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Is Reduced Social Competence a Mechanism Linking Elevated Autism Spectrum Symptoms with Increased Risk for Social Anxiety?

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Abstract

Objectives: Approximately 50% of children with autism spectrum disorder (ASD) develop comorbid social anxiety disorder, and this comorbidity predicts poorer treatment outcomes than either syndrome alone. ASD and social anxiety are both associated with reduced social competence as evidenced by difficulties implementing fundamental social skills for successful social interactions, but it remains unclear whether reduced social competence reflects a mechanism that explains the increased risk for social anxiety associated with elevated autism spectrum symptoms.

Design/Methods: To address this gap in the literature, the current study combined multi-informant measures (child, parent, and teacher report) with a sample of 194 children with and without psychiatric disorders (ages 8–13; 68 girls; 69% White/Non-Hispanic). Autism spectrum traits, social competence, and social anxiety symptoms were measured continuously.

Results: Bias-corrected, bootstrapped conditional effects modeling indicated that elevated parent-reported autism spectrum symptoms predicted reduced teacher-perceived social competence ($\beta=-.21$) and elevated child self-reported social anxiety ($\beta=.17$); reduced social competence accounted for 20% of the autism/social anxiety link (indirect pathway $\beta=.04$, $ER=.20$), and reduced social competence also predicted higher social anxiety independent of autism symptoms ($\beta=-.16$; all 95% CIs exclude 0.0, indicating significant effects). Exploratory analyses suggested that these findings were driven primarily by autism spectrum social communication difficulties rather than restricted/repetitive behaviors/interests.

Conclusions: The current findings are consistent with prior work implicating reduced social competence as a risk factor for the development of social anxiety among children with ASD, and extend prior work by demonstrating that this link is robust to control for mono-informant/mono-

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Conflict of Interest:

The authors have no conflicts of interest to report.

Ethical Approval:

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

Informed Consent:

Informed consent was obtained from all individual participants included in the study.

measure bias, age, sex, SES, majority/minoritized race/ethnicity status, clinical comorbidities, and item overlap across measures.

Keywords

autism spectrum; social anxiety; social competence

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that affects approximately 1.5–4.9% of children in the United States (Xu et al., 2019). The core deficits in the acquisition and consistent implementation of social skills in ASD are associated, in turn, with reduced social competence (Solomon et al., 2010) that has been hypothesized to lead, in part, to the myriad distressing and impairing outcomes associated with ASD (e.g., White et al., 2007). For example, children diagnosed with ASD in early childhood are at increased risk for developing social anxiety disorder in later childhood or adolescence (Spain et al., 2018). ASD and social anxiety disorder often co-occur (Zaboski & Storch, 2018), and previous literature suggests that deficits in social competence may be a mechanism through which children with ASD develop social anxiety (Chang et al., 2012). Further, emerging evidence emphasizes the need to consider conditions such as ASD (Constantino & Todd, 2003; Robinson et al., 2011) and social anxiety disorder (Fehm et al., 2008) as extremes along natural continuums of characteristics that are normally distributed across the general population. Given the variability of social competence within the general population (Rose-Krasnor, 1997), it is possible that social competence serves as a mechanism linking autism spectrum symptoms and elevated social anxiety even in non-clinical populations. However, extant literature demonstrating these relations is often limited by single informant methods, does not address construct/measurement overlap, is confined to samples of children meeting full diagnostic criteria for psychiatric disorders, and is understudied in middle childhood relative to adolescence and adulthood. Understanding the mechanisms and processes through which autism spectrum symptoms confer risk for co-occurring social anxiety symptoms is important given that their combined presence predicts poorer treatment outcomes relative to children presenting with either syndrome alone (Maddox, Miyazaki, & White, 2016; Pellecchia et al., 2016). Additionally, social competence is a skill that can be taught to both typically developing children (Denham & Brown, 2010) and children with ASD (White et al., 2007); exploring ways in which focusing on the development of social competence in all children may decrease risk for future distress and impairment, such as elevated social anxiety, is imperative. The current study adds to the existing literature by examining social competence as a potential mechanism linking autism symptoms with increased social anxiety using well-validated, multi-informant measures of autism symptoms, social competence, and social anxiety symptoms in a clinically diverse sample.

Social Anxiety Symptoms and Autism Spectrum Symptoms

Social anxiety disorder is characterized by persistent, marked fear or anxiety in social situations that may leave one vulnerable to scrutiny, with these symptoms resulting in clinically significant distress or functional impairment (APA, 2013). Prevalence rates for social anxiety disorder are significantly higher in children with ASD than expected based

on epidemiological estimates (White et al., 2009). Epidemiological estimates suggest that social anxiety disorder is present in approximately 7%-13% of children (NICE, 2013). However, comorbid social anxiety disorder occurs in up to 50% of children diagnosed with ASD (Bellini, 2004; Maddox & White, 2015; Spain et al., 2016), and there is a paucity of research regarding the mechanisms and processes that predict this increased comorbidity in school-aged children (White et al., 2009) – a critical omission given that the co-occurrence of these disorders predicts attenuated treatment response relative to children presenting with either condition alone (Schreibman & Anderson, 2011). Specifically, children with ASD who present with comorbid social anxiety do not benefit from school-based behavioral interventions for ASD to the same extent as children with ASD only (Pellecchia et al., 2016). Similarly, children with comorbid ASD and social anxiety demonstrate diminished response to cognitive behavioral therapy for social anxiety disorder relative to children with social anxiety alone (Maddox, Miyazaki, & White, 2016). Further, autism symptoms covary with social anxiety symptoms even in children who do not meet diagnostic criteria for either disorder, and elevated autism symptoms in neurotypical children confer increased risk for future development of social anxiety disorder (Pickard et al., 2020).

The broader literature suggests several potential pathways to explain the increased risk for the development of social anxiety disorder among children with ASD and neurotypical children with elevated autism symptoms, including deficits in social competence. For instance, children with ASD are at increased risk for reduced social competence as evidenced by unsuccessful social interactions with peers and increased risk for bullying and victimization by peers (van Roekel et al., 2010). Similarly, reduced social competence in neurotypical children predicts greater peer difficulties (Motoca et al., 2012). These negative peer interactions and stressful experiences, in turn, are often early contributors to or direct precipitants of the development of social anxiety disorder (Bellini, 2006; Rapee & Spence, 2004). Similarly, Bellini (2006) found that the combination of elevated physiological arousal and reduced social competence significantly predicted social anxiety symptoms among children with ASD – a finding that is consistent with evidence from non-ASD samples (e.g., Biederman et al., 1995).

Autism Spectrum Symptoms and Social Competence

Social competence is a multidimensional construct that includes several interconnected dimensions: social and emotional skills (e.g., altruistic behavior), emotion regulation, social conventions (e.g., rules of a classroom), perceived peer acceptance, and perceived self-efficacy (Dirks, Treat, & Weersing, 2007; Santos, Peceguina, Daniel, Shin, & Vaughn, 2013). Even in very young children, autism symptoms predict parent reports of their children's social competence (Dakopoulos & Jahromi, 2019). Additionally, in adolescents, greater parent-reported autism symptoms predict both parent- and self-report of lower social competence, and children with ASD are more likely to rate themselves as less socially competent, as having more negative self-perceptions, and as experiencing lower quality of life than their neurotypical counterparts (Jamison & Schuttler, 2015). Parent-reported autism spectrum symptom severity also predicts reduced social competence as observed in classroom settings (Lyons, Cappadocia, & Weiss, 2011).

The extant literature regarding first-line psychotherapy for ASD documents both reduced social competence in ASD across the lifespan and myriad interventions developed specifically to improve social competence in people with ASD (Cappadocia & Weiss, 2011; Gates, Kang, & Lerner, 2017; Gunning et al., 2019; Pollard, 1998; Rao, Biedel, & Murray, 2008; Tobin, Drager, & Richardson, 2014; Walton & Ingersoll, 2013; White, Koenig, & Scahill, 2007; Wolstencraft et al., 2018). Additionally, social-emotional learning often targets social competence in children across developmental levels with and without psychiatric disorders (Durlak et al., 2011), suggesting that social competence is a crucial mechanism for success for all children (Lane et al., 2004; Lane et al., 2004b). Taken together, the current literature is consistent in documenting that (a) autism spectrum social communication and RRB symptoms covary significantly with social competence; and (b) that individuals with ASD demonstrate reduced social competence throughout development (Rosenthal et al., 2013; Jamison & Schuttler 2015).

Social Anxiety Symptoms and Social Competence

Similar to findings from the autism literature, replicated evidence indicates that individuals with social anxiety disorder view themselves as less socially competent and/or characterized by unsuccessful social interactions and outcomes compared to typically developing individuals (Arkowitz et al., 1975; Farrell et al., 1979; Glenn et al., 2019; Halford & Foddy, 1982; Twentyman & McFall, 1975). However, findings are somewhat mixed regarding whether individuals with social anxiety disorder actually exhibit social competence deficits (Baker & Edelman, 2002; Biedel et al., 1975; Cartwright-Hatton et al., 2005) or whether these individuals merely perceive themselves as being less socially successful (Crozier & Burnham, 1990; Kaeppeler & Erath, 2017; Voncken & Bogels, 2008). Additionally, decreased parent-reported social competence as well as negative interpretations of events and self-directed attention in social interactions predicted the development of social anxiety disorder in a longitudinal study from childhood to young adulthood (Miers et al., 2013). Taken together, evidence suggests that social competence may be a mechanism through which social anxiety disorder develops, both for children with ASD (e.g., Chang et al., 2012) and neurotypical children (Pickard et al., 2017).

Current Study

Taken together, there is evidence linking both autism and social anxiety symptoms with actual and perceived impairments in social competence (Cartwright-Hatton et al., 2005; Glenn et al., 2019; Solomon et al., 2010). In addition, emerging evidence suggests that reduced social competence may be a mechanism linking autism symptoms with increased risk for developing social anxiety symptoms (Chronis-Tuscano et al., 2018). For example, Chang and colleagues (2012) found that reduced social competence covaried with social anxiety symptom severity in a sample of children with comorbid ASD and anxiety. Further, autism symptoms and social anxiety symptoms covary in samples of children who do not meet criteria for either disorder (Pickard et al., 2020), and social competence covaries with autism and social anxiety symptoms in neurotypical children (Pickard et al., 2017, 2020). To our knowledge, the current study is among the first to examine the extent to which social competence reflects a shared mechanism linking autism spectrum symptoms

and social anxiety symptoms in a clinically diverse sample of school-aged children using a multi-informant approach.

Method

Procedures

The present study is a secondary data analysis of a larger protocol (e.g., Chan et al., 2022). The current study's sample reflects consecutive cases recruited by or referred to a university-based Children's Learning Clinic (CLC) through community resources (e.g., pediatricians, community mental health clinics, school system personnel, self-referral) between March 2015 and February 2020 who completed testing prior to the COVID-19 pandemic shutdown. The CLC's client base consists of children with suspected learning, behavioral, or emotional problems, as well as typically developing children (those without a suspected psychological disorder) whose parents agreed to have them participate in developmental/clinical research studies. IRB approval was obtained/maintained prior to/throughout data collection; all parents and children gave informed consent/assent.

Parents and teachers were provided with rating scales according to the larger study's protocol [LINK] as part of a comprehensive psychoeducational evaluation. Psychostimulants were prescribed to 46 children with ADHD in the study. Parents and teachers were asked to complete measures based on children's behavior when not taking psychostimulants if applicable. Children completed measures, including the current study's social anxiety questionnaire, during the initial appointment of the psychoeducational evaluation.

All children and their parents completed a comprehensive psychoeducational and diagnostic evaluation that included a detailed, semi-structured clinical interview using the Kiddie Schedule for Affective Disorders and Schizophrenia for School-Aged Children (K-SADS; Kaufman et al., 1997), standardized parent and teacher ratings from the Behavior Assessment System for Children (BASC-2/3; Reynolds & Kamphaus, 2015), ADHD Rating Scale for DSM-5 (ADHD-5; DuPaul et al., 2014), and the Child Symptom Inventory (CSI-4; Gadow & Sprafkin, 1997) as well as child self-report internalizing measures. The diagnostic battery was further supplemented with the modified Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) for cases in which ASD was suspected based on other information gathered during the psychoeducational evaluation. Finally, the Autism Diagnostic Observation Schedule (ADOS-2; Module 3; Lord et al., 2012) was selectively administered to participants for whom ASD was suspected by a clinician who had achieved research reliability on the ADOS-2. The ADOS-2 is considered part of the 'gold standard' assessment battery for ASD that can be used across ages, developmental levels, and language skills (Lord et al., 2012). Diagnoses of ASD and all other clinical disorders included in the sample were conferred based on differential diagnosis considering all available clinical information indicating onset, course, duration, frequency, and severity of symptoms consistent with the syndrome(s) diagnosed. Psychoeducational evaluation reports were provided to caregivers. For more information regarding the larger study's protocol, please refer to the preregistered protocol [LINK].

Participants

The final sample comprised 194 school aged children aged 8–13 years ($M=10.40$, $SD=1.50$; 35% females) with and without psychiatric disorders, including children diagnosed with ASD (11.3%), anxiety (28.9%), ADHD (64.9%), oppositional defiant (7.2%), and depressive (5.2%) disorders. Of the children diagnosed with anxiety disorders, 21 (37.5%) had social anxiety, 30 (53.6%) had generalized anxiety, 3 (5.4%) had separation anxiety, 4 (7.1%) had specific phobias, and 2 (3.6%) had otherwise specified anxiety disorders. Positive screens for DSM-5 specific learning disorders (17.0%) were defined based on score(s) > 1.5 standard deviations below age norms on one or more KTEA-3 Academic Skills Battery reading and math subtests, as specified in DSM-5 (APA, 2013). Neurotypical children (14.4%) had normal developmental histories and non-clinical parent/teacher ratings and were recruited through community resources. Percentages for the diagnostic categories do not sum to 100% due to comorbidities. Sample ethnicity was mixed with 135 White/Non-Hispanic (69.6%), 27 Black (13.9%), 18 multiracial (9.3%), 13 Hispanic (6.7%) children, and 1 Asian child (0.5%). All participants spoke English.

Children were excluded from the larger study if they presented with gross neurological, sensory, or motor impairment; non-stimulant medications that could not be withheld for neuropsychological testing, as required by the larger study; or history of seizure disorder, psychosis, or intellectual disability.

Measures

Autism Spectrum Symptoms—The Child Symptom Inventory-IV (CSI-IV; Gadow & Sprafkin, 1997) ASD section contains 14 items that assess autism spectrum social communication and RRB symptoms on a 4-point Likert scale (*never, sometimes, often, very often*). Psychometric support for the CSI-IV ASD subscale includes good internal consistency ($\alpha = .85$) as well as expected relations with related childhood symptoms and clinical diagnoses (Gadow et al., 2004). Internal consistency based on the current sample was also good ($\alpha = .85$). The CSI-IV is frequently used as a broadband screening measure (Gadow et al., 2008) and has demonstrated utility as a continuous measure of autism symptoms in clinically referred children with and without ASD (Kim et al., 2019). Parent-reported raw scores on the ASD subscale of the CSI-IV were used to assess autism symptoms, with higher scores indicating greater quantity/frequency of autism symptoms.

Social Competence—The Social Skills Improvement System (SSIS; Gresham et al., 2010) is a 46-item teacher report form that assesses children's social competence. Teachers rate the frequency with which children display each social behavior on a 4-point Likert scale, and then rate their perception of the importance of that social behavior on a 3-point Likert scale. The SSIS total score reflects children's social competence across several social skill domains, including communication, cooperation, assertion, responsibility, empathy, engagement, and self-control. Psychometric support for the SSIS includes excellent internal consistency ($\alpha = .95-.97$) and high 6- to 8-week test-retest reliability ($r = .82-.86$; Gresham et al., 2010). Internal consistency based on the current sample was also excellent ($\alpha = .96$). Higher raw scores indicate greater social competence.

Social Anxiety Symptoms—The Multidimensional Anxiety Scale for Children 2nd Edition–Self-Report (MASC-2-SR) assesses anxiety dimensions in children and adolescents aged 8 to 19 years (March & MHS, 2013). The MASC-2 social anxiety subscale contains nine items that are answered on a 4-point Likert scale (*never, rarely, sometimes, often*). Psychometric support for the MASC-2 social anxiety subscale includes good internal consistency ($\alpha = .85$) as well as good one- to four-week test-retest reliability ($r = .90$; March, 2013). Internal consistency based on the current sample was excellent ($\alpha = .91$). Child self-report of social anxiety symptoms were selected given evidence that child self-reports of internalizing symptoms appear to be more sensitive than parent reports to early symptom emergence despite parent and child reports being highly correlated over time ($r_{med} = .65$; Cole et al., 2002). Higher raw scores indicate greater quantity/frequency of social anxiety symptoms.

Intellectual Functioning (IQ) and Socioeconomic Status (SES)—IQ was estimated using the WISC-V Short Form (Sattler, 2016). Hollingshead (1975) SES was estimated based on caregiver(s)' education and occupation.

Data Analysis Plan

The study's primary analyses used jamovi v.1.6.23 (jamovi project, 2021) with 1,000 bootstrapped samples to analyze the bias-corrected relations among autism symptoms, social competence, and social anxiety symptoms while covarying age, sex, SES, and race/ethnicity (Preacher, Rucker, & Hayes, 2007). To remove mono-informant bias, different informants were used for autism symptoms (parent report), social competence (teacher report), and social anxiety (child self-report). Pathway directionality was specified *a priori* based on the available literature reviewed above. Autism symptoms were modeled to predict social competence and social anxiety symptoms given conceptualizations that social competence difficulties emerge at least in part due to the core autism symptom clusters (Contugo, 2009) and evidence that social anxiety symptoms develop later than autism symptoms in children (Kuusikko et al., 2008; Spain et al., 2018). Social competence, in turn, was modeled to predict social anxiety symptoms given evidence that it predicts the severity of social anxiety symptoms (Chang et al., 2012). Notably, the cross-sectional design precludes testing competing models regarding directional effects of autism and social anxiety or social anxiety and social competence (i.e., reversing arrows does not distinguish plausible models; Thoemmes, 2015). Effects are considered statistically significant if their 95% confidence intervals (CIs) do not contain zero. Effect ratios (ER) for significant indirect effects indicate the proportion of the total effect (c pathway) that is conveyed via the indirect pathway (ab; i.e., $ER = ab/c$). We hypothesized that autism spectrum symptoms would predict decreased social competence and increased social anxiety symptoms. Additionally, we expected that decreased social competence would predict increased social anxiety symptoms. Finally, we predicted that reduced social competence would reflect a mechanism linking elevated autism spectrum symptoms with increased risk for elevated social anxiety symptoms (i.e., a significant indirect effect of autism symptoms on social anxiety symptoms through social competence).

Results

Preliminary Analyses

Each of the independent and dependent variables were screened for univariate outliers, defined as values greater than 3 standard deviations outside of the mean. Six data points (1.0%) were identified as outliers and were corrected to the most extreme value within 3 standard deviations of the mean. Missing data were determined to be missing completely at random (Little's MCAR test: $\chi^2(864) = 915.53, p = .11$) and were imputed using expectation maximization based on all available data. This process affected 0.10% of data points. Teacher-reported social competence scores and child-reported overall anxiety symptoms for subsets of the sample were reported in separate manuscripts to investigate conceptually unrelated hypotheses (Chan et al., 2022; Kofler et al., 2018). Child-reported social anxiety symptoms and parent-reported autism spectrum symptoms have not been previously reported for any children in the current sample.

Primary Analyses

Results of the bias-corrected, bootstrapped conditional effects model with 1,000 bootstrapped samples covarying sex (0=Male, 1=Female), age, SES, and race/ethnicity (dummy coded as 0=White and Non-Hispanic, 1=Non-White and/or Hispanic) are summarized here. Reporting is truncated for readability; full model outputs including precise 95% CIs are shown in Table 2. There was a significant total effect of parent-reported autism symptoms on child-reported social anxiety symptoms prior to accounting for teacher-reported social competence (c pathway; $\beta = .17$, 95% CI excludes 0.0, indicating a significant effect), indicating that children with higher autism symptoms also presented with higher social anxiety symptoms. In addition, higher parent-reported autism symptoms predicted reduced teacher-reported social competence (a pathway; $\beta = -.21$), and higher teacher-reported social competence predicted lower child self-reported social anxiety symptoms after accounting for autism symptoms (b pathway; $\beta = -.16$). Further, there was a significant indirect effect of autism symptoms on social anxiety symptoms via the social competence pathway (ab pathway; $\beta = .04$; effect ratio/EF=.20; all 95% CIs exclude 0.0), indicating that 20% of the relation between autism symptoms and social anxiety symptoms is conveyed via their shared association with reduced social competence. After accounting for the indirect pathway, the relation between autism symptoms and social anxiety symptoms was no longer significant (95%CI includes 0.0, indicating no effect). In terms of background confounders, females were rated by teachers as higher in social competence ($\beta = .22$; 95% CI excludes 0.0); no other direct effects of sex, age, SES, or race/ethnicity were detected.

Taken together, these findings were generally consistent with our hypotheses, and indicated that autism symptoms, social competence, and social anxiety symptoms are significantly interrelated even when assessed using different informants and measures, and that reduced social competence may reflect a mechanism through which autism spectrum symptoms confer risk for social anxiety symptoms. In total, the model explained 11.5% of the variance in teacher-reported social competence and 5.7% of the variance in child-reported social anxiety symptoms.

Sensitivity Analyses

Next, we conducted a series of sensitivity analyses to (a) probe the impact of our *a priori* decision to recruit a clinically heterogeneous sample of children with disorders in addition to, or other than, ASD and social anxiety; (b) evaluate the extent to which the autism symptoms/social competence relations reported above may reflect item overlap; and (c) explore the extent to which the primary findings were driven by specific autism spectrum symptom cluster(s).

First, given the oversampling of children with ADHD in the current sample, we repeated the analyses above, this time also controlling for ADHD diagnostic status. The pattern and interpretation of results were unchanged, including a significant total effect of autism symptoms on social anxiety symptoms (c pathway; $\beta=.17$) that was no longer significant after controlling for the significant indirect effect of autism symptoms on social anxiety symptoms via the social competence pathway (ab pathway; $\beta=.03$; $ER=.18$), and significant direct effects of autism symptoms on social competence (a pathway; $\beta=-.20$) and social competence on social anxiety symptoms (b pathway; $\beta=-.16$; all 95% CIs exclude 0.0). ADHD status predicted reduced social competence as expected ($\beta=-.27$; 95% CI excludes 0.0) but not social anxiety symptoms (95% CI includes 0.0). Similarly, given our *a priori* decision to recruit a clinically heterogeneous sample of children with clinical disorders beyond ASD and social anxiety disorder, we also tested depression, oppositional-defiant, and specific learning disorder diagnoses as covariates, and the results were once again unchanged with the exception that the direct effect of social competence on social anxiety symptoms failed to reach significance (b pathway; 95% CI includes 0.0); the indirect effect of autism symptoms on social anxiety symptoms via the social competence pathway remained significant (ab pathway; $\beta=.03$, $ER=.18$), as did the direct effect of autism symptoms on social competence (a pathway; $\beta=-.19$). Depression significantly predicted social anxiety symptoms (c and c' pathways; $\beta=.28-.29$; all 95% CIs exclude 0.0); there were no significant total/direct effects of ODD or SLD (95% CIs include 0.0).

Next, given that our measure of social competence (SSIS Total Score) contains a Communication subscale that overlaps conceptually if not directly with the social communication deficits that are core features of autism spectrum symptoms, it seemed reasonable to hypothesize that the autism spectrum/social competence relations reported above may be an artifact of item overlap. To explore this possibility, we replicated the primary analyses once again, this time after creating a modified SSIS Total Score with the Communication subscale items removed. The 'item overlap' hypothesis was unsupported; the link between autism symptoms and social competence remained significant (a pathway; $\beta=-.22$), and the overall pattern and interpretation of results was highly similar, including a significant total effect of autism symptoms on social anxiety symptoms (c pathway; $\beta=.17$), direct effect of the modified social competence measure on social anxiety symptoms (b pathway; $\beta=-.15$), and indirect effect of autism symptoms on social anxiety symptoms via the modified social competence pathway (ab pathway; $\beta=.03$, $ER=.19$). Slightly different from the primary model, the direct effect of autism symptoms on social anxiety symptoms remained significant after accounting for the indirect effect ($\beta=.14$; all 95% CIs exclude 0.0), although the effect ratio was highly similar to the primary model ($ER = .19$ vs. $.20$).

Finally, we explored the extent to which specific autism spectrum symptom clusters were driving the relations reported above. This involved repeating the primary model once again, this time with two autism predictors (social communication deficits, RRBs: restricted/repetitive behaviors/interests). Results indicated that autism spectrum social communication symptoms showed a highly similar pattern relative to the primary models, including significant associations with reduced social competence (a pathway; $\beta = -.23$) and an indirect relation with social anxiety symptoms via the social competence pathway (ab pathway; $\beta = .03$, $ER = .27$; both 95% CIs exclude 0.0). Different from the primary model, the total/direct effect of autism spectrum social communication symptoms on social anxiety symptoms did not reach significance (c, c' pathways), and there were no direct or indirect effects of autism spectrum RRB symptoms on social competence or social anxiety symptoms (a, c, c' pathways; all 95% CIs include 0.0). The same pattern of results was obtained using both the original and modified social competence predictor.

Taken together, the sensitivity analyses were highly consistent with the results from our *a priori* analytic plan, and suggest that the findings are robust to our recruitment of a clinically heterogeneous sample, cannot be explained by item/construct overlap, and are driven primarily by autism spectrum social communication difficulties rather than restricted/repetitive behaviors/interests.

Discussion

The current study was among the first to examine the extent to which social competence reflects a shared mechanism linking autism symptoms and social anxiety symptoms in a clinically diverse sample. Overall, the results of the present study were consistent with extant literature and our hypotheses. As expected, we found that greater autism symptoms predicted greater social anxiety symptoms, replicating previous findings that autism spectrum symptoms are linked with social anxiety symptoms (Kuusikko et al., 2008; White et al., 2009). Also, in line with our predictions, we found that increased autism symptoms predicted lower social competence, which is aligned with extant literature (Rosenthal et al., 2013). Previous studies suggest that autism spectrum symptoms predict social anxiety symptoms due to the significant overlap in the behavioral phenotypes and functional consequences of ASD and social anxiety disorder (Spain et al., 2016), and sensitivity analyses from the current study add to this literature by revealing that this relation is not solely attributable to item/measurement overlap.

The study design of Chang et al. (2012) answered a similar question as the current study and found that social competence covaried with the severity of social anxiety symptoms in a sample of children diagnosed with comorbid ASD and anxiety disorders. Given these previous findings suggesting that social competence may be a mechanism through which ASD confers greater risk for social anxiety, we predicted that social competence would serve as an intermediary between autism symptoms and social anxiety symptoms in the current study. This prediction was supported. In addition to replicating previous findings that greater autism symptoms predict more social anxiety and more difficulties with social competence, we also found significant effects of social competence on social anxiety symptoms directly and as an intermediary between autism symptoms and social anxiety symptoms, accounting

for approximately 20% of the autism spectrum/social anxiety association. Interestingly, the indirect effect of autism symptoms on social anxiety via reduced social competence replicated across our primary and exploratory/sensitivity analyses, as did direct relations between reduced social competence and increased social anxiety. These findings were consistent with our hypotheses and extant literature (e.g., Chang et al., 2012), and provide support for future longitudinal work to examine reduced social competence as a potential causal mechanism linking autism symptoms with the development of social anxiety disorder (Wood & Gadow, 2010).

The consistency between our findings and those of Chang et al. (2012) is striking in light of methodological differences across studies, including our use of continuous symptom measures, relatively broad operationalization of social competence, and inclusion of children with and without ASD and anxiety. That is, some but not all of the children in the current sample met diagnostic criteria for ASD and/or an anxiety disorder, so the wide ranges of scores in our constructs of interest are reflective of the clinical diversity within our sample (Table 1). In contrast, Chang and colleagues (2012) only included children who met diagnostic criteria for both ASD and an anxiety disorder, so across studies it seems that social competence plays an important role in individuals across the spectrum of both autism spectrum and anxiety symptoms rather than just for individuals with clinical diagnoses of both syndromes. These findings build on extant literature supporting these relations in clinical (Chang et al., 2012) and neurotypical populations (Pickard et al., 2017, 2020), replicating and extending findings in a sample of children with and without a variety of psychiatric disorders. In addition, Chang et al. (2012) found that social anxiety covaried with two specific components of social competence, assertion and responsibility, whereas we measured social competence more broadly rather than fractionating it into individual skills, suggesting that the autism/social anxiety link may be due, in part, to both general and specific aspects of children's social-behavioral challenges.

Limitations

The clinical diversity of the sample is a strength of the study given that the findings are likely more reflective of children who present for evaluation of social-behavioral, attention, and learning difficulties. However, the proportion of children diagnosed with ASD in the current sample departs from most extant literature which studies these constructs in children diagnosed with ASD and/or social anxiety disorder (e.g., Chang et al., 2012). However, we considered our clinically diverse sample appropriate for the current study, given that autism spectrum traits are normally distributed in the general population and are heritable and potentially impairing even at subthreshold levels (Constantino & Todd, 2005). Additionally, clinical child samples such as ours oversample for children with elevated autism symptoms, social difficulties, and anxiety symptoms (Reale et al., 2017), allowing our study to capture a broad range of functioning in these domains. However, the results may not generalize specifically to children with clinically diagnosed ASD and social anxiety disorder despite (a) the consistency between our findings and prior work with ASD+anxiety samples (e.g., Chang et al., 2012); and (b) our sensitivity analyses indicating that the findings were robust to control for the sample's clinical diversity. Similarly, our use of multiple informants addresses limitations in much extant literature that relies on single informants, which

artificially inflates relations among constructs (Homburg et al., 2012). Nevertheless, this methodological decision bears its own limitations, as it may underestimate the impact of constructs on each other in a specific context (e.g., at school by using all teacher-report measures). Additionally, our sample identified as predominantly White/non-Hispanic, which precluded us from making more fine-grained comparisons across racial/ethnic groups. This will be an important consideration for future studies, given that the conceptualization and observation/reporting of social competence may differ cross-culturally (Chen & French, 2008). Also, this study was cross-sectional, and as such causal conclusions cannot be drawn. Rather, we view the current findings as providing empirical support to justify conducting the more costly longitudinal designs needed to test the extent to which social competence reflects a causal mechanism linking elevated autism symptoms with the development of social anxiety symptoms (Wood & Gadow, 2010).

Clinical Implications and Future Directions

Results of the current study confirm that autism spectrum symptoms reflect a risk for both reduced social competence and increased social anxiety symptoms, while building on prior work suggesting that reduced social competence may be a mechanism linking ASD with the development of social anxiety (e.g., Chang et al., 2012). The current findings extend prior work by demonstrating that these relations are not spurious effects attributable to mono-informant/mono-measure bias and/or construct/item overlap across measures; are robust to control for clinical comorbidities, age, sex, SES, and race/ethnicity (broadly defined); and appear to be driven primarily by autism spectrum social communication rather than restrictive/repetitive behaviors/interests. As such, social competence may be an appropriate intervention target to mitigate social anxiety in children with elevated autism symptoms, consistent with most first-line psychosocial treatments for ASD (Gates, Kang, & Lerner, 2017), and it may represent an important target for the prevention of social anxiety among neurotypical children and those with psychiatric disorders other than ASD, as autism symptoms are continuously distributed among these populations (Constantino & Todd, 2003). Nonetheless, our models accounted for only about 6–12% of the variance in our outcomes of interest, and as such future studies may care to examine additional mechanisms that may link ASD and social anxiety disorder, such as similarities in physiological dysregulation (Bellini, 2006), shared environmental correlates and outcomes (Rappée & Spence, 2004; van Roekel et al., 2010), and/or neurobiological similarities (Richey et al., 2014). Identifying the mechanisms and processes that produce the increased risk for social anxiety disorder among children with ASD and neurotypical children with elevated autism spectrum symptoms has the potential to inform the modification of existing treatments or development of novel interventions that may improve quality of life for these children.

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Data Availability Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1.

Sample and Demographic Variables.

	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>	<i>Skew</i>	<i>Kurtosis</i>
Sex (Boys/Girls)	126/68		--	--	--	--
Age	10.40	1.50	8.10	13.40	0.42	-1.08
Medication Status (Y/N)	46/128		--	--	--	--
SES	48.20	11.40	20	66	-0.53	-0.43
Race/Ethnicity (W/B/H/M/A)	135/27/13/18/1					
IQ (Standard Scores)	104.00	14.50	78	147	0.05	0.37
ASD Symptoms (Parent Report)						
Raw Scores	3.67	2.00	0	18	1.50	1.89
Social Anxiety Symptoms (Child Self-Report)						
Raw Scores	11.30	6.19	0	26	0.40	-0.44
Social Competence (Teacher Report)						
Raw Scores	77.80	23.10	8	129	-0.01	-0.10
Social Competence (Teacher Report) – Modified						
Raw Scores	57.30	19.50	1	101	0.01	-0.21

Note. Medication Status = Current ADHD psychostimulant medication status, SES = Hollingshead socioeconomic status, IQ = Full Scale Intelligence (WISC-V Short Form), Race/ethnicity (W = White, B = Black, H = Hispanic, M = Multiracial, A = Asian). Modified social competence scores = SSIS social competence scores with communication subscale removed.

Table 2.

Conditional effects model testing social competence as a potential mechanism linking elevated ASD symptoms with increased risk for social anxiety.

Indirect and Total Effects							
Type	Effect	Estimate	SE	95% C.I. (a)		β	
				Lower	Upper		
Indirect	ASD Symptoms \Rightarrow Social Competence \Rightarrow Social Anxiety	0.04926	0.03395	0.00412	0.13899	0.03385	
	Age \Rightarrow Social Competence \Rightarrow Social Anxiety	-0.04008	0.05378	-0.19857	0.03795	-0.00975	
	Sex \Rightarrow Social Competence \Rightarrow Social Anxiety	-0.45360	0.26265	-1.08491	-0.04073	-0.03434	
	SES \Rightarrow Social Competence \Rightarrow Social Anxiety	-0.00586	0.00741	-0.02705	0.00284	-0.01062	
	Race/ethnicity \Rightarrow Social Competence \Rightarrow Social Anxiety	0.10772	0.19395	-0.15214	0.70085	0.00794	
Component	ASD Symptoms \Rightarrow Social Competence	-1.13558	0.41734	-1.97676	-0.32708	-0.21356	
	Social Competence \Rightarrow Social Anxiety	-0.04338	0.02062	-0.08395	-0.00243	-0.15848	
	Age \Rightarrow Social Competence	0.92401	1.09465	-1.21348	3.27599	0.06150	
	Sex \Rightarrow Social Competence	10.45733	3.49408	2.96716	16.76540	0.21668	
	SES \Rightarrow Social Competence	0.13515	0.13875	-0.12696	0.41060	0.06699	
	Race/ethnicity \Rightarrow Social Competence	-2.48331	3.76264	-9.82184	5.12219	-0.05008	
Direct	ASD Symptoms \Rightarrow Social Anxiety	0.20003	0.12030	-0.02347	0.45812	0.13744	
	Age \Rightarrow Social Anxiety	-0.22063	0.32405	-0.85087	0.43415	-0.05365	
	Sex \Rightarrow Social Anxiety	1.29114	1.01757	-0.72004	3.25354	0.09775	
	SES \Rightarrow Social Anxiety	-0.01057	0.04582	-0.10618	0.07902	-0.01913	
	Race/ethnicity \Rightarrow Social Anxiety	-0.42211	0.99194	-2.32879	1.70053	-0.03110	
Total	ASD Symptoms \Rightarrow Social Anxiety	0.24928	0.10876	0.03611	0.46246	0.17129	
	Age \Rightarrow Social Anxiety	-0.26071	0.30520	-0.85889	0.33747	-0.06340	
	Sex \Rightarrow Social Anxiety	0.83755	0.98296	-1.08902	2.76412	0.06341	
	SES \Rightarrow Social Anxiety	-0.01643	0.04162	-0.09801	0.06515	-0.02975	
	Race/ethnicity \Rightarrow Social Anxiety	-0.31440	1.01711	-2.30790	1.67911	-0.02316	

Note. Confidence intervals computed with method: Bias corrected bootstrap

Note. Betas are completely standardized effect sizes

Table 3.

Zero-Order Correlation Matrix

	ASD Symptoms	Social Anxiety Symptoms	Social Competence	Social Competence-Modified	Age	SES	Sex	Race/Ethnicity
ASD Symptoms (Parent Report)	1	0.17*	-0.22*	-0.22*	--	--	--	--
Social Anxiety Symptoms (Child Self-Report)	0.15*	1	-0.18*	-0.18*	--	--	--	--
Social Competence (Teacher Report)	-0.28*	-0.15*	1	0.99*	--	--	--	--
Social Competence - Modified	-0.28*	-0.15*	0.99*	1	--	--	--	--
Age	0.09	-0.05	-0.01	-0.01	1	--	--	--
SES	-0.11	-0.04	0.10	0.10	-0.05	1	--	--
Sex	-0.15*	0.06	0.28*	0.28*	-0.11	-0.01	1	--
Race/Ethnicity	0.04	-0.01	-0.09	-0.08	-0.01	-0.20*	-0.03	1

Note. Pearson's r denoted in *italics* (top triangle) represents partial correlations controlling for age, sex, SES, and race/ethnicity.

* indicates that correlations are significant at $p < .05$.