doors to anxiety (Bellini, 2006). They state that a child's temperament (e.g., behavioural inhibition) can lead to withdrawal from social interactions. Social withdrawal results in fewer opportunities for peer interactions and the subsequent development of

interpersonal skills, which negatively impacts social functioning. Poor social functioning will increase the risk of negative peer experiences and lead to increased anxiety (Bellini, 2006). Social withdrawal is a negative reinforcer because it decreases anxiety. Therefore, youth will increase in social withdrawal when faced with future social interactions. Increased social withdrawal will cause the same cycle to occur, resulting in increased anxiety (Bellini, 2006).

Researchers and clinicians in the field of ASD have proposed similar developmental models for anxiety in youth with ASD (Bellini, 2006). Tantam (2000) suggested that youth with ASD are likely to engage in inappropriate social behaviours due to their social communication and reciprocity difficulties. Inappropriate social behaviours can interfere with forming lifelong and meaningful relationships and put them at risk for social rejection and victimization (Bellini, 2006; Bellini et al., 2007; Hammond & Hoffman, 2014). These experiences, in turn, may increase the risk of anxiety within this population (Hammond & Hoffman, 2014). Consequently, comorbid anxiety in youth with ASD can exacerbate autism characteristics, including social impairments, sensory sensitivities, and repetitive behaviours (Bellini, 2004; Lai et al., 2019; Sukhodolsky et al., 2008; White et al., 2009). Finally, based on the described established mechanisms, age, sex, and IQ are likely to impact the relationship between anxiety and social functioning (White & Roberson-Nay, 2009). For example, youth with higher cognitive levels have a greater awareness of their social difficulties and may experience anxiety when social cues are misinterpreted and fear they will be unsuccessful in their social interactions (White & Roberson-Nay, 2009). On the other hand, youth with lower cognitive levels who are less aware of their social difficulties and youth who are uninterested in social interactions may be less likely to experience anxiety (White & Roberson-Nay, 2009). Unfortunately, youth may experience greater social difficulties as they age because social complexity increases. In addition, peer

relationships become more important as youth transition into adolescence (Ollendick & Hirshfeld-Becker, 2002; White & Roberson-Nay, 2009). Exploring the role of social functioning, as well as age, sex, and IQ direct effects and possible interactions with social functioning, would advance the understanding of the development of anxiety in youth with ASD (White & Roberson-Nay, 2009).

To date, there are several gaps in the literature regarding this area of study. Many studies exploring mechanisms for anxiety in ASD exclude participants with lower IQ scores (i.e., <70) potentially due to concerns with measuring anxiety and/or mechanisms among these individuals (Russell et al., 2019). In addition, many studies exclude children below 6 years old and adolescents above 15 years old. Therefore, these populations are under-represented in the literature (van Steensel & Heeman, 2017). Second, there is a lack of studies in the literature that include multiple informants to assess anxiety and/or mechanisms. For example, most studies only include self-report (which automatically excludes certain segments of the ASD population) or parent-report to assess anxiety. Of the studies that include multiple informants, most include parent and child. However, there are many discrepancies with measuring anxiety in ASD; therefore, reporting should occur from multiple sources (e.g., parents and teachers) (Vasa et al., 2018). In particular, teachers' reports are not usually included within the literature of anxiety disorders (Mychailyszyn et al., 2010). However, teachers offer a unique perspective because they provide an assessment of youth's functioning in a school setting, where youth spend the majority of their time and teachers are familiar with the behaviour of other youth the same age. Incorporating teachers' perspectives along with parents' also allows for comparison of the youth's anxious behaviours across home and school settings (Mychailyszyn et al., 2010). Regarding social functioning, as well, teachers offer a valuable perspective because they observe

peer interactions in the classroom and on the playground. In addition, including multiple informants is beneficial because children's behaviour often differs in different settings and in the presence of different peers, and observations regarding behaviour may be reported differently (Rescorla, 2005). Third, despite a clear theoretical relationship between anxiety and social functioning in youth with ASD, this relationship has been largely unexplored empirically. However, some interventions targeting social skills show promise in ameliorating anxiety (e.g., Lordo et al., 2017). Studying developmental models for anxiety in youth with ASD may reveal new knowledge beneficial for researchers and clinicians working with ASD populations (Bellini, 2006).

Study Objectives and Hypotheses

The overall purpose of the present study was to explore the association between anxiety symptoms and social functioning in youth (i.e., children and adolescents) with ASD in a large heterogenous dataset. The first specific objective was to determine the percentage of youth with ASD with clinically significant anxiety symptoms, as rated by both parents and teachers, in age, sex and IQ subgroups. We hypothesized that there would be a high percentage of clinically significant anxiety symptoms in youth with ASD. Due to the conflicting results in the literature, no directional hypotheses were made regarding subgroup comparisons.

The second objective was to examine the association between anxiety symptoms and social functioning (overall score and five specific domains: social communication, social cognition, social awareness, social motivation, and restricted interests and repetitive behaviours) as reported by parents and teachers. We hypothesized there would be an inverse relationship between anxiety symptoms and social functioning, with greater social functioning difficulties correlating with higher levels of anxiety symptoms.

The third objective was exploratory with an aim to examine the moderating influence of age, sex, and IQ on the association between overall social functioning and anxiety symptoms. We were interested in determining whether the association between social functioning and anxiety is different for younger vs. older youth, males vs. females, and individuals with lower vs. higher IQ.

Method

Design

The present study involved secondary data analyses, using data from the Simons Foundation for Autism Research Initiative (SFARI). SFARI is an initiative aimed at improving the understanding, diagnosis, and treatment of ASD. The dataset we analyzed, the Simons Simplex Collection (SSC), is a core project of SFARI, whose researchers collected phenotypic data from simplex families, in which only one child is affected with ASD (Gotham et al., 2013). The present study comprised a cross-sectional design as all measures included in the SSC dataset were administered at the same point in time.

Procedure

SSC probands were recruited from 12 university-affiliated sites in the United States and Canada (Baylor College of Medicine, Boston Children's Hospital/Harvard Medical School, Columbia University, Emory University, McGill University, University of California – Los Angeles, University of Illinois at Chicago, University of Michigan, University of Missouri, University of Washington, Vanderbilt University, and Yale University). Recruitment of participants ended in 2011. Each site had a geneticist and clinical psychologist as co-principal investigators (Fischbach & Lord, 2010).

All study procedures were approved by Institutional Review Boards at each university (Gotham et al., 2013). Informed consent from parents or caregivers and assent from children was obtained at each SSC site. Participation in the original study was voluntary and participants could refuse to participate or leave the study at any time. Families were reimbursed for parking costs and received a $25 Visa gift card for completing the initial questionnaires. Participating family members were each compensated with a $50 Visa gift card for completing the remainder of the study. Participation in the study required 4.5 to 7 hours of parents' time and 2.5 to 4 hours of their child's time. All completed de-identified data were transferred and stored in a secured central databank.

Probands were administered a variety of diagnostic (e.g., the Autism Diagnostic Interview- Revised [ADI-R] and the Autism Diagnostic Observation Schedule [ADOS]) and behavioural measures assessing characteristics of ASD, cognitive ability, adaptive behaviour, language, motor function, and emotional and behavioural problems (Fischbach & Lord, 2010). Parent questionnaires were administered to collect information regarding demographics as well as family medical history, developmental milestones, immunizations, medications, and dietary supplements. Finally, information regarding genetic, autoimmune, and psychiatric disorders in extended family members was collected (Fischbach & Lord, 2010).

Participants

SSC probands were between the ages of 4 and 18 years at the time diagnostic and behavioural measures were administered (completed within a 6-month period), met criteria for ASD on the ADOS and the ADI-R, and had a nonverbal mental age of at least 24 months (Gotham et al., 2013). Children with severe sensory impairments (e.g., blindness or deafness),

motor difficulties, genetic syndromes, or medical histories (e.g., birth complications, history of severe nutritional deprivation, low birth weight) were excluded (Gotham et al., 2013).

The SSC dataset contains data from 2,745 individuals (2,373 males and 372 females) aged 4 to 18 and is well-characterized and heterogeneous in IQ. Of the 2,745 individuals, all have parent data for the anxiety measure, however, less than half have teacher data (n = 1236). For the social functioning measure, 2,734 have parent data and only 1360 have teacher data. There were no differences in child variables (age, sex, and IQ) for those who did or did not have teacher data.

For objective 1, three subgroups were created based on age (early childhood [4 to 5:11 years, n = 625], middle childhood [6 to 10:11 years, n = 1358], and adolescence [11 to 18 years, n = 752]). These age groups were determined by SFARI researchers; however, they also reflect logical developmental age groupings (i.e., the early childhood group includes pre-school aged children, the middle childhood group includes elementary school aged children, and the adolescence group includes middle and high school aged adolescents). Similarly, four subgroups were created based on IQ (no Intellectual Disability [ID; IQ ≥ 85, n = 1408], borderline [IQ 70-84, n = 508], mild/moderate ID [IQ 40-69, n = 533], and severe/profound ID [IQ < 40, n = 296]). These IQ groups were also determined by SFARI researchers and are based on traditional categories that define borderline and mild, moderate, severe, and profound ID, based on standard deviations below the mean. The descriptive statistics for the categorical variables are shown in Table 1. For objectives 2 and 3, continuous age and IQ variables were used (see Table 2). G*Power 3.1 software was used to calculate the power associated with N, which showed adequate power to see a small to medium effect size (Faul et al., 2009). Finally, other

demographic information was collected from the parent questionnaires including annual household income, mother and father education, and parent's marital status (see Table 3).

Table 1

Descriptive Statistics for Categorical Covariates

	n	%
Age groups		
Early childhood	635	23.1
Middle childhood	1358	49.5
Adolescence	752	27.4
Total	2745	100.0
Sex		
Males	2373	86.4
Females	372	13.6
Total	2745	100.0
IQ groups		
No ID	1408	51.3
Borderline	508	18.5
Mild/moderate ID	533	19.4
Severe/profound ID	296	10.8
Total	2745	100.0

Table 2

Descriptive Statistics for Continuous Covariates

	N	*M* (*SD)*	Range
Age (mos)	2745	108.27 (42.76)	48-216
IQ	2745	81.21 (27.92)	7-167

Table 3

Descriptive Statistics for Parent Demographic Information

	n	%
Annual household income		
< $20,000	239	9.2
$21,000-$50,000	504	19.4
$51,000-$80,000	806	31.1
$81,000-$100,000	399	15.4
$101,000-$130,000	78	3.0
$131,000-$160,000	135	5.2
> $161,000	431	16.6
Total	2592	100.0
Mother's education		
Less than high school	6	0.2
Some high school	22	0.8
High school diploma/GED	223	8.1
Some post-secondary	596	21.8
Associate degree	219	8.0
Bachelor's degree	973	35.6
Graduate degree	693	25.4
Total	2732	100.0
Father's education		
Less than high school	13	0.4
Some high school	52	1.9
High school diploma/GED	325	12.0
Some post-secondary	527	19.4
Associate degree	183	6.7
Bachelor's degree	849	31.3
Graduate degree	765	28.2
Total	2714	100.0

Parent's marital status		
Never married	63	2.3
Married	2477	90.4
Separated	36	1.3
Divorced	164	6.0
Total	2740	100.0

Measures

Achenbach System of Empirically Based Assessment (ASEBA; Achenbach & Rescorla, 2001). The dependent variable, anxiety, was drawn from the anxiety DSM-oriented scale of the ASEBA forms. ASEBA has several forms that provide information about youth's emotional and behavioural functioning across two major domains of internalizing and externalizing behaviour. Users of the ASEBA measures can choose between eight empirically-derived syndrome scales (i.e., anxious/depressed, withdrawn/depressed, somatic complaints, social problems, thought problems, attention problems, rule-breaking behaviour, aggressive behaviour) or five DSM-oriented scales (Achenbach & Rescorla, 2001). The DSM-oriented scales include: Affective Problems, Anxiety Problems, Pervasive Developmental Problems, Attention-Deficit/Hyperactivity Problems, and Oppositional Defiant Problems. Items used to construct the DSM-oriented scales were identified by an international panel of experts as being consistent with the diagnostic categories of the DSM-IV (APA, 1994; Rescorla et al., 2012). The anxiety DSM-oriented scale was used as the main dependent variable in the present study.

The ASEBA forms used in the present study include younger and older versions for each of the parent and teacher forms (Achenbach, 2001). For parent report, these include the Child Behavior Checklist (CBCL) for ages 1½ to 5 (CBCL/1½-5) or 6 to 18 years (CBCL/6-18). The CBCL is a 113-item parent-report assessing their child's emotional and behavioural functioning.

The Caregiver-Teacher Report Form (C-TRF) or Teacher Report Form (TRF) was used as the teacher's perspective of anxiety for children aged 1½ to 5 years and youth aged 6 to 18 years, respectively. The C-TRF is a parallel version of the CBCL and is a 99-item caregiver or teacher-report assessing the emotional and behavioural functioning of children ages 1½ to 5 years as observed in preschools, early childhood programs, or daycare settings (Rescorla et al., 2012). The TRF is also a parallel version of the CBCL and is a 113-item teacher-report which will be used as the teacher's perspective for youth aged 6 to 18. The anxiety DSM-oriented scale of the ASEBA forms have 6 items, each rated on a 3-point scale (0 = *Not True,* 1 = *Somewhat* or *Sometimes True*, 2 = *Very True* or *Often True*).

Raw scores from parent and teacher reports on the anxiety DSM-oriented scale were converted to standardized *T* scores (*M*=50; *SD*=10) to compare children of the same sex and age and to ensure equivalence of scores across test versions (Factor et al., 2017). Therefore, for each child/youth, we used two *T* scores (parent and teacher report) as our measure of anxiety for objective 1. We also dichotomized these scores for objective 1 into anxiety (i.e., clinical and borderline clinical) or no anxiety (i.e., normal range of anxiety). Clinically significant anxiety was defined as a *T* score above 65. For objectives 2 and 3, continuous raw scores were used for data analyses.

The ASEBA forms are frequently used in clinical studies and have good psychometric properties including high internal consistency and test-retest reliability (Achenbach, 1994). For the anxiety DSM-oriented scale of the CBCL and TRF, Cronbach's alpha is .72 and .73, respectively. Unfortunately, item-level data were unavailable for the CBCL and TRF and therefore, we were unable to calculate the internal consistency of the anxiety DSM-oriented scale for the present study. The test-retest correlations for the anxiety DSM-oriented scale of the

various ASEBA forms ranged from .73 to .80 (Rescorla, 2005). The cross-informant agreement (Pearson *r*s) between mother and father ratings on the CBCL is .66 and between ratings by pairs of teachers on the TRF is .48 for the anxiety DSM-oriented scale. However, the cross-informant agreement between parents (CBCL) and teachers (TRF) on this scale is .23. The low cross-informant agreement of this scale lends strength to our decision to examine both types of informants in the present study. Finally, regarding anxiety in particular, evidence supports the validity of the ASEBA forms in measuring anxiety in typically developing children and in children with intellectual disabilities (Vasa et al., 2013). Studies show that subscale scores are significantly correlated with clinical diagnoses and the CBCL anxiety syndrome scale has better concurrent validity than the anxious/depressed syndrome scale (Vasa et al., 2013). More recently, the ASEBA forms have been used to assess mental health concerns in youth with ASD, including anxiety (Vasa et al., 2013).

Social Responsiveness Scale (SRS; Constantino & Gruber, 2005). Measurement of youths' social functioning also included both parent and teacher perspectives and was drawn from the SRS – Parent and Teacher Report. The SRS is a 65-item parent- and teacher-report assessing social functioning deficits associated with ASD over the previous 6 months in youth aged 4 to 18 (Bruni, 2014). The SRS consists of five different subscales (Social Awareness, Social Cognition, Social Communication, Social Motivation, and Restricted Interests and Repetitive Behaviours) and the overall total score (Bruni, 2014). The Social Awareness subscale has 8 items assessing an individual's awareness of others' social cues. The Social Cognition subscale has 12 items assessing an individual's ability to interpret social behaviour. The Social Communication subscale has 22 items assessing reciprocal communication during social interactions. The Social Motivation subscale has 11 items assessing the extent to which an

individual is motivated to engage with others in social situations. Finally, the Restricted Interests and Repetitive Behaviours subscale has 12 items assessing stereotyped behaviour and circumscribed interests and unusual preoccupations (Bruni, 2014). Parents or teachers rate how true each item is on a 4-point Likert-type scale (1 = *Not True*, 2 = *Sometimes True*, 3 = *Often True*, 4 = *Almost Always True*) (Bruni, 2014). The total SRS score was used as the measure of social functioning more broadly and the five subscales were used for the domains of social functioning.

The results yield a total raw score (ranging from 0 to 195) and a *T* score (*M*=50; *SD*=10). Clinically significant deficits in social functioning correspond to a *T* score above 75, indicating the individual has severe difficulties with social functioning that interfere with their ability to interact with peers. Moderate (or "some clinically significant") deficits in social functioning correspond to *T* scores between 66 and 75. Mild to moderate deficits in social functioning correspond to *T* scores between 60 and 65. Lastly, *T* scores of 59 and below suggest no difficulties with social functioning (Bruni, 2014). Separate norms were created for the SRS based on gender and rating source (i.e., parent or teacher) using ASD samples (Bruni, 2014; White & Roberson-Nay, 2009). We used the continuous SRS total raw score for overall social functioning (parent and teacher report = 2 total scores) and the continuous subscale raw scores for the domains of social functioning (parent and teacher report for all five subscales = 5*2 = 10 scores) for data analyses.

The SRS has demonstrated good psychometric properties. The internal consistency for the SRS total score ranged from .93 to .97 for both normative and clinical samples and ranged from .77 to .90 for the specific subscales (Booker & Starling, 2011; Constantino & Gruber, 2005). In the present study, the Cronbach's alpha was .94 (parent) and .95 (teacher) for the SRS

total score, .64 (parent) and .69 (teacher) for the social awareness domain, .72 (parent) and .77 (teacher) for the social cognition domain, .84 (parent) and .88 (teacher) for the social communication domain, .77 (parent) and .79 (teacher) for the social motivation domain, and .81 (parent) and .84 (teacher) for the restricted interests and repetitive behaviours domain. The test-retest reliability correlations ranged from .88 to .95 (Constantino & Gruber, 2005). The interrater reliability correlations ranged from .75 (father/teacher) to .91 (mother/father). Finally, the concurrent validity was calculated by comparing parent- and teacher-reported SRS total scores to scores from the Autism Diagnostic Interview-Revised (ADI-R) and ranged from .65 to .77 for parent reports and .52 to .70 for teacher reports (Constantino & Gruber, 2005).

Cognitive Functioning. The Differential Ability Scales–Second Edition (DAS-II; Elliott, 2007), Mullen Scales of Early Learning (MSEL; Mullen, 1995), Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV; Wechsler, 2003), or the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) were used to measure IQ, depending on the youth's age and skill level. IQ scores were obtained from the Full Scale IQ (FSIQ) standard score (M=100; SD=15) on the WISC-IV and WASI, the Early Learning Composite standard score (M=100; SD=15) on the MSEL, or the General Conceptual Ability standard score (M=100; SD=15) on the DAS-II. However, for lower functioning youth for whom a standard score cannot be obtained, a ratio IQ was calculated (mental age divided by chronological age, multiplied by 100; as in Perry et al., 2008). These cognitive measures have demonstrated good reliability and validity (Factor et al., 2017).

Statistical Analyses

Data were analyzed using IBM SPSS Statistics V26 software. We first conducted preliminary analyses to prepare the data for further analyses and summarize the results in terms

of age, sex, IQ, and additional demographic information. We screened the data for input errors, impossible values (in the minimum and maximum values on each item), and missing data. No input errors or impossible values were detected, presumably because the SFARI dataset had been carefully prepared prior to us obtaining it. Participants with missing data for the main dependent variable, anxiety (as rated by parents), were deleted from the dataset (n = 111). Before beginning analyses, we examined the distributions of all variables for skewness and kurtosis. Most variables were normally distributed. Age was slightly positively skewed. We also checked Cronbach's alphas to confirm reliability of the SRS for the present sample (as reported above). Descriptive statistics of all variables of interest were conducted for both the categorical (objective 1) and continuous (objectives 2 and 3) data (see Tables 3 and 4).

The first objective involved descriptive analyses of the dichotomous variable (anxiety/no anxiety) to determine the percentage of youth with anxiety, overall, and then in subgroups based on age, sex, and IQ. These percentages were reported separately based on parent and teacher report. Chi-square analyses were used to compare the likelihood of overall anxiety in subgroups based on age, sex, and IQ. Follow-up pairwise chi-squares were conducted when appropriate.

The second objective involved correlation and regression analyses, using the continuous anxiety scores. First, we examined all the continuous variables for distributional properties to ensure correlation and regression assumptions including linearity, normality, and homoscedasticity, were satisfied. All assumptions were satisfied. We conducted bivariate analyses between age, sex, and IQ with the variables of interest to examine how the variables related to one another and to ensure we included all study variables related to the dependent variable (i.e., anxiety) at a statistically significant level (p<.05) in the multivariate analyses. Correlations were conducted between age and IQ with the variables of interest to examine for

redundancy, collinearity, and other relationships that would help us better understand the data. Independent *t* tests were conducted to examine possible sex differences in anxiety. We then conducted correlation analyses between anxiety and overall social functioning as well as the five domains of social functioning.

We conducted hierarchical regression analyses to examine the association between overall social functioning and its specific domains with anxiety, controlling for age, sex, and IQ. To do this, we entered the control factors at Step 1, then social functioning (overall or the domains) as predictors at Step 2, with anxiety continuous raw score as the outcome. Partial eta-squared was calculated as a measure of effect size for significant independent variables.

The third objective involved moderator analyses to examine whether the association between anxiety and overall social functioning was moderated by age, sex, or IQ. A moderator is a third variable that modifies the strength or direction of the relationship between an independent variable (IV) and a dependent variable (DV) (Sharma et al., 1981). Three interaction terms were created including: age x SRS Total, sex x SRS Total, and IQ x SRS Total. We entered anxiety raw score as a continuous DV, overall social functioning, age, and IQ as continuous IVs, sex as a binary IV, and the three interaction terms as moderator variables concurrently in a single linear regression model. Partial eta-squared was calculated as a measure of effect size for significant independent variables.

We analyzed the parent and teacher reports separately for all correlation, regression, and moderator analyses. The large number of analyses increases our type I error rate and therefore, we used Bonferroni corrections where appropriate and interpreted the analyses with caution. We had a large sample size and therefore, many of the statistical tests conducted emerged as

significant. We calculated appropriate effect size statistics to ensure we did not overinterpret these results.

Results

Objective 1: Percentage of Youth with Anxiety

Overall Anxiety Rates

The overall percentage of youth with ASD who were considered to have anxiety (operationally defined as scores in the borderline or clinically significant range on the anxiety DSM-oriented scale of the ASEBA measures) was 38% and 39% for parent and teacher report, respectively.

Examining severity of anxiety symptoms using the continuous variable *T* scores for the Anxiety scale also revealed no significant differences between parent (M = 60.30, SD = 9.17) and teacher (M = 60.78, SD = 7.99) report of anxiety rates for those youth who had both ratings available ($t(1232) = 1.66$, $p = .097$).

Anxiety Rates by Age

Parent Report. Anxiety rates were 18%, 44%, and 45% for early childhood, middle childhood, and adolescence groups, respectively (combined across sex and all IQ groups), as shown in Figure 1. Chi-squared analyses indicated that the proportion of youth with anxiety differed across age groups ($\chi^2(2)=145.59$, $p<.001$). Follow-up pairwise chi-squares showed that the early childhood group was significantly less likely to be rated as having anxiety than the middle childhood ($\chi^2(1=129.48$, $p<.001$) or the adolescence ($\chi^2(1)=114.99$, $p<.001$) age group. The latter two did not differ from one another ($\chi^2(1)=0.153$, $p=.696$).

Teacher Report. Similar results were found based on data from teachers. Anxiety rates were 14%, 46%, and 51% for early childhood, middle childhood, and adolescence groups,

respectively (combined across sex and all IQ groups), as shown in Figure 2. Chi-squared analyses indicated that the proportion of youth with anxiety differed across age groups ($\chi^2(2)=119.53$, $p<.001$). Follow-up pairwise chi-squares showed that the early childhood group was significantly less likely to be rated as having anxiety than the middle childhood ($\chi^2(1)=100.06$, $p<.001$) or the adolescence ($\chi^2(1)=99.66$, $p<.001$) age group. The latter two did not differ from one another ($\chi^2(1)=1.62$, $p=.203$).

Figure 1

Parent Anxiety Rates Based on Age Group (n = 2745)

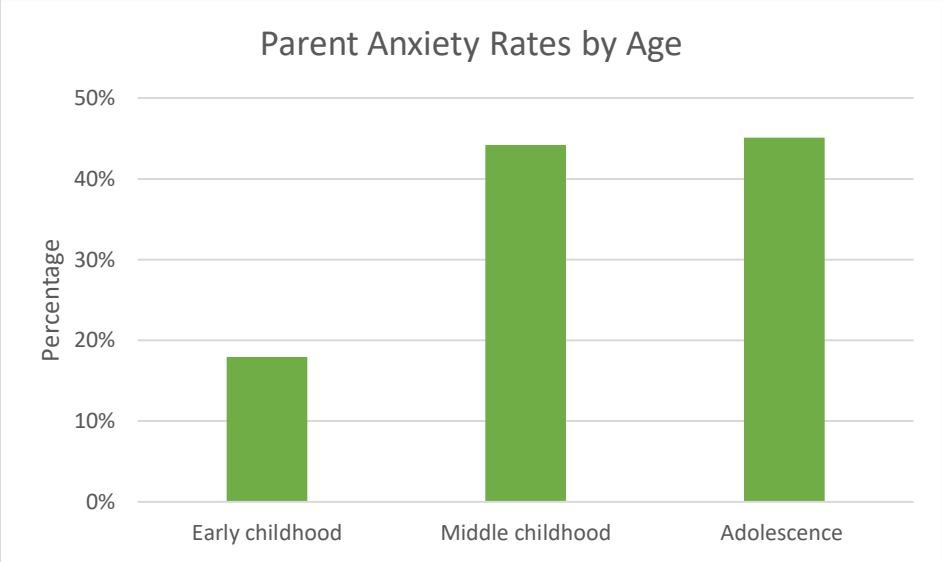
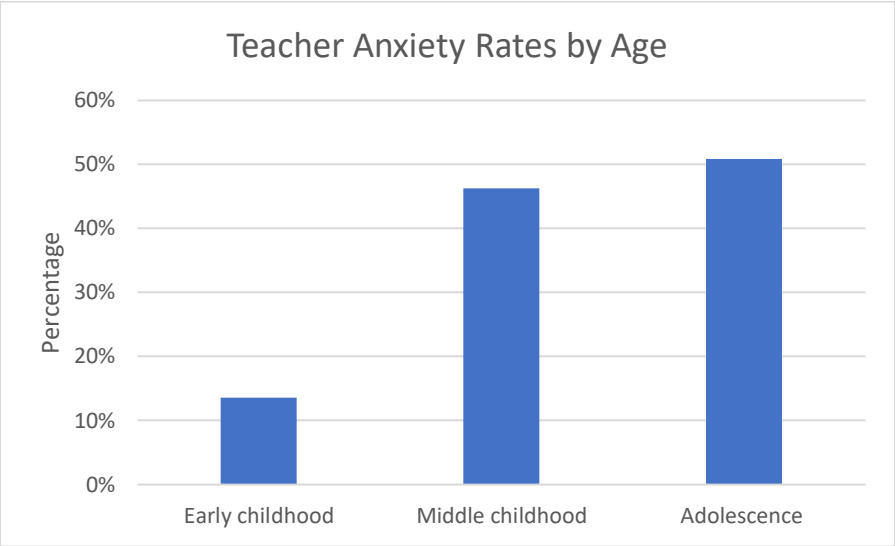


Figure 2

Teacher Anxiety Rates Based on Age Group (n = 1236)



Anxiety Rates by Sex

Parent Report. Anxiety rates were 33% and 39% for females and males respectively (combined across all age and IQ groups), as shown in Figure 3. Chi-squared analyses indicated males were significantly more likely to be rated as showing anxiety ($\chi^2(1)=4.41$, $p<.05$). However, the effect size was small ($\Phi = .04$, $p<.05$).

Teacher Report. Anxiety rates were 37% and 39% for females and males respectively (combined across all age and IQ groups), which was not a significant difference ($\chi^2(1)=0.33$, $p=.564$). See Figure 4.

Figure 3

Parent Anxiety Rates Based on Sex (n = 2745)

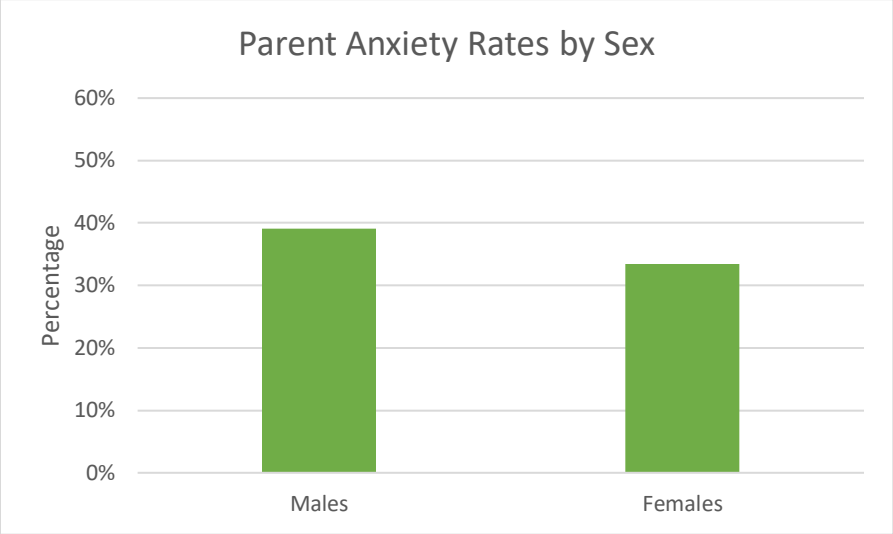
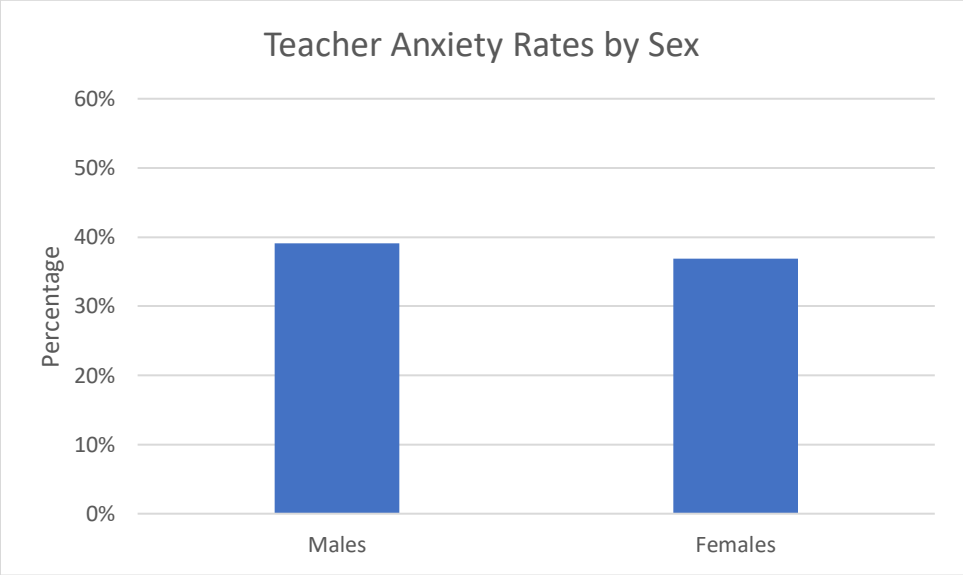


Figure 4

Teacher Anxiety Rates Based on Sex (n = 1236)



Anxiety Rates by IQ

Parent Report. Anxiety rates were 43%, 38%, 33%, and 28% for the four IQ groups: no ID, borderline, mild/moderate ID, and severe/profound ID groups, respectively (combined across

all age groups and sex), as shown in Figure 5. Chi-squared analyses indicated that the proportion of youth with anxiety differed across IQ groups ($\chi^2(3)=31.42$, $p<.001$). Follow-up pairwise chi-squares showed that the no ID group was significantly more likely to be rated as having anxiety compared to the mild/moderate ID ($\chi^2(1)=15.20$, $p<.001$) and the severe/profound ID ($\chi^2(1)=22.30$, $p<.001$) group. However, the no ID group and the borderline group did not differ from one another ($\chi^2(1)=2.75$, $p=.097$). The borderline group was significantly more likely to be rated as having anxiety compared to the severe/profound ID group ($\chi^2(1)=9.26$, $p<.01$), but did not differ from the mild/moderate ID group ($\chi^2(1)=3.42$, $p=.064$). Finally, the mild/moderate ID group did not differ from the severe/profound ID group ($\chi^2(1)=2.30$, $p=.129$).

Teacher Report. Anxiety rates were 38%, 39%, 37%, and 45% for no ID, borderline, mild/moderate ID, and severe/profound ID groups, respectively (combined across all age groups and sex), as shown in Figure 6. Chi-squared analyses indicated that the proportion of youth with anxiety did not differ across IQ groups ($\chi^2(3)=2.84$, $p=.417$).

Figure 5

Parent Anxiety Rates Based on IQ Group (n = 2745)

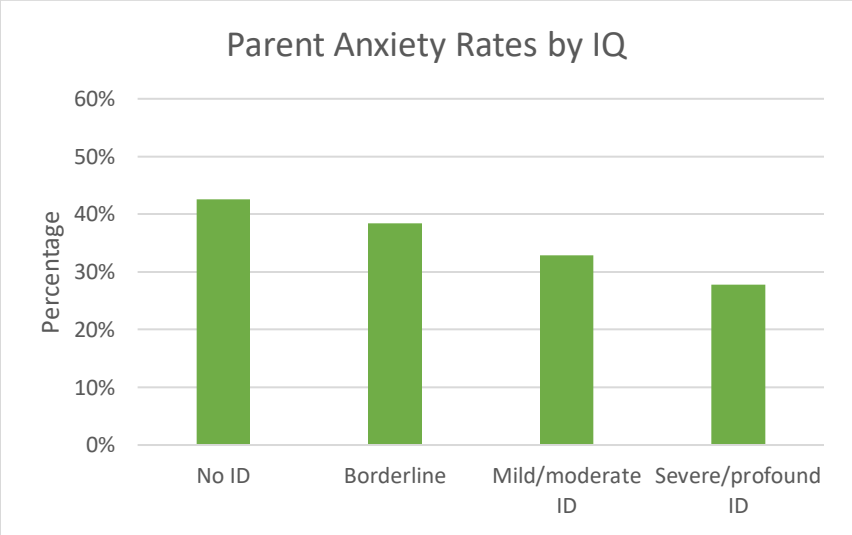
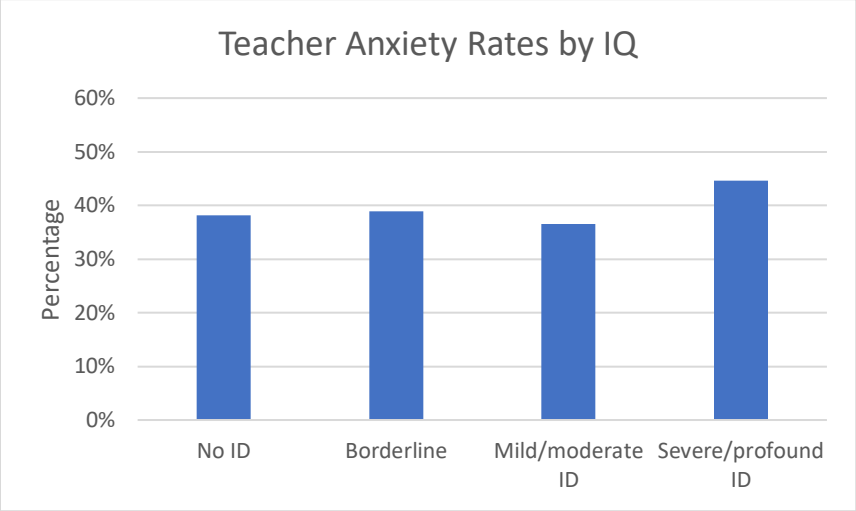


Figure 6

Teacher Anxiety Rates Based on IQ Group (n = 1236)



Objective 2: Association between Anxiety and Social Functioning

Descriptive statistics for all continuous variables of interest are shown in Table 4. Correlations between the covariates (age and IQ) and the variables of interest (anxiety, overall social functioning, and the domains of social functioning) based on parent report are shown in Table 5. There were only very small or no correlations among most of the covariates and the variables of interest. For IQ, there were small negative correlations with SRS subscale scores and a small positive correlation with anxiety (i.e., when IQ is higher, social functioning deficits are lower and anxiety is higher). The relationship of child sex to anxiety was examined using an independent-samples *t* test which showed no significant difference in anxiety scores between males and females ($t(2743) = .367$, $p = .714$).

Table 4

Descriptive Statistics for Continuous Variables of Interest

	N	*M* (*SD*)	Range
CBCL anxiety DSM-oriented scale raw score (parent)	2745	3.86 (3.03)	0-18
TRF anxiety DSM-oriented scale raw score (teacher)	1236	2.66 (2.35)	0-12
SRS raw scores – parent report	2734		
AWR		12.56 (3.67)	1-24
COG		18.53 (5.63)	1-34
COM		33.43 (9.92)	2-60
MOT		14.77 (5.75)	0-32
RIRB		18.67 (6.84)	0-36
Total		97.95 (27.02)	11-177
SRS raw scores – teacher report	1213		
AWR		11.92 (4.11)	1-24
COG		17.45 (6.28)	0-35
COM		32.62 (11.44)	0-60
MOT		14.85 (6.14)	0-32
RIRB		16.72 (7.59)	0-36
Total		93.57 (31.23)	5-179

Note. AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.

Table 5

Intercorrelations between Covariates, Anxiety, and Social Functioning based on Parent Report (n = 2734)

	Anxiety	Age	IQ	AWR	COG	COM	MOT	RIRB
Age	-.034							
IQ	.096*	-.005						
AWR	.162*	-.023	-.199*					
COG	.313*	.059*	-.282*	.605*				
COM	.266*	.098*	-.236*	.694*	.733*			
MOT	.400*	.133*	-.150*	.438*	.547*	.657*		
RIRB	.343*	.127*	-.192*	.573*	.673*	.714*	.554*	
Overall social functioning	.357*	.105*	-.252*	.754*	.846*	.934*	.767*	.851*

Note. AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.
*$p < .01$.

A similar set of correlations was computed based on teacher report and are shown in Table 6. There were medium negative correlations between IQ and all the SRS subscale scores but no correlation with anxiety. The relationship of child sex to anxiety was examined using an independent-samples *t* test which showed no significant difference in anxiety scores between males and females ($t(1234) = -.281$, $p = .779$).

Table 6

Intercorrelations between Covariates, Anxiety, and Social Functioning based on Teacher Report (n = 1360)

	Anxiety	Age	IQ	AWR	COG	COM	MOT	RIRB
Age	.115**							
IQ	-.037	-.005						
AWR	.137*	-.116**	-.363**					

COG	.323**	-.023	-.403**	.676**				
COM	.259**	-.032	-.339**	.752**	.781**			
MOT	.419**	.023	-.254**	.571**	.644**	.757**		
RIRB	.386**	.041	-.328**	.634**	.715**	.742**	.613**	
Overall social functioning	.354**	-.017	-.382**	.808**	.875**	.950**	.826**	.861**

Note. AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.
*$p < .05$. **$p < .01$.

Correlation Analyses

Correlational analyses of the variables of anxiety and social functioning (overall and domains) were conducted for both parent- and teacher-report measures (see Table 7). The magnitude and pattern of correlations were very similar for the two sets of respondents. Medium positive correlations were found between anxiety and social cognition (COG), social motivation (MOT), restricted interests and repetitive behaviours (RIRB), and overall social functioning. Small positive correlations were seen with the other two domains, social awareness (AWR) and social communication (COM).

Table 7

Correlations between Anxiety and Social Functioning

SRS Subscales	Anxiety DSM-oriented scale	
	Parent Report (CBCL) *n*=2745	Teacher Report (TRF) *n*=1236
AWR	.162*	.137*
COG	.313*	.323*
COM	.266*	.259*
MOT	.400*	.419*

RIRB	.343*	.386*
Total	.357*	.354*

Note. CBCL = Child Behavior Checklist; SRS = Social Responsiveness Scale; AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.
*$p < .01$.

Regression Analyses

Parent Report. The first two-step hierarchical regression model was conducted to examine the relationship between the IV overall social functioning against the DV parent-reported anxiety after controlling for the effects of age, sex, and IQ (see Table 8). For the first block of the analysis, the predictor variables age, sex, ad IQ were entered. Model 1 was significant at F (3, 2730) = 9.391, $p < 0.01$. The R^2 was 0.010, suggesting that age, sex, and IQ account for only 1% of the variance in parent-reported anxiety. For the second block, the predictor variable overall social functioning was added to the analysis. Model 2, with four predictor variables (age, sex, IQ, overall social functioning), was significant with F (4, 2729) = 139.275, $p < 0.01$. The ΔR^2 was 0.159, suggesting that Model 2 is an improvement over the earlier model and the addition of overall social functioning to the first block accounts for 16% of the variance in parent-reported anxiety. The Final R^2 was 0.170, suggesting that 17% of the variance in parent-reported anxiety is explained by age, sex, IQ, and overall social functioning, and 83% of the variance in parent-reported anxiety cannot be explained by age, sex, IQ, and overall social functioning. In the final model, age, IQ, and overall social functioning were all significant and sex was not. Effect sizes were small for age ($\eta_p^2 = .007$) and IQ ($\eta_p^2 = .04$) and large for overall social functioning ($\eta_p^2 = .17$). Thus, based on parent data, social functioning accounts for a substantial portion of the variance in anxiety, controlling for age, sex, and IQ, as predicted.

Table 8

Hierarchical Regression Model for Parent-Reported Anxiety and Overall Social Functioning

Model		B	SE.B	β	t	R^2	ΔR^2	η_p^2
1	(Constant)	3.608	.384		9.391*	.010	.010	
	Age	-.002	.001	-.035	-1.821			0.001
	Sex	-.166	.170	-.019	-.979			0.0004
	IQ	.010	.002	.095	4.950*			0.0088
2	(Constant)	-1.580	.419		-3.774*	.170	.159	
	Age	-.006	.001	-.078	-4.432*			0.0072
	Sex	-.149	.156	-.017	-.955			0.0003
	IQ	.022	.002	.199	10.994*			0.0424
	SRS Total	.047	.002	.415	22.881*			0.1680

Note. SRS = Social Responsiveness Scale.
*$p < .01$.

Given that the SRS Total score accounted for a substantial proportion of variance in anxiety, a hierarchical regression model was conducted using the subscales of the SRS to examine the relationship of specific aspects of social functioning with anxiety after controlling for the effects of age, sex, and IQ. Block 1 was identical to the previous analysis. For the second block, the predictor variables social awareness, social cognition, social communication, social motivation, and restricted interests and repetitive behaviours, were added to the analysis instead of the SRS Total score. Model 2, with eight predictor variables (age, sex, IQ, social awareness, social cognition, social communication, social motivation, and restricted interests and repetitive behaviours), was significant at F (8, 2719) = 111.794, $p < 0.01$, as shown in Table 9. The ΔR^2 was 0.237, suggesting that the addition of the domains of social functioning to the first block accounts for about 24% of the variance in parent-reported anxiety. The ΔR^2 of 0.237 is an improvement over the earlier model using the SRS Total score (ΔR^2 = 0.159), suggesting that the greater specificity of the subscales adds to the explanatory power of the model for parent data. All five subscales were significant predictors of anxiety. Effect sizes were small for social

awareness (η_p^2 = .007), social cognition (η_p^2 = .02), social communication (η_p^2 = .007), restricted interests and repetitive behaviours (η_p^2 = .03), and medium for social motivation (η_p^2 = .08). For social awareness and social communication, lower scores (i.e., less deficits) were associated with more anxiety. For social cognition, social motivation, and restricted interests and repetitive behaviours, higher scores (i.e., greater deficits) were associated with more anxiety.

Table 9

Hierarchical Regression Model for Parent-Reported Anxiety and Domains of Social Functioning

Model		B	SE.B	β	t	R^2	ΔR^2	η_p^2
1	(Constant)	3.619	.385		9.394*	.010	.010	
	Age	-.002	.001	-.034	-1.783			0.0012
	Sex	-.180	.170	-.020	-1.058			0.0004
	IQ	.010	.002	.095	4.989*			0.0090
2	(Constant)	-.626	.413		-1.517	.248	.237	
	Age	-.008	.001	-.110	-6.457*			0.0151
	Sex	-.206	.149	-.023	-1.384			0.0007
	IQ	.021	.002	.192	11.039*			0.0428
	AWR	-.089	.020	-.108	-4.506*			0.0074
	COG	.106	.014	.198	7.441*			0.0199
	COM	-.044	.010	-.144	-4.517*			0.0074
	MOT	.183	.012	.347	15.397*			0.0801
	RIRB	.104	.011	.234	9.163*			0.0299

Note. AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.
*$p < .01$.

Teacher Report. The parallel analysis using overall social functioning for teacher data showed similar results for the first block of the analysis with predictor variables age, sex, and IQ entered (see Table 10). Model 1 was significant at F (3, 1211) = 5.622, $p < 0.01$. The R^2 was 0.014, suggesting that age, sex, and IQ account for only 1.4% of the variance in teacher-reported anxiety. For the second block, the predictor variable overall social functioning was added to the analysis. Model 2, with four predictor variables (age, sex, IQ, overall social functioning), was significant with F (4, 1210) = 54.051, $p < 0.01$. The ΔR^2 was 0.138, suggesting that Model 2 is an

improvement over the earlier model and the addition of overall social functioning to the first block accounts for 13.8% of the variance in teacher-reported anxiety. The Final R^2 was 0.152, suggesting that 15% of the variance in teacher-reported anxiety is explained by age, sex, IQ, and overall social functioning, and 85% of the variance in teacher-reported anxiety cannot be explained by age, sex, IQ, and overall social functioning alone. In the final model, age, IQ, and overall social functioning were all significant and sex was not. Effect sizes were small for age (η_p^2 = .018) and IQ (η_p^2 = .013) and large for overall social functioning (η_p^2 = .14). Thus, based on teacher data, social functioning accounts for a substantial portion of the variance in anxiety, controlling for age, sex, and IQ, as predicted.

Table 10

Hierarchical Regression Model for Teacher-Reported Anxiety and Overall Social Functioning

Model		B	SE.B	β	t	R^2	ΔR^2	η_p^2
1	(Constant)	2.058	.438		4.696*	.014	.014	
	Age	.006	.002	.111	3.882*			0.0123
	Sex	.101	.191	.015	.528			0.0002
	IQ	-.003	.002	-.035	-1.215			0.0012
2	(Constant)	-1.581	.483		-3.278*	.152	.138	
	Age	.007	.001	.126	4.757*			0.0182
	Sex	-.039	.177	-.006	-.220			0.0000
	IQ	.010	.002	.114	4.005*			0.0130
	SRS Total	.030	.002	.400	14.022*			0.1399

Note. SRS = Social Responsiveness Scale.
*$p < .01$.

The same procedure (using the subscales of the SRS) for teacher data showed that Model 2, with eight predictor variables (age, sex, IQ, social awareness, social cognition, social communication, social motivation, and restricted interests and repetitive behaviours), was significant at F (8, 1204) = 58.937, $p < 0.01$, as shown in Table 11. The ΔR^2 was 0.267, suggesting that the addition of the domains of social functioning to the first block accounts for

about 27% of the variance in teacher-reported anxiety. This ΔR^2 of 0.267 is an improvement over the earlier model using the total SRS score ($\Delta R^2 = 0.138$), suggesting that the greater specificity of the subscales adds to the explanatory power of the model for teacher data. All five subscales were significant predictors of anxiety. Effect sizes were small for social awareness ($\eta_p^2 = .02$), social cognition ($\eta_p^2 = .02$), social communication ($\eta_p^2 = .03$) and medium for social motivation ($\eta_p^2 = .10$) and restricted interests and repetitive behaviours ($\eta_p^2 = .06$). The direction of the relationships between the domains of social functioning and anxiety followed the same pattern as the parent report (social awareness and social communication had negative relationships with anxiety and the other three domains had positive relationships with anxiety).

Table 11

Hierarchical Regression Model for Teacher-Reported Anxiety and Domains of Social Functioning

Model		B	SE.B	β	t	R^2	ΔR^2	η_p^2
1	(Constant)	2.050	.439		4.672**	.014	.014	
	Age	.006	.002	.112	3.927**			0.0125
	Sex	.101	.191	.015	.530			0.0002
	IQ	-.003	.002	-.035	-1.220			0.0012
2	(Constant)	-.444	.465		-.954	.281	.267	
	Age	.003	.001	.061	2.418*			0.0049
	Sex	-.078	.164	-.012	-.477			0.0002
	IQ	.008	.002	.098	3.658**			0.0110
	AWR	-.111	.022	-.193	-4.938**			0.0199
	COG	.077	.016	.206	4.841**			0.0190
	COM	-.064	.011	-.310	-5.828**			0.0276
	MOT	.167	.015	.437	11.433**			0.0980
	RIRB	.109	.012	.352	9.061**			0.0640

Note. AWR = Awareness; COG = Cognition; COM = Communication; MOT = Motivation; RIRB = Restricted Interests and Repetitive Behaviours.
*$p < .05$. **$p < .01$.

Objective 3: Moderation Effects of Age, Sex, and IQ

Although the domains of social functioning explained more variance in anxiety in the regression analyses, overall social functioning was used in the moderator analyses because the domains would require many analyses and interaction terms and the internal consistency of each domain was lower than the SRS total score.

Parent Report. Results of the moderator analysis for parent-reported anxiety are shown in Table 12. The moderation model was significant at F (7, 2726) = 81.344, $p < 0.01$, but only the interaction between IQ and social functioning was significant (B = .000, t = 3.159, $p < 0.01$), indicating that IQ moderates the relationship between anxiety and social functioning. The effect size of this interaction was, however, very small ($\eta_p^2 = 0.0036$). The nature of the interaction is shown in Figure 7. Comparing children without ID (No ID and Borderline subgroups) to those with ID (all four levels: mild, moderate, severe, and profound ID), the interaction suggests that when social functioning deficits are low, anxiety is low in both No ID and ID groups, whereas when social functioning deficits are high, the No ID group shows higher anxiety than the ID groups. The other two moderator terms were not significant, suggesting that age and sex do not interact to moderate the strength or direction of the relationship between anxiety and social functioning.

Table 12

Moderation Model for Parent-Reported Anxiety and Overall Social Functioning

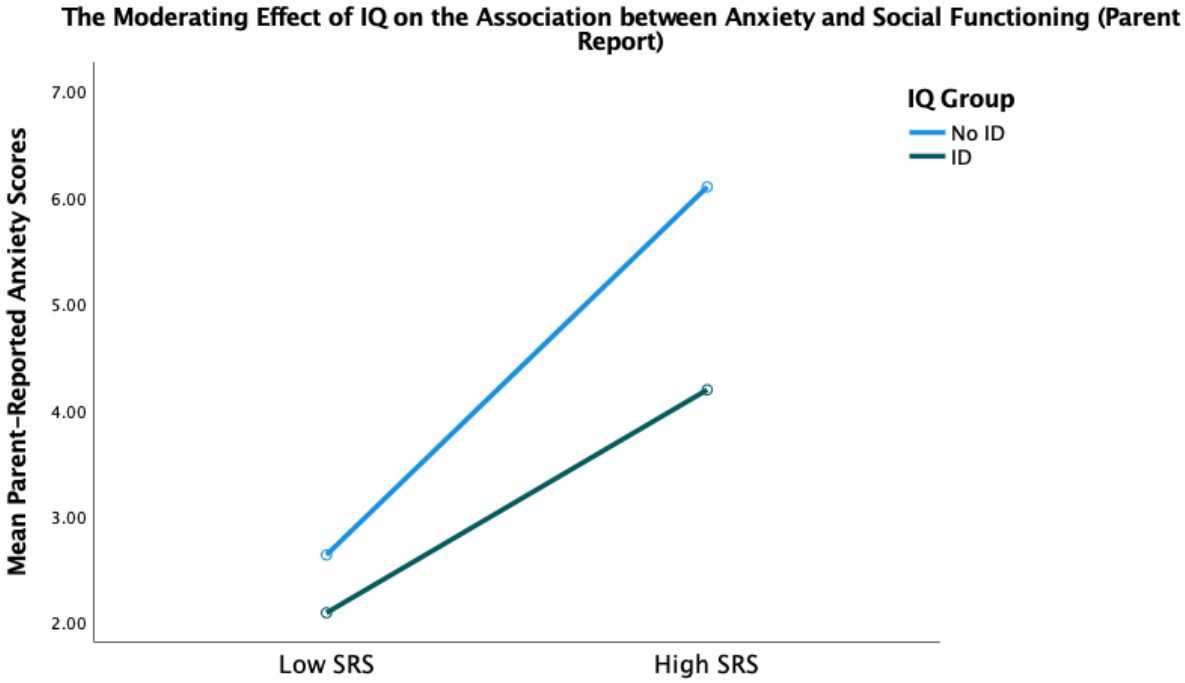
Model		B	SE.B	β	t	R^2	η_p^2
1	(Constant)	.639	1.388		.460	.173	
	Age	-.003	.005	-.049	-.733		0.0002
	Sex	-.346	.589	-.039	-.587		0.0001
	IQ	-.003	.008	-.025	-.347		0.0000
	SRS Total	.026	.013	.229	1.916		0.0014
	Age x SRS Total	-2.059E-5	.000	-.037	-.446		0.0001

Sex x SRS Total	.002	.006	.040	.349	0.0000
IQ x SRS Total	.000	.000	.252	3.159*	0.0036

Note. SRS = Social Responsiveness Scale.
*$p < .01$.

Figure 7

Moderating Effect of IQ on the Association between Anxiety and Social Functioning (Parent-Report)



Teacher Report. Results of the moderator analysis for teacher-reported anxiety are shown in Table 13. The moderation model was significant at F (7, 1207) = 31.388, $p < 0.01$. However, none of the interaction terms was significant, suggesting that age, sex, and IQ do not interact to moderate the strength or direction of the relationship between anxiety and social functioning. Age, IQ, and SRS Total score main effects were no longer significant when the interaction terms were added to the model.

Table 13

Moderation Model for Teacher-Reported Anxiety and Overall Social Functioning

Model		B	SE.B	β	t	R^2	η_p^2
1	(Constant)	.107	1.264		.085	.154	
	Age	.002	.005	.040	.489		0.0002
	Sex	-.159	.518	-.024	-.307		0.0001
	IQ	-.002	.008	-.021	-.217		0.0000
	SRS Total	.013	.012	.176	1.069		0.0010
	Age x SRS Total	5.149E-5	.000	.112	1.081		0.0010
	Sex x SRS Total	.001	.005	.036	.238		0.0000
	IQ x SRS Total	.000	.000	.151	1.483		0.0018

Note. SRS = Social Responsiveness Scale.

Discussion

The primary aims of the present study were to report the prevalence of anxiety and to explore the association between anxiety and social functioning in youth with ASD. Prevalence rates of anxiety in this population vary substantially within the literature and therefore, the percentage of youth in our sample with comorbid anxiety symptoms, as rated by both parents and teachers, was calculated first. We found that a significant percentage of youth in our sample display anxiety symptoms (approximately 38%). This prevalence rate is slightly lower compared to other studies that examined anxiety symptoms, rather than formal diagnoses (Muris et al., 1998). This rate may be lower because the measure used for anxiety in the present study (CBCL, C-TRF, or TRF) contains items mainly pertaining to emotional symptoms, rather than behavioural or physical. Parents and teachers may find it challenging to identify these types of symptoms in this population and therefore, they may be overlooked. The results revealed that parent and teacher reports of anxiety rates are similar. However, when examining the anxiety rates based on subgroups, it is evident that parents and teachers may not be identifying the same children as having anxiety symptoms. It is not surprising that parents and teachers may not be

identifying the same children as findings based on normative samples have found that the level of agreement is low to moderate (Huang, 2017).

The anxiety rates based on subgroups revealed that both males and females have similar rates of anxiety, although male rates are slightly higher according to parent report. The anxiety rates based on age subgroups indicate that adolescents have higher rates of anxiety compared to younger children. These findings are consistent with previous studies examining anxiety rates among youth with ASD (Mayes et al., 2011; Vasa et al., 2013; Weisbrot et al., 2005). Higher anxiety rates observed in adolescents may result from a greater risk for social rejection (and possible cumulative negative effects of rejection, exclusion, and bullying), challenges associated with higher learning, and increased independence (Vasa et al., 2013). Further, it is during this developmental period that peer relationships take precedence over family relationships and forming these relationships requires strong social skills. Finally, the results could also be due to issues with reliability and validity of measures of anxiety in young children.

The anxiety rates based on IQ subgroups revealed that youth with no ID have higher rates of anxiety compared to other IQ groups according to parent report. However, youth with severe/profound ID have higher rates of anxiety according to teacher report. The different profiles reported by parents and teachers may be because teachers are attributing characteristics of ASD to symptoms of anxiety in lower functioning individuals, whereas parents usually have a greater understanding of their children's functioning and do not misinterpret it as anxiety. Previous studies are consistent with the parent findings, which may be explained by youth with higher IQ possessing a greater awareness of their impairments, resulting in increased anxiety (Mayes et al., 2011; Sukhodolsky et al., 2008; Weisbrot et al., 2005). However, these results

must be interpreted with caution because the behavioural manifestations of anxiety among lower functioning individuals are not well understood (Vasa & Mazurek, 2015).

The present study also expanded on previous findings examining the association between anxiety and social functioning among youth with ASD by controlling for age, sex, and IQ, and including domains of social functioning. The results showed medium positive associations between parent- and teacher-reported anxiety and overall social functioning (i.e., higher anxiety is associated with greater social functioning deficits). Further examination revealed that the strength of the associations between anxiety and social functioning domains varied, depending on the domain under scrutiny. Previous research on youth without ASD supports the association between anxiety, specifically social anxiety, and social functioning (Ginsburg et al., 1998; La Greca & Lopez, 1998). According to the zero-order correlations using both parent- and teacher-report, anxiety was positively associated with social cognition, social motivation, and restricted interests and repetitive behaviours (i.e., higher anxiety was associated with greater social cognition and social motivation deficits and more restricted interests and repetitive behaviours). Anxiety was also positively associated with social awareness and social communication, but these correlations were small.

Social cognition refers to the ability to interpret social cues during social situations and is necessary to understand one's relationship with another person (Factor et al., 2017). The results suggest that greater social cognition deficits are associated with more anxiety. It is likely that anxiety and social cognition have a reciprocal relationship, such that anxiety can further impair youth's ability to interpret social cues or contrarily, that the difficulty interpreting social cues can increase anxiety (Factor et al., 2017). It is not surprising that an inability to understand one's

relationship with another person can lead to increased anxiety because of uncertainty in social expectations.

The finding that anxiety is associated with greater social motivation deficits is also consistent with previous research (Factor et al., 2017). Youth with ASD often prefer to be alone due to the lack of reward from social situations and therefore, they may not be motivated to seek opportunities for social interaction (Factor et al., 2017). Additionally, individuals with ASD may find social situations to be aversive and may deliberately avoid these interactions. Individuals with anxiety also display these avoidance behaviours, which may maintain their anxiety. Thus, social motivation deficits may be related to a combination of these ASD and anxiety traits (Factor et al., 2017).

It has been previously thought that repetitive behaviours associated with ASD serve as a buffer to mitigate distress. Individuals with ASD experience fluctuating states of under- and over-arousal and thus, may engage in repetitive behaviours as a means to regulate arousal and maintain optimal stimulation (Lidstone et al., 2014; Ornitz, 1974; Ornitz & Ritvo, 1976). However, the positive association between anxiety and restricted interests and repetitive behaviours suggests that these behaviours may not be successful at regulating arousal and instead, trigger and maintain anxiety (Lidstone et al., 2014). It is also possible that repetitive behaviours may be an innate part of ASD that are self-stimulatory in function and not necessarily anxiety-reducing. It is, however, important to note that the RIRB domain on the SRS contains items that pertain to both insistence on sameness behaviours (such as difficulties changing routine and narrow range of interests) and repetitive motor behaviours (such as hand flapping and spinning objects). It may be the insistence on sameness behaviours, which would have a

greater impact on social functioning, that are linked to anxiety, as found in previous research (Boulter et al., 2014; Wigham et al., 2015).

The medium positive associations between anxiety and the domains of social functioning previously described were based on zero-order correlations. However, when the domains were entered into a regression controlling for covariates (age, sex, and IQ), a more nuanced picture emerged. The regression analyses revealed further interesting patterns that were consistent across parent- and teacher-report; both the strength and direction of the association depended on the social functioning domain. The three domains (social cognition, social motivation, and restricted interests and repetitive behaviours) also had small positive associations with anxiety (with the exception of teacher-reported social motivation, which had a medium positive association) in the regression context. Interestingly, the other two domains (social awareness and social communication) exhibited a paradoxical pattern; they had small positive associations with anxiety in the zero-order correlations, but small negative associations in the regression analyses. Compared to correlation analysis, regression analysis is a more sophisticated method for examining the association between two or more variables of interest that controls for inter-correlations between the variables (SRS domains) and takes covariates (age, sex, and IQ) into account. Therefore, when considering these other factors (i.e., intercorrelations between the variables and the covariates), the associations between the IVs and DV change.

The results from the regressions revealed that increased social awareness and social communication skills was associated with increased anxiety. There is an abundance of clinical evidence suggesting a positive association between social awareness and anxiety (Gillott et al., 2001; Kuusikko et al., 2008; McVey et al., 2018). Youth with greater social awareness are more easily able to interpret others social cues and therefore, are more likely to notice the negative

cues of others. This population may be more likely to receive negative cues from their peers due to their differences that may be recognizable to them. As a result, youth may worry about negative social evaluation (Kuusikko et al., 2008; White et al., 2013). Previous research has also revealed a similar association between social communication and anxiety, whereby an increase in social communication skills results in an increase in anxiety (Davis et al., 2011). Davis et al. (2011) offer two possible explanations for this finding: 1) youth with social communication difficulties may experience difficulties across many areas of functioning and possess a decreased ability to be anxious, or 2) the communication difficulties experienced by these youth may affect their ability to articulate anxiety symptoms. These explanations must be interpreted with caution as they may not reflect the full picture of the relationship between anxiety and social communication difficulties in ASD. For example, development might play a role in this relationship meaning that anxiety and communication skills may change across the lifespan or as a function of developmental level (Davis et al., 2011).

Overall, the results suggest that social functioning difficulties contribute significantly to the variance in anxiety in youth with ASD. The five SRS domains accounted for more variance compared to the total SRS because some of the domains operated in opposite directions. This finding reveals that specific aspects of social functioning account for variance in unique ways. We were able to examine how specific domains of social functioning contribute to anxiety, whereas other studies only examine general social functioning. Further, of the few studies that have investigated the association between anxiety and social functioning, none have controlled for age, sex, and IQ. Similar to previous studies (Magiati et al., 2016; Sukhodolsky et al., 2008; Vasa et al., 2013), age, sex, and IQ accounted for very little of the variance in both parent- and teacher-reported anxiety (around 1%). We found differences in prevalence rates as a function of

age, sex, and IQ in objective 1 when these variables were examined in a univariate manner (i.e., one variable at a time). However, in the multiple regression analyses when the interrelationships among variables are considered (i.e., examining everything simultaneously), the amount of variance accounted for was actually quite small.

The moderator analyses revealed that high IQ made a difference when social functioning difficulties are high. This finding is difficult to compare to the literature because, although previous studies have looked at some of these variables in a correlational way (e.g., Factor et al., 2017), few have looked at age, sex, or IQ as possible moderators. Sukhodolsky et al. (2008) examined IQ as a moderator of the association between parent-reported anxiety and social impairment as measured by the social interaction subscale of the ADI-R. Consistent with our findings, they found a significant interaction between IQ and social impairment, suggesting that the combination of higher IQ and higher social impairment resulted in increased anxiety. This study in conjunction with the present study suggest that anxiety symptoms may manifest differently in youth with a higher cognitive level compared to those with a lower cognitive level (Sukhodolsky et al., 2008).

In summary, the present study had a number of key strengths. Using this large heterogeneous database, we were able to address some of the previous problems in this area of research, such as including individuals that are underrepresented in the literature to date (e.g., youth with lower IQ), and contribute to the literature on mechanisms for the development of anxiety among youth with ASD. The participants were well-diagnosed and the large sample size allowed us to delve into subgroups of youth based on age, sex, and IQ. Although there was significantly less teacher data, youth with and without teacher data were compared and had no significant differences.

Limitations

Although the present study had many key strengths, there are a few limitations worth noting. First, we have more than one informant (i.e., parent and teacher) for ratings of anxiety and social functioning, but we do not have any self-report data regarding these measures. Adolescents may be a better judge of their anxiety and social functioning, because parents and teachers may miss many of their social interactions as they become more independent. White and Roberson-Nay (2009) state that the ideal scenario for child-based evaluations is incorporating parent- and teacher-report as well as self-report data. However, many individuals with ASD would be unable to read or understand questions well enough to complete such self-report measures. Direct observations of youth's social functioning and physiological measures of anxiety would be even better measures as they provide the most objective type of information (Bellini, 2006).

Second, the ASEBA measures may be suitable for youth with ASD, however, they were developed and standardized on typically developing children (Gotham et al., 2013; Rodgers et al., 2012; South et al., 2017). The ASEBA forms have not been validated with an ASD population (Gotham et al., 2013; South et al., 2017). Therefore, there is a lack of validity data on the anxiety DSM-oriented scale of the ASEBA forms in youth with ASD (Vasa et al., 2013). Measures developed specifically for typically developing children may inadvertently miss symptoms of anxiety in youth with ASD because anxiety may present differently in this population (e.g., repetitive behaviour exacerbation) (White & Roberson-Nay, 2009). Further, we were unable to calculate the internal consistency of the ASEBA forms in our study due to the lack of item-level data. Therefore, we cannot conclude that the CBCL and C-TRF/TRF are reliable. If these measures are not reliable, they may not relate to other variables in a sensible

way. The ASEBA forms are widely used, well-established forms of assessment, however, the DSM-oriented scales are less frequently used than the empirically-based narrow band scales. Some studies have found that the internal consistency of the Anxiety Problems subscale is below the cut-off point for considering it acceptable (i.e., less than .60) (e.g., Lacalle et al., 2012), whereas other studies have found it to be moderate (e.g., Nakamura et al., 2009). Third, the CBCL is neither a comprehensive measure of anxiety (i.e., there are a limited number of items) nor a specific anxiety measure; therefore, its ability to accurately identify anxiety is inconclusive (Gotham et al., 2013; Vasa et al., 2013). It could perhaps be thought of as a screener for anxiety. Finally, assessing anxiety in the ASD population is challenging (especially among younger children and those with low IQ), even with appropriate measures, because of diagnostic overshadowing (Vasa et al., 2018).

Similarly, we must exercise caution when interpreting our results pertaining to the role of social functioning because the SRS was primarily designed to assess ASD severity and identifies social impairments associated with ASD (Constantino & Gruber, 2005). Thus, the SRS may not be an appropriate measure for general social functioning and may be specific to ASD. Previous studies examining the relationship between anxiety and social functioning used more general measures of social functioning such as the Social Skills Rating System (SSRS), specifically the Social Skills scale including cooperation, empathy, assertion, responsibility, and self-control (Bellini, 2004; Bellini, 2006; Chang et al., 2012). If the SRS is measuring ASD-specific social abilities then it might be ASD severity, and not necessarily social functioning, that is associated with anxiety. However, Hus et al. (2013) found that SRS scores are highly influenced by non-ASD-specific child characteristics (e.g., cognitive level, expressive language) and behaviour

problems and therefore, the SRS should be interpreted more as a child's overall level of impairment, rather than as a measure of social impairment or ASD severity.

Fifth, the present study is cross-sectional and correlational in nature, which prevents us from understanding the direction of the association between anxiety and social functioning and drawing any causal inferences from the findings (Factor et al., 2017; Rodgers et al., 2012; Storch et al., 2012). Also, we are unable to determine the developmental trajectory of anxiety in ASD with a cross-sectional design (South et al., 2017). Finally, the present study lacks a control group of youth without ASD experiencing anxiety (Factor et al., 2017). The comparison to a control group would allow for a better understanding of the similarities and differences between youth with and without ASD, which would further illustrate the impact of ASD and anxiety on social functioning (Factor et al., 2017).

Future Research

Future research should examine the hypothesis that social functioning difficulties in ASD lead to anxiety, using other measures of social functioning and anxiety. Social functioning should be measured using both rating scales and observational methods in order to demonstrate agreement of level of social functioning (Chang et al., 2012). In addition, future studies could enhance the objectivity of this study by including a behavioural or physiological measure of anxiety. Further, future research employing longitudinal designs is necessary in order to better understand the developmental pathways of anxiety in ASD. This research design will provide answers regarding whether social functioning difficulties lead to anxiety, or vice versa (Bellini, 2006). Future studies should further explore the nature of the relationship between social functioning and anxiety (Bellini, 2006). Longitudinal studies would be useful to further investigate the association between anxiety and social functioning, examine how anxiety

progresses, and determine how social functioning difficulties can affect later expressions of anxiety (Bellini, 2006).

Clinical Implications

The results of the present study have important implications for clinicians working with ASD populations. First, the results emphasize the importance of taking anxiety into account when assessing youth with ASD. During assessments, comorbidities and differential diagnoses must be considered fully. Second, the knowledge that social functioning accounts for a large percentage of the variance in anxiety in this population will help inform behavioural mental health interventions (South & Rodgers, 2017). Interventions that target social functioning (e.g., social skill training programs) may enhance the effectiveness of treatment for youth with ASD (South & Rodgers, 2017). Also, Early Intensive Behavioural Intervention (EIBI), an evidence-based behaviour therapy for the treatment of ASD employing principles of applied behaviour analysis (ABA), is a common and effective intervention used for social skill deficits. Previous research has found that reductions in anxiety symptoms can be achieved by targeting social skills in an explicit manner (Lei et al., 2017). This area of research would benefit from examining the effectiveness of social skills interventions in reducing anxiety (Bellini, 2004). Instead of just examining the effectiveness of ABA strategies in addressing social skill deficits, future behavioural research should explore how social skill development through the use of ABA strategies impacts anxiety behaviours in youth with ASD. Finally, the results of the present study would assist in identifying at-risk youth (i.e., those with low social functioning) and developing preventive therapeutic and school-based interventions with the goal of improving youth's social functioning and social experiences, which will likely reduce anxiety levels and associated difficulties in later developmental stages (Vasa & Mazurek, 2015).

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