ANXIETY AND ADAPTIVE FUNCTIONING OUTCOMES IN AUTISM SPECTRUM DISORDER

By

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Written under the direction of

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THESIS ABSTRACT

Anxiety and Adaptive Functioning Outcomes in Autism Spectrum Disorder

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Autism Spectrum Disorder (ASD) is a lifelong neurological disorder affecting 1 in 59 individuals (Centers for Disease Control and Prevention [CDC], 2018). ASD is highly comorbid with anxiety and core symptomology often also leads to deficits across all domains of adaptive functioning (Simonoff et al., 2008). However, little is known about the intersectionality between anxiety, adaptive function, and the core symptoms of autism. This study aims to identify whether anxiety has a unique impact on adaptive functioning in ASD, and if so, which domains it most impacts. Cross-sectional data (n=367) previously collected at the Center for Autism Research were analyzed. Vineland Adaptive Behavior Scale (VABS; Sparrow, Cicchetti & Balla, 2005) scores were predicted from the interaction between the Social Responsiveness Scale (SRS; Constantino et al., 2000) and the Screening for Children Anxiety Related Disorders-Revised (SCARED; Birmaher et al., 1997) via multiple regression model analyses. No significant results were found, suggesting that anxiety may not play a unique role in predicting adaptive functioning above and beyond core ASD symptoms. Implications for future research, treatment, and intervention are discussed.
Introduction

Autism Spectrum Disorder (ASD) is a lifelong neurological disorder affecting 1 in 59 individuals (Centers for Disease Control and Prevention [CDC], 2018). Research suggests that children diagnosed with ASD often suffer from deficits in adaptive functioning, resulting in negative outcomes in employment, relationships, and academic achievement (Liss et al., 2001; Klin et al., 2006; Hong et al., 2016). While these consequences are typically related to the core symptoms of ASD itself, it has been widely demonstrated that ASD is associated with medical and psychiatric comorbidities that may have as much or more of an impact on adaptive functioning. In particular, anxiety has a high comorbidity with ASD, and is present in nearly 50% of children on the spectrum (Simonoff et al., 2008). However, the extent of impact these co-occurring symptoms have on adaptive outcomes has been understudied. An understanding of this relationship and level of impact is critical for effective treatment development and in reducing negative outcomes in ASD. The identification of the unique role of anxiety symptoms in ASD outcomes would indicate that more attention should be paid to anxiety treatments in ASD, in addition to treatments targeting core symptoms (such as applied behavioral analysis and social skills training). Therefore, the primary goal of this study is to identify the impact that anxiety has on adaptive functioning outcomes in ASD. We hypothesize that anxiety symptoms have a unique contribution to functional outcomes in ASD that are not fully accounted for by the symptoms of ASD themselves. The secondary goal of this study is to identify which domains of adaptive functioning, if any, are most impaired by the presence of anxiety symptoms. Given the literature emphasizing social deficits in
ASD, we hypothesize that the socialization domain will be most impaired by the presence of anxiety in children and adolescents with ASD.

*Autism Spectrum Disorder*

ASD is an all-encompassing term which accounts for multiple previously independent diagnoses. These include: Autistic Disorder, Pervasive Developmental Disorder- Not Otherwise Specified (PDD-NOS), Asperger’s Syndrome, and Childhood Disintegrative Disorder (“Autism Speaks”, 2018). It has been found to be more prevalent in males than females, with a diagnostic rate of 4:1, respectively (CDC, 2018). According to the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-V; American Psychiatric Association, 2013) symptoms of ASD include: persistent deficits in social communication and social interaction, and restricted and repetitive patterns of behavior, interests, or activities. Symptoms must be present during a child’s early developmental period, even if they do not fully emerge until adolescence. The severity of these symptoms have a wide range; however, they typically cause impairment in social, occupational, or other areas of functioning (American Psychiatric Association, 2013). Additionally, the core symptoms of ASD commonly lead to impairments across all domains of adaptive functioning (Liss et al., 2001). Though the criteria are well established, ASD can often be difficult to diagnose due to its high rates of comorbidity with other disorders. Highly comorbid disorders include seizure disorder, depression, and anxiety (Bellini, 2004). Anxiety, in particular, has been found to co-occur in nearly 50% of children on the spectrum (Simonoff et al., 2008).
Adaptive Functioning in Autism Spectrum Disorder

Adaptive functioning is commonly defined as one’s ability to perform behaviors necessary for living independently, including daily living skills, social skills, and communication skills (Kenworthy et al., 2009; Klin et al., 2006). Abilities that fall within this domain range from basic living functions; such as grooming and dressing, to necessary skills for social integration and communication; including one’s ability to develop relationships with others (Klin et al., 2006). Adaptive functioning can be measured by either clinician based interview or parent report questionnaire. Two of the most commonly used measures of adaptive functioning are the Vineland Adaptive Behavior Scale (VABS; Sparrow, Cicchetti & Balla, 2005) and the Adaptive Behavior Assessment System-II (ABAS-II; Harrison & Oakland, 2003).

The assessment of adaptive functioning is a crucial component for evaluating children on the spectrum. While it has been found that adaptive function impairments are represented across all domains, research suggests that there may be a specific “Autism Profile” (Perry et al., 2009), which states, the socialization domain is typically the most affected and has the least variation. For instance, in a study conducted by Perry, Flanagan, Dunn Geier, and Freeman (2009) the researchers explored whether the “Autism Profile” was present in a sample of 318 children between 22 and 71 months of age. They conducted a retrospective file review from three sites that specialize in assessing children with ASD. Through their analyses of the VABS age equivalents, they found support for the presence of this profile. In other words, participants had the highest levels of impairments in the socialization domain while the level of impairment across the other adaptive domains was more varied. In a similar study conducted by Kenworthy,
Case, Harms, Martin, and Wallace (2009), the researchers also found support for the presence of this profile. The ABAS-II was administered to parents of 30 typically developing individuals between the ages of 12 and 21, and 40 individuals between the ages of 12 and 22 with an ASD diagnosis. They found that the participants with an ASD diagnosis showed significantly higher levels of impairment than the typically developing participants. Though the ASD participants showed impairments across all domains, they showed relatively greater levels of impairment in regards to their social skills.

In 2010, 1,089 children between the ages of 4 and 27 with an ASD diagnosis participated in a multi-site study known as the Simons Simplex Collection (SSC). In this study, parents completed the VABS along with other diagnostic measures. The researchers found that participants showed levels of adaptive functioning impairment across all domains. Similar to the previous studies, they found a significantly higher level of impairment within the socialization domain. Participants obtained an average standard score of 72.5 (almost 2 standard deviations below the population mean score of 100) on the socialization domain. Whereas, they only fell about one and a half standard deviations below the mean in all other domains (Kanne et al., 2010).

The aforementioned deficits in adaptive functioning in children with ASD have been found to correlate with a multitude of factors such as symptom severity, cognitive ability, and age. In the study conducted by Kenworthy et al. in 2009, trained research-reliable clinicians administered the ADOS to participants. They found that ASD symptom severity was negatively correlated with adaptive functioning levels in children with high functioning ASD. An increased symptom severity (characterized by higher ADOS symptom tallies), led to a decrease in adaptive functioning across all domains in the
ABAS-II. Perry et al. (2009) explored the independent relationships between adaptive functioning and symptom severity, and adaptive functioning and cognitive ability. In this study, the sample of 192 ASD participants was divided into 6 groups based on cognitive ability. The classification of these groups ranged from “average” (IQ greater than or equal to 85) to “Profound Mental Retardation” (IQ less than or equal to 24). Results indicated that cognitive ability was strongly positively correlated with adaptive functioning, particularly in the communication domain. They also found support for a relationship between symptom severity and adaptive functioning. Autism severity was moderately negatively correlated with adaptive functioning. Thus as participant symptom severity increased, adaptive functioning skills decreased across the domains.

Additionally, Liss et al. (2001) studied adaptive functioning impairments through the comparison of two groups of children. In one group, 9 year old children with high functioning ASD were matched with same-aged children with a developmental language disorder. In the second group, 9 year old children with low functioning ASD were matched with same-aged children with low IQ. They found that cognitive ability was strongly predictive of adaptive functioning impairments in the children with low functioning ASD. However, this was not the case for the children in the high functioning ASD group. In terms of age, Klin et al. (2006) found evidence to suggest that adaptive functioning (specifically communication and social skills) worsens with age. They conducted a multi-site study in which 187 individuals with an ASD diagnosis between the ages of 7 and 18 participated. Trained clinicians at each site administered the VABS and ADOS to all participants. Their results indicated that individuals with ASD may
become more impaired relative to their typically developing peers as they enter into adolescence (Klin et al., 2006).

Adaptive functioning plays an integral role in understanding the symptomology of ASD. Therefore, its assessment is crucial for diagnosis as well as intervention planning (Kenworthy et al., 2009; Fenton et al., 2003). Taking a closer look at these skills allow us to better understand an individual’s ability to function in daily situations that are necessary for independent success (Lopata et al., 2013). Impairments in these skills, such as socialization and communication, are defining features of ASD. Therefore, evaluating these in multiple contexts allows for increased accuracy when diagnosing (Fenton et al., 2003). This information is particularly important when considering the future of ASD interventions. Having a better understanding of the areas in which children with ASD commonly suffer will allow for successful treatment planning for each child. For instance, we have seen that socialization is commonly impaired, therefore, this should be a central part of ASD intervention.

Anxiety and Autism Spectrum Disorder

Children on the spectrum are commonly diagnosed with at least one co-occurring psychiatric disorder. In a sample of 112 children, Simonoff et al. (2008) found that roughly 70% of participants had at least one comorbid disorder and 41% were characterized with 2 or more comorbid disorders. Specifically, high rates of comorbid anxiety diagnoses have been reported in children with ASD (Wood & Gadow, 2010). Roughly 40-55% of children on the spectrum have clinically elevated anxiety symptoms or have been diagnosed with at least one anxiety disorder (Van Steensel, Bogels, & Perrin, 2011; Simonoff et al., 2008). Furthermore, the literature suggests that anxiety
diagnoses are more common in children with ASD compared to their typically developing peers (Bellini, 2004). Findings suggest that social anxiety is the most common type of anxiety to co-occur in ASD (Bellini, 2004). Simonoff et al. (2008) found that amongst their sample, the highest co-occurring diagnosis with ASD was social anxiety (29.2%).

Comorbid anxiety has been found to impact multiple areas of daily functioning in children with ASD (Eussen et al., 2012). Prior research suggests that anxiety causes high rate of impairment, specifically, in the areas of socialization. Impacted socialization skills include quality of social communication, socially assertive and responsible behaviors, and social relations. In order to examine the impact of anxiety on social functioning in ASD, Chang, Quan and Wood (2012) administered a series of standardized measures and questionnaires to 53 school aged children and their parents. Their results indicated that social anxiety causes an increase in social functioning deficits and that higher levels of social anxiety were correlated with lower “assertive and responsible” social skills. These behaviors include initiating conversations with peers or joining in on group activities, and asking permission to use someone’s property or reporting an accident, respectively (Chang et al., 2012). Similarly, Bellini (2004) administered standardized measures that assess social behavior and anxiety symptomology to 41 adolescents with an ASD diagnosis and their parents. Results suggested an inverse relationship between assertive social skills and social anxiety in high functioning teens with ASD (Chang et al., 2012).

As part of a multi-site study (Social Spectrum Study), 130 children were recruited and administered ASD and anxiety assessments at 2 time points. The researchers found that significant anxiety levels contributed to social communication impairments at each
time point (Duvekot, Van Der Ende, Verhulst, & Greaves-Lord, 2017). Eussen et al. (2012) hypothesized that increased anxiety severity is correlated with decreased quality of social relations. Social relations were measured through administration of the Children’s Communication Checklist (CCC; Bishop 1998). This checklist measures social relations via questions about whether or not a child has friends, if they are bullied or teased, and if they are rejected by their peers, or have social support (Bishop, 1998). Their hypothesis was supported, as they found that increased levels of anxiety were associated with reduced quality of social relations (Eussen et al., 2012).

As exemplified through the literature, anxiety and ASD are highly comorbid disorders. Therefore, it is important to understand why this intersection between the two exists. Wood and Gadow (2010) proposed two functions of anxiety symptoms that might explain the heavy comorbidity between the two. First, it is possible that core ASD symptoms lead to the manifestation of anxiety. For instance, social rejection as a result of impaired social skills may generate stress (Wood & Gadow, 2010). Similarly, an absence of coping strategies when undergoing stress may result in anxiety (Wood & Gadow, 2010). In addition, an understanding of one’s social deficits can lead to increased anxiousness. If a child is cognizant of their social impairments, they may become anxious about social situations (White, Oswald, Ollendick, & Scahill, 2008).

Second, anxiety may be a moderator of ASD symptoms. This is to say, core deficits in ASD such as repetitive behaviors and social skills problems may be increased as a result of anxiousness (Wood & Gadow, 2010). For instance, repetitive behaviors may be triggered as a result of increased anxiety. If a child with ASD experiences an anxiety provoking situation or thought, they may exhibit repetitive behaviors as a mechanism to
decrease their anxiousness (Wood & Gadow, 2010). Additionally, if a child displays social anxiety due to a fear of being rejected by their peers, the social ineptness that accumulates from that anxiousness can exacerbate the symptoms of ASD (Chang et al., 2012).

*The Relationship between Anxiety, Adaptive Functioning, and Autism Spectrum Disorder*

The independent interplays between anxiety and ASD, and adaptive functioning and ASD have been highly researched. However, very little is known about the unique relationship between all three. Specifically, there is a large gap in the literature regarding the way in which having anxiety affects adaptive functioning outcomes in children with ASD, above and beyond ASD’s score symptoms. Research findings suggest that children on the spectrum commonly have impairments in adaptive functioning and also suffer from comorbid anxiety. Therefore, a deeper understanding of this relationship is crucial when considering the symptomology of ASD.

There has been research that suggests a relationship between adaptive functioning and the prevalence of anxiety symptoms. In 2015, Magiati et al. conducted a cross-sectional study that examined the association that gender, age, and adaptive functioning had with anxiety. They administered assessments of overall emotional, behavioral, and adaptive functioning to parents of 241 school aged children attending special schools in Singapore. Through their analyses they found that levels of adaptive functioning impairment contributed to anxiety symptom severity. Adaptive functioning was especially predictive of the severity of social anxiety and Generalized Anxiety Disorder (Magiati et al., 2015). Studies have shown that anxiety often leads to impairments in socialization, one of the core domains of adaptive functioning. However, there is little to
no research about the collective impact that anxiety has on the other domains of adaptive functioning in children with ASD (i.e.: communication and daily living skills). We know that people with ASD who have comorbid anxiety may have worse outcomes in adaptive functioning, but the extent to which those outcomes are driven by anxiety or ASD is unknown. It is important to understand the underlying mechanisms of adaptive functioning impairment due to the intersection of anxiety and ASD in order to successfully diagnose and intervene. We hypothesize that the interaction between anxiety and ASD symptoms will effect adaptive functioning outcomes, and that the Socialization domain (VABS) will be most impaired as a result.
Methods

Procedure

The purpose of this retrospective study was to identify whether symptoms of anxiety play a unique role in adaptive functioning impairment among individuals with ASD by using cross-sectional data from a large repository of data previously collected at the Center for Autism Research (CAR), of the Children’s Hospital of Philadelphia. Participant data were previously collected under six federally, state, and industry funded studies conducted over an eight-year period. The studies spanned several areas of autism research, including neurobiology of ASD and clinical exploration of autism phenotypes through brain imaging. However, these six studies all involved overlapping experimental protocols, particularly in terms of the clinical and questionnaire assessment. As this was a retrospective study, no new participants were recruited. In order to recruit participants, the coordinators of the original studies utilized a variety of recruitment mechanisms including: sending email requests, postings on websites and social media platforms, speaking with collaborators such as physicians or other practitioners, and community outreach (i.e.: handing out flyers at local autism events).

Participants were assessed at one time point in each of the studies. Since each study required in-depth characterization, assessment protocols typically required multiple days of participation. Participants completed a wide array of assessments and questionnaires, such as diagnostic and behavioral questionnaires/assessments and neuroimaging procedures. Evaluative assessments were administered by qualified faculty, post-doctoral fellows, and research-reliable study clinicians at CAR. Participants were also given both self-report and informant report measures which were filled out either
prior to or during study visits. Compensation was not a factor in the present study, due to lack of direct participant involvement. However, all participants who contributed to the data were previously compensated for their time at the end of participation for each hour of participation, travel fees (mileage and tolls), meals during visits, and lodging if applicable. With the procedures of the current study relying on data collection and analyses, the help of research assistants or other students was not required.

Since this study makes use of archival data, it was considered for exempt review by the Institutional Review Board. All data generated during these studies have been kept confidential in accordance with institutional HIPAA policies at the Children’s Hospital of Philadelphia. Additionally, all data included in this dataset were de-identified further protecting the participants who contributed to the dataset. There was no need for obtaining additional informed consent or assent for the present study. All participants contributing to the data gave informed consent and assent (when applicable) prior to participation in the original studies. Consent included the future use of data for additional studies (including the current study). Data were not included in the present study for those participants who indicated they would not like their data used for future research. After the original data collection phase ended, participants were debriefed either in person at CAR or via phone. Families were also given verbal or written feedback along with treatment recommendations.

Participants

Approximately 800 participants were actively enrolled in the prior studies that contributed to our dataset. Only data from the participants with a confirmed ASD diagnosis were compiled for the present study, reducing the sample size to 367.
Participants with missing data necessary for this study were excluded from analyses (n=19). One additional participant was excluded from analyses due to inaccurately entered data (VABC above the ceiling), bringing our final sample down to 347 after analyses. Participant ages ranged from 5-18 years and approximately 88% (n= 306) were male. The gender distribution of our sample was expected due to the higher prevalence of ASD diagnoses in males. Ethnicity information was provided by 87% of participants, with roughly 80% (n=278) identifying as Non-Hispanic. Additionally, 99% of participants provided information about race. Eighty three percent (n= 289) of participants identified as White, 8% (n= 29) Black, 4% (n=14), biracial, 2% Asian (n= 7), and 2% (n=7) indicated ‘race not specified’ or other. An estimate of socioeconomic status via combined family income was reported by 86% (n= 298) of participants and the medium income ranged from $70,000-$100,000.

Measures

The independent variables in this study were total scores on the Social Responsiveness Scale (SRS; Constantino et al., 2000), and the Screening for Children Anxiety Related Disorders-Revised (SCARED-R; Birmaher et al., 1997). The SRS (Constantino et al., 2000) is a 65-item parent-report questionnaire that measures ASD related symptomology in children ages 4-18 years. Parents are asked to rate the frequency of reciprocal social behaviors, communication, and repetitive and stereotypic behaviors in their child. The questionnaire yields a single summary score that can be used as an index of the child’s severity of social deficits. The SRS has demonstrated good internal consistency, test-retest reliability, and inter-rater reliability (Constantino et al., 2000). The Revised version of the SCARED (SCARED-R; Birmaher et al., 1997) is a 66-item
self-report questionnaire that intends to measure the entire spectrum of DSM-defined anxiety disorder symptoms in children.

The dependent variable in this study was the functional outcomes of ASD, which was measured through the Vineland Adaptive Behavioral Composite (VABC). The VABC is generated through the Vineland Adaptive Behavior Scale (VABS; Sparrow, Cicchetti & Balla, 2005) and is the total score. The VABS is a highly reliable and well normed measure of adaptive behavior functioning, that measures what a child routinely does, not merely what they are capable of doing. Adaptive functioning is assessed across the domains of Communication, Daily Living, Socialization, and Motor Functioning. Together, these measures were used to assess the impact of the interaction of anxiety and ASD symptoms on adaptive functioning outcomes in children with ASD.

Data Analysis

Data analyses for this study were conducted using the statistical language R. The initial step in the analysis process was organization and filtering of acquired data. The principal inclusion criteria for the dataset is the administration of a VABS, as this was used as the primary outcome measure. Many of the participants included in this dataset had been enrolled in multiple studies at CAR. This presented the unique opportunity to aggregate all of their assessments and questionnaires and select the study that resulted in the most comprehensive dataset. For instance, if a participant was enrolled in multiple studies, data from the study resulting in the most comprehensive dataset was selected for inclusion. These criteria allowed for minimizing the presence of missing data within this selected dataset.

Our first hypothesis was tested via multiple linear regression models predicting VABS total scores from SRS and SCARED-R total scores. In particular, we aimed to see
whether there is a SRS by SCARED-R interaction that predicts VABS total scores. Our second hypothesis, that the Socialization domain of adaptive functioning, if any, would be most impaired was also tested via multiple linear regression models. We measured the effect of the interaction between SRS and SCARED total scores on each of the individual subdomains of the VABS (Communication, Daily Living, and Socialization). Post hoc analyses, also using linear multiple regression, were conducted to evaluate whether any observed effects were driven by individual anxiety subdomains (for example, social anxiety versus generalized anxiety). To do so, we observed the outcome of interaction between the SRS total score and each of the SCARED-R subscale scores on the VABS total scores.
Results

Distribution of Scores

The distribution of participant scores on each measure used are presented in Figure 1. The SRS is used to measure severity of ASD symptoms, and scores above 60 are considered to be clinically significant. The mean score for our sample was 75 (SD = 10.13), which falls above the cutoff. This distribution of scores was to be expected given that the current sample only included individuals who had a documented ASD diagnosis.

The SCARED-R is used to measure anxiety symptoms and has a clinical cut off of 25. The mean score for our sample was 18 (SD= 12.93). Interestingly, although the distribution of scores was fairly varied, only 27% (n=93) of participants had a score above the clinical cut off. The literature predicts that roughly 40% of individuals with ASD will also present anxiety symptomology. This would suggest that our sample was less effected by anxiety as compared to the broader ASD population.

The VABS is used to measure levels of adaptive functioning across multiple domains. Scores ranging from 86-114 indicate adequate adaptive functioning, scores from 71-85 indicate moderately low adaptive functioning, and scores below 70 indicate severe impairment. The mean score for our sample was 76 (SD = 11.65) suggesting that in general, the sample had moderately low adaptive functioning. The distribution was skewed toward lower scores suggesting that a majority of participants’ adaptive functioning was moderately to severely impaired.
Multiple Linear Regression Models

Contrary to our first hypothesis, the interaction between anxiety and ASD severity did not significantly predict adaptive functioning outcomes. While the overall multiple regression models revealed significant results across all analyses, this was driven by the individual influence of SRS scores on VABS scores (SRS was significantly predictive of VABS scores) due to the high correlation between ASD severity and adaptive functioning impairment. Our first hypothesis primarily focused on the interaction between anxiety and ASD symptoms in predicting adaptive behavior. For that reason, we focused on the interaction term within each of the models. A multiple linear regression predicting VABS total score from SRS total and SCARED-R total scores revealed non-significant results ($p = .294$; see Table 1). The models predicting scores on each individual VABS domain
(Communication, Daily Living Skills, and Socialization) from the SRS and SCARED-R total scores also revealed non-significant results, which did not support our second hypothesis. These results are summarized in Tables 2-4. Post hoc analyses predicting VABS total scores from the SRS total score and each individual SCARED-R subscale scores (Panic, Generalized Anxiety, Separation Anxiety, and Social Anxiety) also revealed non-significant findings. These results are summarized in Tables 5-8.

Table 1. A summary of multiple linear regression model predicting VABS total score from SRS total score and SCARED-R total score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Total</td>
<td>-0.487</td>
<td>0.627</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-6.107</td>
<td>2.76e-09 ***</td>
</tr>
<tr>
<td>SCARED-R Total: SRS Total</td>
<td>1.052</td>
<td>0.294</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Adjusted R² = 0.1623, (F(3, 343) = 23.34, p = 9.01e-14
Note: t and p values are presented here. Predicting VABS total scores from SRS total scores revealed significant results (p= 2.76e-09). Non-significant results were found both when predicting VABS total scores from the SCARED-R total scores (p=0.627) and the interaction between SCARED-R and SRS total scores (p= 0.294).

Table 2. A summary of multiple linear regression model predicting VABS Communication domain score from SRS total score and SCARED-R total score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Total</td>
<td>-0.722</td>
<td>0.471</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-4.956</td>
<td>1.13e-06 ***</td>
</tr>
<tr>
<td>SCARED-R Total: SRS Total</td>
<td>1.123</td>
<td>0.262</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Adjusted R² = 0.1017, (F(3, 343) = 14.05, p = 1.163e-08
Note: t and p values are presented here. Predicting VABS total scores from SRS total scores revealed significant results (p= 1.13e-06). Non-significant results were found both when predicting VABS total scores from the SCARED-R total scores (p=0.471) and the interaction between SCARED-R and SRS total scores (p= 0.262).
### Table 3. A summary of multiple linear regression model predicting VABS Daily Living Skills domain score from SRS total score and SCARED-R total score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Total</td>
<td>-0.181</td>
<td>0.857</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-3.872</td>
<td>1.29e-02 ***</td>
</tr>
<tr>
<td>SCARED-R Total: SRS Total</td>
<td>0.779</td>
<td>0.437</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.

Adjusted $R^2 = 0.07686$, (F(3, 343) = 10.6, $p = 1.104e$-06

Note: t and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=1.29e$-02). Non-significant results were found both when predicting VABS Daily Living Skills domain scores from the SCARED-R total scores ($p=0.857$) and the interaction between SCARED-R and SRS total scores ($p=0.437$).

### Table 4. A summary of multiple linear regression model predicting VABS Socialization domain score from SRS total score and SCARED-R total score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Total</td>
<td>-1.361</td>
<td>0.175</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-8.385</td>
<td>1.33e-15 ***</td>
</tr>
<tr>
<td>SCARED-R Total: SRS Total</td>
<td>1.813</td>
<td>0.071</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.

Adjusted $R^2 = 0.2588$, (F(3, 343) = 41.26, $p < 2.2e$-16

Note: t and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=1.33e$-15). Non-significant results were found both when predicting VABS Socialization domain scores from the SCARED-R total scores ($p=0.175$) and the interaction between SCARED-R and SRS total scores ($p=0.071$).

### Table 5. A summary of multiple linear regression model predicting VABS total score from SRS total score and SCARED-R Panic subscale score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Panic</td>
<td>0.410</td>
<td>0.682</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-6.157</td>
<td>2.08e-09 ***</td>
</tr>
<tr>
<td>SCARED-R Panic: SRS Total</td>
<td>-0.163</td>
<td>0.871</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.

Adjusted $R^2 = 0.1349$, (F(3, 343) = 18.99, $p = 2.052e$-11

Note: t and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=2.08e$-09). Non-significant results were found both when predicting VABS total scores from the SCARED-R Panic scores ($p=0.682$) and the interaction between SCARED-R Panic scores and SRS total scores ($p=0.871$).
**Table 6.** A summary of multiple linear regression model predicting VABS total score from SRS total score and SCARED-R Generalized Anxiety subscale score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Gen. Anxiety</td>
<td>-0.699</td>
<td>0.485</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-6.563</td>
<td>1.95e10  ***</td>
</tr>
<tr>
<td>SCARED-R Gen. Anxiety: SRS Total</td>
<td>1.360</td>
<td>0.175</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Adjusted $R^2 = 0.1768$, (F(3, 343) = 25.76, $p = 4.707e-15$
Note: $t$ and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=2.76e-09$). Non-significant results were found both when predicting VABS total scores from the SCARED-R Generalized Anxiety scores ($p=0.485$) and the interaction between SCARED-R Generalized Anxiety and SRS total scores ($p=0.175$).

**Table 7.** A summary of multiple linear regression model predicting VABS total score from SRS total score and SCARED-R Separation Anxiety subscale score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Sep. Anxiety</td>
<td>-0.313</td>
<td>0.754</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-6.384</td>
<td>5.6e-10  ***</td>
</tr>
<tr>
<td>SCARED-R Sep. Anxiety: SRS Total</td>
<td>0.757</td>
<td>0.450</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Adjusted $R^2 = 0.151$, (F(3, 343) = 21.52, $p = 8.558e-13$
Note: $t$ and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=5.6e-10$). Non-significant results were found both when predicting VABS total scores from the SCARED-R Separation Anxiety scores ($p=0.754$) and the interaction between SCARED-R Separation Anxiety and SRS total scores ($p=0.450$).

**Table 8.** A summary of multiple linear regression model predicting VABS total score from SRS total score and SCARED-R Social Anxiety subscale score

<table>
<thead>
<tr>
<th>Predictors</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCARED-R Social Anxiety</td>
<td>-1.427</td>
<td>0.155</td>
</tr>
<tr>
<td>SRS Total</td>
<td>-5.797</td>
<td>1.53e-08  ***</td>
</tr>
<tr>
<td>SCARED-R Social Anxiety: SRS Total</td>
<td>1.651</td>
<td>0.100</td>
</tr>
</tbody>
</table>

***p < 0.001, **p < 0.01, *p < 0.05.
Adjusted $R^2 = 0.1383$, (F(3, 343) = 19.51, $p = 1.062e-11$
Note: $t$ and $p$ values are presented here. Predicting VABS total scores from SRS total scores revealed significant results ($p=1.53e-08$). Non-significant results were found both when predicting VABS total scores from the SCARED-R Social Anxiety scores ($p=0.155$) and the interaction between SCARED-R Social Anxiety and SRS total scores ($p=0.100$).
Discussion

The primary purpose of the current study was to better understand the impact that anxiety has on adaptive functioning outcomes in children with ASD. It was hypothesized that the interaction between anxiety and ASD symptoms would significantly predict adaptive functioning outcomes. In addition, we aimed to determine which domain of adaptive functioning, if any would be most impaired by this interaction. We hypothesized that the Socialization domain would be most affected due to the previous literature.

Cross-sectional data from 6 previously conducted studies at the Center for Autism Research were compiled and analyzed. The final sample consisted of 347 individuals between the ages of 5-18 with a confirmed ASD diagnosis, making this retrospective study the largest study of its kind to date. Data were analyzed via multiple linear regression models. First we looked at how predictive the interaction between SRS and SCARED-R total scores were of VABS total scores. Next, we again looked at the interaction of SRS and SCARD-R total scores, this time measuring their effect on each of the domains of the VABS individually. We also conducted post hoc analyses to look at the potential observed effects of the SCARED-R more granularly. We measured the extent to which the interaction between the SRS total and individual anxiety subscale scores would predict VABS total scores.

Our hypothesis that anxiety would interact with social deficits in predicting adaptive functioning was not supported. Across the models we expected that SRS scores would be highly predictive of VABS scores due to the high correlation between ASD symptoms and adaptive functioning. Therefore, these significant findings do not necessarily indicate that anxiety also plays a role in adaptive functioning outcomes. In
order to measure the effect of having anxiety and ASD on adaptive functioning, we looked at the interaction between the two and found non-significant results.

The results of the present study suggest that anxiety may not actually significantly predict or affect adaptive functioning outcomes in children with ASD. The main implication of our findings is related to treatment. As we know, anxiety in ASD is very common, so anxiety treatments are often necessary. However, anxiety treatment may not also help to improve adaptive functioning, as the two may not be related. Therefore, the present data do not support the notion that anxiety-specific treatments in ASD are likely to impact adaptive function, above and beyond the benefits of standard treatments, such as Applied Behavior Analysis, that target core social deficits.

It is possible that the VABS may be sensitive to detecting severe adaptive functioning impairments. For instance, someone can have significant anxiety that may not affect adaptive functioning enough to be recognized by this measure, although adaptive functioning is still affected. According to the literature, almost 50% of individuals with ASD will also experience comorbid anxiety symptoms. The distribution of SCARED-R scores in our sample indicated that 28% of participants fell above the clinical cut off, which according to previous literature, may not be representative of the general ASD population. This may have impacted our results due to floor effects, where there was insufficient variance at the low end of the SCARED-R distribution to have predictive power. In addition, the SCARED-R, while highly validated, is not specifically designed to measure anxiety in ASD. Due to the symptomology of ASD, anxiety may present itself differently in children on the spectrum than in their typically developing peers, causing symptoms to be overlooked. As such, this measure may not successfully
capture the presence of symptoms in children with ASD. For example, limited verbal ability or repetitive behaviors may mask anxiety symptoms. Therefore, additional research using other anxiety measures or ASD-specific anxiety measures, such as the Parent-Rated Anxiety Scale for ASD (PRAS-ASD; Scahill et al., in press) may suggest a more significant relationship with adaptive functioning outcomes.

The present study contained various limitations. The first limitation is related to the measures selected for analyses. Given that anxiety symptoms may present themselves differently in individuals with ASD, it is possible that the SCARED-R was not able to appropriately detect present anxiety symptoms. Furthermore, the SCARED-R relies on self-report which can be challenging for children on the spectrum. Individuals with ASD may not be cognizant of or understand the anxiety symptoms they are feeling, which may lead to inaccurate reporting and ultimately inaccurate data. Another possibility is that the VABS is highly sensitive to severe adaptive functioning impairment and as such, mild effects on adaptive functioning were not captured. The second limitation is related to the sample used. Although our sample was very large, the results may not generalize to the general ASD population. Over 80% of participants were Non-Hispanic White males, and a majority of participants came from average SES families. Our findings would need to be validated in follow up studies with other measures and a more diverse sample to be confirmed.
References


