WEAK CENTRAL COHERENCE AND SOCIAL SKILLS IN CHILDREN WITH AUTISM SPECTRUM DISORDERS: THE ROLE OF ANXIETY AND COGNITIVE FUNCTIONING

AN ABSTRACT

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

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BY

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Abstract

The present study examined the relationships between anxiety, cognitive functioning, weak central coherence, and social skills in a group of 102 children diagnosed with an Autism Spectrum Disorder (ASD; Autistic disorder, Asperger's disorder, and PDD-NOS). The results indicated that children diagnosed with Asperger's disorder had significantly higher cognitive functioning and Block Design scores (i.e., weaker central coherence) compared to those diagnosed with autism or PDD-NOS. Regression analyses results showed that anxiety and cognitive functioning moderated the association between weak central coherence and social skills. For children with low cognitive functioning and high anxiety, weak central coherence was associated with poorer social skills than those with low cognitive functioning, high anxiety, and strong central coherence. For children with high cognitive functioning and high anxiety, weak central coherence was associated with better social skills than those with high cognitive functioning and strong central coherence. Implications of these findings are discussed.

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Table of Contents

List of Tables

List of Figures

Introduction

The Centers for Disease Control estimate that 1 in 88 children are affected by an Autism Spectrum Disorder (ASD; Autistic Disorder [Autism], Asperger's disorder, and PDD-NOS) (Centers for Disease Control and Prevention, 2012). The core features of ASDs include impairments in social interaction and communication and stereotyped behaviors and interests. Due to the severity of the social deficits in children with ASDs, recent research has focused on understanding the underlying mechanisms that drive such deficits. One area of research suggests that the social impairments result from "weak central coherence" (WCC). WCC refers to a processing bias for details and local information. This bias is proposed to interfere with children's ability to understand certain aspects of social interaction (e.g., facial expressions, voice intonation, body language). However, findings linking WCC to impairments in social functioning have been inconsistent. The purpose of the present study was to further examine the relationship between WCC and social functioning. The present study focused on two individual characteristics that may help explain inconsistent findings in the literature in regards to the relationship, namely anxiety and cognitive functioning.

Literature Review

Autism Spectrum Disorders

Autism Spectrum Disorders (ASDs), which include Autistic Disorder (Autism), Asperger's Disorder, and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS), belong in a broader class of pervasive developmental disorders (PDDs; Autism, Asperger's disorder, Rett's disorder, Childhood Disintegrative Disorder [CDD], and PDD-NOS). PDDs are neurodevelopmental disorders that are characterized by stereotyped behaviors and restrictive interests as well as impairments in two core areas of development: social interaction and communication. The terms PDD and ASD are often used synonymously, as they both refer to disorders that affect the same areas of childhood development. In the present paper, the terms PDD and ASD will be used interchangeably depending on which term was utilized by the referenced study.

In addition to the core features of ASDs, children with ASDs often exhibit a number of associated symptoms, including hyperactivity, attention deficits, obsessive-compulsive symptoms, anxiety, and depression (Klin, McPartland, & Volmar, 2005). Children with ASDs are also at high risk for being diagnosed with comorbid disorders. Numerous studies have reported that children with autism or Asperger's disorder meet diagnostic criteria for other psychiatric disorders; the most common being Attention Deficit/Hyperactivity Disorder (ADHD), anxiety and conduct disorders (Muris, Steerneman, Merckelbach, Holdrincet, & Meesters, 1998; Green, Gilchrist, Burton, & Cox, 2000). It remains uncertain whether these co-occurring symptoms in children with

ASDs are true syndromes or if they are derived from the core features of ASDs, however, the presence of these symptoms may cause further impairment in children with ASDs and require additional treatment.

The *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev; *DSM-IV-TR*; American Psychiatric Association, 2000) defines autism as a disorder involving impairments in social interaction and communication, and the presence of stereotyped behaviors and restricted interests. Similar to the diagnostic criteria for autism, the DSM-IV-TR diagnostic criteria for Asperger's disorder includes deficits in social interaction and the presence of stereotyped behaviors and interests. Unlike autism, Asperger's disorder does not involve clinically significant impairments in communication. According to the DSM-IV-TR, a diagnosis of PDD-NOS is warranted when a child presents with impairments in social interaction associated with impairments in communication or the presence of stereotyped behaviors and interests and does not meet diagnostic criteria for a specific PDD (e.g. autism), Avoidant Personality Disorder, Schizophrenia, or Schizotypal Personality Disorder. “Atypical autism”, which refers to presentations of autistic symptoms that are 'atypical', 'subthreshold', and/or delayed in onset, is included in this category.

Social Deficits in ASDs

While ASDs are distinguishable by their diagnostic criteria, onset, and prognosis, they share a central feature – impairments in social interaction. In the initial account of autism, Kanner (1943) stated that “the outstanding, 'pathognomonic,' fundamental disorder is the children's inability to relate themselves in the ordinary way to people and situations from the beginning of life” (p. 242). Social impairments in ASDs may include deficits in nonverbal communication (e.g., poor eye contact, lack of gesturing), lack of social or emotional reciprocity, failure to develop appropriate peer relationships, and a lack of spontaneous seeking to share enjoyment and interests (APA, 2000). These deficits may further impair children's ability to initiate and respond to social interactions, leading to negative outcomes such as rejection and isolation (Gantman, Kapp, Orenski, & Laugeson, 2012). Given the significant impairments in social functioning, it is particularly important for researchers to identify the mechanisms through which such deficits occur.

Weak Central Coherence (WCC)

There are several theoretical perspectives on the cognitive processes that may result in the core features of ASDs. Most of these perspectives focus on the impairments associated with ASDs. However, one proposed theory, referred to as weak central coherence (WCC) theory, attempts to address both the impairments as well as the superior abilities (e.g., superior performance on visuospatial tasks) found in children with ASDs. The weak central coherence theory suggests that children with ASDs fail to integrate local information (i.e., details) into a global entity (Frith, 1989). WCC stems from Uta Frith's observation that typically developing children and adults tend to process information for meaning (i.e., globally), often at the expense of attention to details. Frith called this tendency *central coherence* and suggested that it is *weak* in children with ASDs. Frith hypothesized that WCC could explain the superior performance of children with ASDs on tasks that favor local rather than global processing, such as the Embedded Figures Test.

In one of their early studies, Shah and Frith (1983) compared the performance of children and adolescents with autism on the Children's Embedded Figures Test to that of typically developing children and children with mental retardation. In the Embedded Figures Test (EFT; Witkin, Oltman, Raskin, & Karp, 1971), children must find a target shape (e.g., a triangle) hidden within a more complex pattern or picture (e.g., a house) as quickly as possible. They found that the autistic group performed better than the mentally retarded and typically developing children, who were matched for mental and chronological age, on the Children's Embedded Figures Test. These results suggest that the superior performance of children with autism on certain visuospatial tasks may be due to atypical information-processing.

In a later study, Shah and Frith (1993) tested the weak central coherence theory by examining the performance of adolescents and adults with ASDs on the Block Design subtest of the Wechsler Intelligence Scales for Children (WISC; Wechsler, 1974) or the Wechsler Adult Intelligence Scales (WAIS; Wechsler, 1981). Both the WISC and the WAIS measure intellectual ability. The Block Design subtest "requires first the breaking up of each design presented into logical units, and second a reasoned manipulation of blocks to reconstruct the original design from separate parts" (Kohs, 1923). Children with ASDs have a characteristic pattern of performance on the WISC, with poor performance on the Comprehension subtest, which requires children to answer questions based on his or her general and social understanding, and peak performance on the Block Design subtest (Allen, Lincoln, & Kaufman, 1991; Freeman, Lucas, Forness, & Ritvo, 1985; Ohta, 1987). Furthermore, Shah and Frith found that high functioning (nonverbal IQ $\geq$ 85) and low functioning (nonverbal IQ < 85) adolescents and adults with autism performed better than controls (i.e., typically developing adolescents and adults with normal nonverbal IQs, typically developing children with scores on the nonverbal scale similar to that of the low functioning group, and individuals with learning disabilities who had nonverbal IQs in the mildly retarded or borderline range) on the Block Design subtest of the WISC and an experimental Block Design task. In the experimental Block Design task, participants were shown two dimensional designs that were presented as wholes (i.e., as in the WISC Block Design or unsegmented) or as separate blocks (i.e., the design is deconstructed or segmented). The control groups were faster on the segmented designs than they were on the unsegmented designs. This indicates that segmentation discriminated subjects with autism from the control groups. The researchers suggested that the Block Design subtest favors local processing and that WCC in children with autism is manifested by their enhanced ability to segment designs on the Block Design subtest.

Beyond the studies using the Block Design subtest to gauge WCC, there have been a number of studies over the past decade that have examined central coherence in children with ASDs using other tasks. Most of these studies have shown that children with ASDs perform better than typically developing children on visuospatial tasks that favor local processing (e.g., the Embedded Figures Test, Navon hierarchical figures task). For example, Morgan et al. (2003) found that children with ASDs were faster than their controls (matched for age, gender, and nonverbal ability) on the Preschool Embedded Figures Test. Similar results were found in a study that compared the performance of adults with Asperger's disorder and autism to controls (matched for age and IQ) on the Embedded Figures Test (Jolliffe & Baron-Cohen, 1997). Another study used two variations of the Navon hierarchical figures task (Navon, 1977) to examine central coherence in children with ASDs and typically developing children (Plaisted, Swettenham, & Rees, 1999). In the Navon task, children are shown a large letter composed of smaller letters of either the same kind (compatible condition) or a different kind (incompatible condition) and asked to identify the letters at the global and/or local level. In one variation of the task (the divided attention condition), children were not given any information about which level the target would appear. In the second variation (the selective attention condition), children were instructed to attend to the local or the global level. The results indicated that there were no group differences in the selective attention condition. However, in the divided attention condition, the autistic children showed local advantage (i.e., responded more quickly and more accurately to local targets) and showed local interference (i.e., were slower when the target appeared at the global level when the letters were incongruent). On the other hand, the typically developing children showed the opposite pattern; they responded more quickly and more accurately to global targets (i.e., global advantage) and were slower and made the most errors when the target appeared at the local level (i.e., global interference).

Studies have also shown that children with ASDs perform worse than typically developing children on verbal tasks that require global processing (e.g., homograph reading tasks). In homograph reading tasks, children must use sentence context to choose the correct pronunciation of a homograph. Frith and Snowling (1983) compared the performance of children and adolescents with autism, typically developing children, and children with dyslexia on a homograph reading task. The children were matched on the basis of reading age (i.e., a child's reading ability expressed with reference to an average

age at which a comparable ability is found). They found that the children and adolescents with autism performed significantly worse than the controls on pronouncing homographs correctly. Similarly, Jolliffe and Baron-Cohen (1999) found that adults diagnosed with autism and Asperger's disorder were less likely to give the context-appropriate pronunciation of a homograph compared to normal adults (matched for age, IQ, gender, and handedness) on a homograph reading task.

Weak central coherence and theory of mind. Frith (1989) proposed that WCC leads to social impairments in children with ASDs by causing deficits in 'theory of mind'. Theory of mind refers to the ability to attribute mental states (e.g., beliefs, purpose) to others (Premack & Woodruff, 1978; Leslie, 1987). Frith and colleagues proposed that the social impairments found in children with ASDs were due to deficits in theory of mind (Baron-Cohen, Leslie & Frith, 1985). To date, research linking WCC to theory of mind has been inconsistent and Frith and colleagues have correspondingly modified their theory. Rather than being considered a cognitive deficit, weak central coherence is now considered to be a processing bias that can be overcome in situations with explicit demands for global processing, such as the selective attention condition of a Navon task (Happè & Frith, 2006). From this perspective, WCC does not lead to poor theory of mind. Rather WCC and theory of mind are considered independent cognitive aspects of ASDs that may interact (Frith, Happè, & Siddons, 1994; Happè & Frith, 2006; Morgan et al., 2003).

Although there is mixed evidence in regards to the relationship between WCC and theory of mind, it is possible that WCC may affect social functioning in children with ASDs through mechanisms other than theory of mind. For example, high anxiety in children with ASDs may exacerbate the effect of WCC such that under this condition, WCC interferes with children's social interactions. Furthermore, high intellectual capacity in children with ASDs may allow them to recognize their social shortcomings, leading to even higher levels of anxiety and therefore, greater social deficits in the context of WCC (Niditch, Varela, Kamps, & Hill, 2012).

Anxiety, Cognitive Functioning, and Weak Central Coherence

It seems plausible that WCC and social skills deficits may be associated in children with ASDs through the level of anxiety and cognitive functioning. In particular, the present study examined if WCC is more likely to be associated with poor social skills for children who are highly anxious. In addition, the present study examined if high awareness of symptomatology (i.e., children who have high cognitive functioning, compared to those with lower cognitive functioning) compounds the negative effects of WCC and high anxiety such that children with the weakest central coherence and highest levels of anxiety and cognitive functioning may demonstrate the poorest social skills. A visual model of these proposed associations is depicted in Figure 1.

Anxiety. Anxiety is considered to be one of the most common psychiatric disorders affecting children and adolescents. Prevalence rates of anxiety disorders between 2.6% and 41.2% have been reported in pre-adolescent children (i.e., under 12 years old) (Cartwright-Hatton, McNicol, & Doubleday, 2005). However, the prevalence rates of anxiety disorders in children with ASDs are significantly higher than in the normal population. A meta-analysis of studies examining anxiety in youth with ASDs estimated that 39.6% of children and adolescents with ASDs have clinically impairing anxiety or at least one anxiety disorder (van Steensel & Bögels, 2011). Simonoff et al.

(2008) examined psychiatric disorders in 112 children and adolescents with ASDs. They found that 41.9% of the children and adolescents met diagnostic criteria for at least one anxiety disorder. In a similar study, de Bruin and colleagues (2007) found that 55.3% of the children in their sample who were diagnosed with PDD-NOS (N=94) met diagnostic criteria for at least one anxiety disorder.

Importantly and relevant to the proposed model, studies have shown that emotion and mood affect perceptual processing (Fredrickson & Branigan, 2005; Srinivasan & Hanif, 2010). More specifically, anxiety and depression are associated with a preference for local rather than global processing. For example, Derryberry and Reed (1998) investigated the relationship between mood and processing in undergraduate students. The students were divided into a low and high anxious group based on scores obtained on the State Trait Anxiety Inventory (STAI; Spielberger, 1983). The students were presented with a Navon task embedded within games that induced a positive or a negative motivational state. The results indicated that during the negative games, students high in trait anxiety showed a local processing bias (i.e., faster processing of local targets) and intact global processing (i.e., no impairments in processing global targets). Another study examined the effect of mood on visual processing (Basso, Schefft, Ris, & Dember, 1996). The study found that individuals with depression and trait anxiety had a local processing bias while individuals with positive mood and optimism had a global processing bias. These studies indicate that WCC in individuals with ASDs may be associated with their emotional state.

However, to date, only one study has examined the possible association between anxiety and WCC (i.e., a local processing bias) in children with ASDs (Burnette, Mundy, Meyer, Sutton, Vaughan, & Charak, 2005). In this study, WCC was measured using the Block Design subtest of the WISC-III, the Embedded Figures Test, the Differential Abilities Scale - Pattern Construction subtest (DAS; Elliott, 1990), and a homograph reading task. Consistent with previous findings, the study found that the children with ASDs reported significantly greater levels of social anxiety than the control group, which consisted of typically developing children and children with learning disabilities. However, the study found equivocal support for WCC in children with ASDs. Similar to previous findings, the children with ASDs performed significantly worse than the controls on verbal measures of WCC (e.g., homograph reading tasks). Contrary to previous findings, the children with ASDs performed significantly worse than the controls on visual measures of WCC. Also, the researchers did not find an association between anxiety and WCC. The lack of an association between anxiety and WCC in this study may be due to the equivocal findings in regards to WCC as well as the use of self-report measures of anxiety. The reliability and validity of self-report measures that assess psychiatric symptoms in children and adolescents with ASDs remains unclear (Mazefsky, Kao, & Oswald, 2011).

The Burnette et al. (2005) study's results notwithstanding, the majority of the literature points to an association between heightened anxiety and a preference for local processing. Thus, the present study investigated whether high anxiety would exacerbate the effects of WCC and produce poor social skills for children with ASDs. That is, high anxiety may contribute to a local processing bias in children with ASDs, which, in social interactions, would interfere with children’s ability to perceive the more global aspects (i.e., overall context and meaning) of social interactions. For example, when conversing with others, children with ASDs and high anxiety may focus on details (e.g., certain words and regions of the face) and fail to integrate the details into a coherent meaning, which may lead to impairments in understanding verbal and nonverbal communication in social interactions.

Cognitive functioning. While cognitive impairments are not common in children with Asperger's disorder or PDD-NOS, mild to profound mental retardation (MR) is common in children with autism (APA, 2000). Chakrabarti and Fombonne (2005) examined the prevalence of PDDs in preschool children and found that 50% of the children with autism (n=26) had mild to moderate MR and 19.2% had severe to profound MR. Of the children diagnosed with PDD-NOS (n=53), mild to moderate MR and severe to profound MR were present in 7.6% and 0% of the children, respectively. On the other hand, cognitive impairments were not present in any of the children diagnosed with Asperger's disorder.

A number of studies have examined the association between cognitive functioning and anxiety in children with ASDs. Most of these studies have found that as cognitive functioning increases (typically measured as IQ score) so does anxiety. For example, Sukhodolsky et al. (2008) examined anxiety in children and adolescents with high (i.e., IQ $\geq$ 70) and low functioning (i.e., IQ $<$ 70) PDDs. Anxiety was measured using a 20-item parent-report anxiety scale that serves as a screener for anxiety disorders. The results of the study indicated that children without cognitive impairments (i.e., high functioning) were rated by their parents as more anxious than children with cognitive impairments (i.e., low functioning). Furthermore, higher levels of anxiety were associated with higher IQ and greater social impairment.

It is unclear what drives the relationship between cognitive functioning and anxiety but some researchers have hypothesized that compared to children with ASDs and cognitive impairments, high functioning children with ASDs may have more insight of their behavioral abnormalities, which may make them susceptible to heightened anxiety (Wing, 1992). Niditch et al. (2012) examined the effects of cognitive impairment, social awareness, and aggression on anxiety in children (2-9 years of age) with ASDs. Similar to previous studies, the researchers found that IQ was positively correlated with anxiety in children with ASDs. That is, higher IQ was associated with higher anxiety. Furthermore, they found that higher aggression in the context of higher IQ and social awareness predicted anxiety. It may be possible that as IQ increases, so does the awareness that other people perceive their social skills and behavior, including engaging in aggressive behavior, as unacceptable, which may result in increased anxiety. Thus, as proposed here, high cognitive functioning may exacerbate the association between WCC and social skills by amplifying the effects of anxiety on WCC.

Age and gender considerations. There is evidence that suggests that anxiety symptom severity in children with ASDs may vary with respect to age. For example, LeCavalier (2006) used the parent and teacher-report form of the Nisonger Child Behavior Rating Form (CBRF; Aman, Tassé, Rojahn, & Hammer, 1996) to examine specific anxiety symptoms in individuals with PDDs between the ages of 3 and 21. The study found a significant age effect on the Insecure/Anxious subscale of the Nisonger Child Behavior Rating Form. Specifically, younger children (ages 3 to 6) scored lower than older individuals on the Insecure/Anxious subscale. Furthermore, for the entire sample (i.e., 3 to 21 year olds), anxiety severity ratings increased with age, with the 13 to

21 year olds scoring the highest on the Insecure/Anxious subscale. Davis III and colleagues (2011) examined the developmental trajectory for the presentation of anxiety in individuals with ASDs. The researchers used a cross-sectional analysis to examine anxiety across the lifespan of individuals with autism. Participants included toddlers (17-36 months), children (3-16 years old), young adults (20-48 years old), and adults (49-65 years old) diagnosed with autism. All of the participants in the young adult and adult groups were diagnosed with intellectual disabilities. Cognitive impairments were present in 26.5% of the participants in the child group and 22.5% of the participants in the toddler group. After controlling for IQ, the authors found that anxiety increased from early childhood (i.e., toddlerhood) to childhood, decreased from childhood to young adulthood, and increased from young adulthood to older adulthood.

Anxiety symptom severity in children with ASDs may also vary with respect to gender ASDs are more prevalent in males than females. While 1 in 54 males are affected by an ASD, only 1 in 252 females are affected by an ASD, which represents a sex ratio of approximately 4:1 (Centers for Disease Control and Prevention, 2012). Several studies have examined gender differences in the core symptomatology of ASDs. However, few studies have explored gender differences in the associated features (e.g., hyperactivity, mood problems) of ASDs. Solomon et al. (2012) examined gender differences in internalizing problems in children and adolescents (ages 8-18) with ASDs. The girls and boys were matched for age and IQ. Internalizing problems were measured using the Children's Depression Inventory (CDI; Kovacs, 1992) and the Anxiety, Depression, and Internalizing Problems subscales of the Behavior Assessment System for Children - Second Edition (BASC-2; Reynolds & Kamphaus, 2004). The researchers found that the parents of the adolescent girls (i.e., girls between the ages of 12 and 18) reported significantly greater levels of internalizing problems on the Anxiety, Depression, and Internalizing Problems subscales of the BASC-2 compared to the parents of the adolescent boys. In a similar study, Mandy et al. (2011) examined sex differences in the associated features of ASDs. Participants included girls and boys between 3 and 18 years old (matched for age and IQ) with high functioning ASDs. Associated features of ASDs were measured using parent and teacher ratings of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). The SDQ contains an emotional symptoms scale that measures internalizing problems. Items such as "nervous or clingy in new situations," "many fears," and "easily scared" appear in the emotional symptoms scale. They found that parents reported greater emotional symptoms in girls than boys.

In sum, only a handful of studies have examined the role of age and gender in anxiety in youth with ASDs. Although two studies suggest an increase in anxiety with age for youth with ASDs (from toddler age to adolescence), one study did not account for possible IQ confound. Thus, the present study explored the possible associations of age with WCC, anxiety, IQ, and social skills, but specific predictions regarding these associations were not made. The two previous studies that examined gender differences in anxiety for youth with ASDs found that more anxiety is reported in girls with ASDs than boys with ASDs. Therefore, it is possible that girls with ASDs experience more anxiety than boys with ASDs, which would put them at higher risk for greater social skills deficits in the context of WCC. This possibility is explored in the present study.

Hypotheses

The present study examined the potential moderating effects of anxiety and cognitive functioning on the relation between weak central coherence and social skills in children with ASDs. It was hypothesized that (1) WCC would be associated with poorer social skills, and (2) anxiety and cognitive functioning would moderate the association between WCC and social skills such that (a) at high levels of anxiety, WCC would be related to poorer social skills than at lower levels of anxiety and (b) at high levels of cognitive functioning, children with high anxiety and WCC would show the poorest social skills relative to all other children in the sample. In addition to the aforementioned hypotheses, this study explored possible age associations with WCC, anxiety, IQ, and social skills. Furthermore, although scant literature suggests that girls with ASDs experience more internalizing symptoms than boys with ASDs, it is not clear how such differences would interact with WCC and cognitive functioning given there is no literature examining the variables in combination. In the present study, the role of gender in the proposed model was examined but no specific hypotheses regarding the role of gender were made.

Methods

Participants

Archival data from families seen at the Autism Assessment Center of Children's Hospital in New Orleans between February 2006 and September 2011 were used for this study. The participants included 102 children between the ages of 6 years and 13 years. The children were evaluated by a licensed clinical psychologist and diagnosed as having autism (n = 40), PDD-NOS (n = 44), or Asperger's disorder (n = 18). This study included 84 males and 18 females.

Procedure

Prior to the evaluation, families were mailed a packet of forms that included an intake form that asks caregivers background information and the parent report form of the Behavior Assessment System for Children – Second Edition (BASC-2; Reynolds & Kamphaus, 2004). On the day of the evaluation, caregivers completed the Autism Diagnostic Interview, Revised (ADI-R; Lord, Rutter, & LeCouteur, 1994) with a doctoral level psychologist. Children were administered a measure of cognitive functioning by a psychometrist. Children completed the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, Dilavor, & Risi, 2000) in the presence of the psychologist and a psychometrist. ASD diagnoses were made by the psychologist based on scores obtained on the ADI-R and the ADOS, as well as cognitive testing, behavioral observations, and intake information.

Measures

Autism Diagnostic Interview, Revised. (ADI-R; Lord, Rutter, & LeCouteur, 1994). The ADI-R is a semi-structured parent interview that is used to support a diagnosis of autism or another ASD in children and adults. The interview consists of 93 items and focuses on three domains: social, communication, and repetitive and restricted behaviors. The items are coded as 0 (no definite behavior of the type specified), 1 (behavior of the type specified probably present but defining criteria not fully met), 2 (definite abnormal behavior of the type described in the definition and coding), and 3 (extreme severity). Items are scored on current behavior unless the item has a specific age restriction. For example, *reciprocal friendships* is only coded for children above the age of 10. The diagnostic algorithm, a standardized technique that aids clinicians with making a diagnosis, of the ADI-R is based on DSM-IV and International Classification of Diseases - Tenth Revision (ICD-10; World Health Organization) diagnostic criteria. The ADI-R has good inter-rater reliability with kappas ranging from .62 to .89 (Lord et al., 1994). The internal consistency alphas are as follows: .84 for the Social domain, .76 for the Communication - Verbal domain, .76 for the Communication - Nonverbal domain, and .54 for the Repetitive and Restricted Behavior domain (Lecavalier et al., 2006).

Autism Diagnostic Observation Schedule. (ADOS; Lord, Rutter, Dilavor, & Risi, 2000) The ADOS is a semi-structured, standardized, observation-based assessment that is used to inform diagnosis of an ASD. Individuals suspected of having an ASD are administered one of four modules based the individual's age and verbal ability. For example, Module 1 is used with children with no expressive language and Module 4 is used with verbally fluent adolescents and adults. In the ADOS, individuals are presented with various activities that allow the observer to assess behaviors that are directly related to ASDs (i.e., deficits in reciprocal social interaction and communication and stereotyped behaviors and restricted interests). Items are coded on a three point scale ranging from 0 (no evidence of abnormal behavior) to 2 (definite evidence) to 3 (markedly abnormal behavior). The diagnostic algorithm of the ADOS has separate cutoff scores for autism and non-autism ASDs (i.e., Asperger's disorder and PDD-NOS). In order to meet diagnostic criteria for autism, an individual must meet or exceed the higher cutoff score of the Communication domain, the Social Interaction domain, and the Communication-Social Interaction domain, which is a summation of the communication and social scores. Criteria is met for a non-autism ASD when the lower cutoff score of the domains are met. Items are coded for repetitive behaviors and restricted interests, however, these items are not included in the diagnostic algorithm because the ADOS does not offer an adequate opportunity to measure restricted and repetitive behaviors (i.e., insufficient time to observe such behaviors). The ADOS has good inter-rater reliability (most modules have a kappa above .60), internal consistency, and test-retest reliability (Lord et al., 2000).

Cognitive functioning. Based on the children's age and abilities, they were administered either the Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III; Wechsler, 2002) or the Wechsler Intelligence Scale for Children - Fourth Edition (WISC-IV; Wechsler, 2003) as a part of their assessment. The WPPSI-III yields a Full Scale IQ, a Verbal IQ, a Performance IQ, and a Processing Speed Quotient. The WISC-IV yields a Full Scale IQ and four composites: Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed. The Block Design subtest is factored into the Performance IQ of the WPPSI-III and the Perceptional

Reasoning Composite of the WISC-IV. In order to avoid using the same measure for two constructs, in this study, cognitive functioning does not include Block Design subscores. The sum of the Verbal Comprehension/Verbal IQ and Processing Speed composite scores were used as the measure of cognitive functioning (IQVCPS). Previous studies have dichotomized IQ to examine the effects of cognitive functioning on anxiety. Cutoffs are generally based on categorical assignations from the Wechsler manuals. For example, some studies have assigned children in the borderline mental retardation range and below as low functioning and those above this range as high functioning. However, others have used other categories to determine low functioning versus high functioning. For example, children in the Low Average range and below are categorized as low functioning and those above this category as high functioning. Because the IQVCPS measure is not normed and existing categories cannot be employed, we dichotomized the IQVCPS variable based on the median split to determine low and high functioning categories.

Weak central coherence. The Block Design subtest of the WPPSI-III or the WISC-IV was used as a measure of WCC. The Block Design subtest is considered to be a good measure of WCC because the construction of a block design requires mentally breaking up a design into its separate parts and then reconstructing the design to match the design shown. In the Block Design subtest of the WISC-IV, individuals are presented with a two dimensional design that is printed in red and white. A picture of Design 9 from the Block Design subtest of the WISC-IV is provided in the Appendix. Individuals are instructed to replicate the design using blocks that have two all red sides, two all white sides, and two half red and half white sides with a diagonal division. Depending on the age of the individual, the test begins with Design 1 or Design 3. The test begins with designs that require four blocks to complete the design (i.e., 2 x 2 designs) and increases in difficulty to designs that require nine blocks to complete the design (i.e., 3 x 3 designs). The examiner records the time it takes (in seconds) for the individual to complete the design and scores the design based on whether or not the design is completed correctly within the allotted time. For some designs, a time bonus is given if the design is completed correctly within a certain amount of time. For example, if Design 9 (shown in the Appendix) is completed in 31 to 75 seconds, an individual receives a score of four. If an individual completes Design 9 in 1 to 10 seconds, the individual receives a score of seven. If the design is not completed within the allotted time or the design is completed incorrectly, the individual receives a score of zero. The test is discontinued if an individual fails to successfully complete two consecutive designs. Children completed the Block Design subtest as part of the WPPSI-III or the WISC-IV.

Anxiety and social skills. The Anxiety and Social Skills subscale scores from the Parent Report Form (PRS) of the Behavioral Assessment System for Children - Second Edition (BASC-2; Reynolds & Kamphaus, 2004) were used to assess children's anxiety and social skills, respectively. The BASC-2 is a multi-dimensional assessment that measures clinical (e.g., anxiety, hyperactivity) and adaptive (e.g., adaptability, social skills) aspects of behaviors and personality. The PRS is available in three age ranges: preschool, child, and adolescent. This study used the child and adolescent forms of the BASC-2. The child form (PRS-C) consists of 160 items and is used for children between the ages of 6 and 11. The adolescent form (PRS-A) consists of 150 items and is used for adolescents and adults (i.e., 12 to 21 year olds). Items are rated using the following frequency scale: N (Never), O (Often), S (Sometimes), and A (Almost Always). The item raw scores are summed and converted into standardized *T*-scores (M = 50, SD = 10). For adaptive scales, lower *T*-scores are indicative of deficits; *T*-scores between 31 and 40 are considered at-risk and *T*-scores below 31 are considered clinically significant. For the clinical scales, higher scores are indicative of problematic behavior; *T*-scores between 60 and 69 are considered at risk and *T*-scores above 70 are considered clinically significant. Clinically significant scores indicate a high level of maladjustment. Scores within the “at risk” range suggest a problem is significant but it may not be severe enough to require treatment. Internal consistency coefficients for the child and adolescent forms of the BASC range from .73-.95 and .76-.95, respectively. Test-retest reliability coefficients between .76 and .86 have been reported for the child and adolescent forms of the BASC. Children and adolescents with ASDs were included in the general and clinical samples of the BASC-2 and in the studies that examined the reliability and validity of the BASC-2 (Reynolds & Kamphaus, 2004).

The BASC-2 Anxiety scale measures anxious behaviors in children (e.g., the tendency to worry excessively or be excessively nervous). The Anxiety subscale includes items such as “worries,” “is fearful”, and “worries about what other children think”. The Social Skills scale measures social competency in children (e.g., proper conduct when interacting with others) and empathy (e.g., offers assistance to others, exhibits concern for the well-being of others). The Social Skills scale includes items such as “shows interest in others’ ideas” and “says, ‘please’ and ‘thank you’.”

To determine whether the Anxiety subscale of the BASC-2 is a reliable scale, internal consistencies were calculated. Because the BASC-2 PRS consists of different forms for different age groups, separate reliability analyses were conducted for children aged 6-11 (i.e., those whose parent completed the child form of the BASC-2) and children aged 12-13 (i.e., those whose parent completed the adolescent form of the BASC-2). Cronbach's alphas for the Anxiety subscale of the child and the adolescent forms were .82 (14 items) and .77 (11 items), respectively.

Results

Preliminary Analyses

Prior to testing the stated hypotheses, group comparisons on the main variables across categorical diagnostic groups were conducted.

An LSD post hoc test (see Table 1) showed that Block Design subtest scores were significantly higher for children diagnosed with Asperger's disorder (M = 9.78; SD = 3.46) than those diagnosed with autism (M = 7.35; SD = 3.16), p = .007 and those diagnosed with PDD-NOS (M = 6.82; SD = 2.93), p = .001. In addition, levels of cognitive functioning (i.e., IQVCPS) were significantly higher for children diagnosed with Asperger's disorder (M = 188.11; SD = 17.79) than those of children diagnosed with autism (M = 153.63; SD = 25.71), p = .000 and those diagnosed with PDD-NOS (M = 158.18; SD = 22.41), p = .000. There were no significant differences in anxiety ratings between children diagnosed with Asperger's disorder (M = 60.78; SD = 14.89) and children with autism (M = 58.00; SD = 17.108) or PDD-NOS (M = 58.68; SD = 16.026).

As a validity check for the measure of cognitive functioning (i.e., the summation of the Verbal Comprehension/Verbal IQ and Processing Speed scores), full scale IQ scores of the low cognitive functioning and high cognitive functioning groups were examined (see Table 2). Because the sample was divided into a low and high cognitive functioning group based on the median split of the summation of the Verbal Comprehension/Verbal IQ and Processing Speed composite scores, an independent samples t-test was conducted to examine whether the full scale IQ scores of the two groups were significantly different. The results of the t-test indicated that the mean full scale IQ scores of the low cognitive functioning (M = 67.78; SD = 10.035) and high cognitive functioning (M = 91.31; SD = 11.160) groups were significantly different, *t* (100) = 11.196, p = .000.

WCC and Social Skills

To test the hypothesis that WCC and social skills are related to each other, correlational analyses were conducted. Zero-order correlations among the main variables and demographic variables are presented in the upper part of Table 3. These analyses indicated that WCC and social skills were not significantly correlated with one another. However, social skills was significantly correlated with anxiety. Anxiety was also significantly correlated with cognitive functioning (i.e., IQVCPS) and age. The Block Design subtest was significantly correlated with cognitive functioning and gender.

Anxiety and Cognitive Functioning as Moderators of WCC and Social Skills

To test the hypothesis that anxiety and cognitive functioning would moderate the relationship between WCC and social skills, a hierarchical regression was conducted. In the regression, anxiety, IQVCPS, and Block Design scores were entered in Step 1. The two-way interactions between these variables (anxiety x IQVCPS, IQVCPS x Block Design, anxiety x Block Design) were entered in Step 2. The three-way interaction term (anxiety x IQVCPS x Block Design) was entered in Step 3. A summary of this analysis is presented in Table 4. The results of the regression indicated that anxiety significantly predicted social skills (β = .426, p = .000) as did the three-way interaction term (β = 8.496, p = .014). As presented in Figures 2 and 3, the graphs of this interaction indicated that for children with high anxiety and weak central coherence, those with low cognitive functioning had poorer social skills than those with high cognitive functioning. For children with high anxiety and strong central coherence, those with low cognitive functioning had better social skills than those with high cognitive functioning. However, for children with low anxiety and weak central coherence, children with low cognitive functioning had better social skills than those with high cognitive functioning. For children with low anxiety and strong central coherence, those with high cognitive functioning had better social skills than those with low cognitive functioning. Contrary to expectations, at high levels of anxiety, WCC did not result in poorer social skills than at lower levels of anxiety. Also, the results did not support my hypothesis that children with high cognitive functioning, high anxiety, and WCC would have the poorest social skills of all the children in the sample. The results showed that children with high cognitive functioning, low anxiety, and WCC had the poorest social skills of all the children in the sample.

Supplementary Analyses

Gender and age effects. A hierarchical regression analysis was conducted to test whether age or gender would affect the relationship between WCC and social skills (see Table 5). Age and gender were entered in Step 1 of the regression. Anxiety, Block Design scores, and IQVCPS were entered in Step 2. The two-way interaction terms (anxiety x Block Design, IQVCPS x anxiety, IQVCPS x Block Design) were entered in Step 3. The three-way interaction term (Block Design x IQVCPS x anxiety) was entered in Step 4. The results of this regression indicated that neither gender ($\beta = -.049$, $p = .624$) nor age ($\beta = .154$, $p = .124$) were significant predictors of social skills. Anxiety was a significant predictor of social skills ($\beta = .421$, $p = .000$). The three-way interaction term (anxiety x

IQVCPS x Block Design) was a significant predictor of social skills (β = 8.482, p = .017).

Unique contribution of the Block Design subtest. To test whether WCC is unique to the Block Design subtest, hierarchical regression analyses were conducted. A separate regression was conducted for each of the other two subtests that compose the Performance composite of the WPPSI-III and the Perceptual Reasoning composite of the WISC-IV (i.e., Matrix Reasoning and Picture Concepts). In the first regression, anxiety, IQVCPS, and Picture Concepts score were entered in Step 1. The two-way interaction terms between these variables (anxiety x IQVCPS, IQVCPS x PicConcepts, anxiety x PicConcepts) were entered in Step 2. The three-way interaction term (anxiety x IQVCPS x PicConcepts) was entered in Step 3. In the next regression, anxiety, IQVCPS, and Matrix Reasoning scores were entered in Step 1. The two-way interaction terms between these variables (anxiety x IQVCPS, IQVCPS x MatReasoning, anxiety x MatReasoning) were entered in Step 2. The three-way interaction term (anxiety x IQVCPS x MatReasoning) was entered in Step 3. In these regressions, Picture Concepts (β = .037; p = .744) and Matrix Reasoning (β = -.115; p = .298) did not significantly predict social skills. Furthermore, none of the two-way or three-way interaction terms that included these subtests were significant in predicting social skills. Zero-order correlations indicated that the Picture Concepts subtest was significantly correlated with anxiety, IQVCPS and the Block Design subtest. The Matrix Reasoning subtest was significantly correlated with IQVCPS, the Block Design subtest, and the Picture Concepts subtest (see lower portion of Table 2).

Another set of regressions was conducted to examine if the Block Design contributed to the explanation of variance in social skills beyond the contribution of Picture Concepts and Matrix Reasoning (see Tables 6-8). In these regressions, two of the subtests (e.g., Picture Concepts and Block Design) were entered in Step 1. The third subtest (e.g., Matrix Reasoning) was entered in Step 2. Anxiety and IQVCPS were entered in Step 3. In Step 4, the two-way interaction terms between the subtest entered in Step 2 (e.g., Matrix Reasoning), anxiety, and IQVCPS were entered. The three-way interaction term between the subtest entered in Step 2 (e.g., Matrix Reasoning), anxiety, and IQVCPS was entered in Step 5. In each of the regressions, anxiety was a significant predictor of social skills. None of the individual subtests (i.e., Block Design, Picture Concepts, Matrix Reasoning) significantly contributed to the explanation of variance in social skills beyond the other two subtests. As shown in Table 8, in the hierarchical regression in which Picture Concepts and Matrix Reasoning subtest scores were entered into Step 1 and Block Design scores were entered into Step 2, the three-way interaction term (anxiety x IQVCPS x Block Design) that was entered into Step 5 was marginally significant ($\beta = .6.931$, $p = .063$).

ASD severity effects. To test whether the proposed model would differ with respect to ASD severity (i.e., ASD diagnosis), the three categorical ASD diagnoses were dummy coded and a hierarchical regression was conducted (see Table 9). In the regression, the dummy codes were entered in Step 1. Anxiety, IQVCPS, and Block Design scores were entered in Step 2. The two-way interactions between these variables were entered in Step 3. The three-way interaction term was entered in Step 4. The results of the regression indicated that ASD severity does not change relationship between WCC and social skills. Anxiety ($\beta = .437$, $p = .000$) was a significant predictor of social skills as was the three-way interaction term (anxiety x IQVCPS x Block Design; $\beta = 8.192$, $p = .017$).

Discussion

The present study examined weak central coherence in relation to social skills in children with ASDs. More specifically, this study examined the potential moderating effects of anxiety and cognitive functioning on the relationship between weak central coherence and social skills in children with ASDs. While the results indicated that weak central coherence and social skills were not significantly correlated, anxiety was significantly positively correlated with social skills. In addition, anxiety and weak central coherence were significantly positively correlated with cognitive functioning.

Further, the three-way interaction between anxiety, weak central coherence, and cognitive functioning significantly predicted social skills. The graphs of this interaction indicated that children with high cognitive functioning, high anxiety, and weak central coherence had better social skills than those with low cognitive functioning, high anxiety, and weak central coherence. On the other hand, children with low cognitive functioning, low anxiety, and weak central coherence had better social skills than those with high cognitive functioning, low anxiety, and weak central coherence.

The first part of the second hypothesis that for children with high levels of anxiety, weak central coherence would be related to poorer social skills than those of children with low levels of anxiety was not supported by the results. Contrary to expectations, children with high anxiety and weak central coherence had *better* social skills than those with low anxiety and weak central coherence regardless of their level of cognitive functioning. Additionally, the results did not support the second part of the second hypothesis that children with high cognitive functioning, high anxiety, and weak central coherence would have the poorest social skills of all the children in the sample. Analysis revealed that children with high cognitive functioning, high anxiety, and weak central coherence had better social skills than most of the children in the sample. The social skills of these children were only lower than those with low cognitive functioning, high anxiety, and strong central coherence.

One possible explanation for these unexpected results is that high anxiety may be beneficial for children with ASDs who have weak central coherence. That is, while children with ASDs may show atypical information processing (i.e., weak central coherence), it is possible that for those with high anxiety, such atypical processing is not detrimental to their social functioning. Specifically, for children with weak central coherence, the presence of high anxiety may amplify the effects of weak central coherence such that these children fixate on aspects of visual social stimuli (e.g., the mouth region of faces) that lead to improved social functioning. In this study, the majority of the children showed normative to “at risk” levels of anxiety (76.5%), which may have facilitated focusing on *adaptive* aspects of visual social stimuli. Indeed, the Yerkes-Dodson Law states that individuals perform best at intermediate levels of arousal. Therefore, children with ASDs may perform best in social situations when they experience intermediate (i.e., normative to “at risk”) levels of anxiety.

The results showed a significant and positive association between anxiety and social skills. The Social Skills subscale of the BASC-2 assesses children’s attention to the needs of others (e.g., empathy) as well as their knowledge of appropriate social behavior. Higher scores on the Social Skills subscale may reflect greater emotional understanding in children with ASDs. Previous research suggests that as social understanding (e.g., empathic skills) increase, so does the awareness that other people may perceive their social skills and behavior as impaired, which increases anxiety (Niditch et al., 2012). According to Bellini (2004), greater emphatic skills may be associated with more effective emotional coping skills as well as an ability to adjust behavior based on feedback from others, which may promote more positive social interactions. Therefore, it is possible that for high functioning children, high anxiety results from greater insight of their social and behavioral impairments. However, their greater social understanding coupled with the ability to modify their behavior (e.g., reduce aggression) may result in better social skills due to improved social interactions.

An alternative explanation that should be considered is that parent report measures of social skills may not accurately reflect children's social functioning. For example, Capps and colleagues (1995) examined the relationships between cognitive functioning, perceived self-competence, emotional understanding, and parent reports of social adaptation in a group of high functioning children with autism. The researchers found that children who perceived themselves as less socially competent had higher cognitive functioning and displayed greater understanding of other's emotional experiences and were better able to access their own emotional experiences compared to those who perceived themselves as more socially competent. Furthermore, parents of children who perceived themselves as less socially competent reported that their children exhibited more socially adaptive behavior than the parents of children who perceived themselves as more socially competent. Therefore, parents of higher functioning children who perceive themselves as less socially competent may report that their children are more socially adept because these children display better emotional understanding compared to those who have lower cognitive functioning.

Previous studies that have examined the relationship between weak central coherence and social skills have used theory of mind performance to predict social skills. These studies have yielded inconsistent results regarding an association between WCC and theory of mind, thereby suggesting that WCC and social skills are unrelated. However, the findings of the present study suggest that inconsistent results regarding an association between WCC and social skills may be explained by the context in which these two variables are played out. More specifically, the effects of WCC on social skills may be moderated by the child's level of anxiety and cognitive functioning.

While not in the predicted fashion, this study provides evidence that anxiety and cognitive functioning moderate the association between weak central coherence and social skills in children with ASDs. However, there are several limitations of this study. Parent reports of children's functioning were utilized in this study. Reports from multiple informants would have provided greater insight of children's functioning. Additionally, since the measure of cognitive functioning that was used in this study was a summation of two composite scores and not a true IQ score, the results should be interpreted with some caution. Nonetheless, this is the first study that has examined the relationships between anxiety, cognitive functioning, weak central coherence, and social skills in children with ASDs. Further research is needed to understand the influence that anxiety and cognitive functioning may have on the relationship between weak central coherence and social functioning in children with ASDs.

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Tables

Table 1

Mean Scores (+ SD) on Reports of Anxiety, Block Design scores, and IQ by Group

	Diagnosis		
Variables	Autism	PDD-NOS	Asperger's
Anxiety	58.00(17.108)	58.68(16.026)	60.78(14.894)
Block Design score	7.35(3.159)$_a$	6.82(2.928)$_a$	9.78(3.457)$_b$
IQVCPS	153.62(25.714)$_a$	158.18(22.408)$_a$	188.11(17.792)$_b$

Note. Means in the same row with different subscripts are statistically different at the .05 level. Anxiety is the total score on the Anxiety subscale of the BASC-2.

Table 2

Mean Full Scale IQ Scores (+SD) by Group

	Cognitive Functioning	
	Low	High
Full Scale IQ Score	67.78 (10.035)	91.31 (11.160)

Note. The low cognitive functioning group was composed of children whose combined Verbal Comprehension/Verbal IQ and Processing Speed score was below 163. The high cognitive functioning group was composed of children whose combined Verbal Comprehension/Verbal IQ and Processing Speed score was greater than or equal to 163.

Table 3

Summary of Correlations Between the Main Variables and Demographic Variables

Measure	1.	2.	3.	4.	5.	6.	7.	8.
1. Block Design	--	.108	.068	.621***	-.054	.237*	.370***	.562***
2. Social Skills		--	.437***	.186	.156	-.055	.175	.025
3. Anxiety			--	.290**	.357***	-.054	.274**	.158
4. IQVCPS				--	-.112	.010	.575***	.553***
5. Age					--	-.037	.000	.011
6. Gender						--	-.037	.195
7. Picture Concepts							--	.380***
8. Matrix Reasoning								--

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Block Design Scores, and Cognitive Functioning

Step 1:	β (*SE B*)
Anxiety	.426 (.066)**
Block Design score	.065 (.399)
Cognitive Functioning	.022 (.052)
R^2	.197
Significant F Δ	F (3, 98) = 8.015**
Step 2:	
Anxiety x Block Design	.527 (.026)
IQVCPS x Anxiety	-.338 (.003)
IQVCPS x Block Design	.525 (.010)
R^2 Δ	.016
F Δ	F (3, 95) = .632
Step 3:	
Anxiety x Block Design x IQVCPS	8.496 (.001)**
R^2 Δ	.049
Significant F Δ	F (1, 94) = 6.240**

Total statistics for model: R^2 = .512, F (7, 101) = 4.761, p < .001.
* p < .05, ** p < .01

Table 5

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Block Design Scores, and Cognitive Functioning Controlling For Age and Gender

Step 1:	β (*SE B*)
Age	.154 (.484)
Gender	-.049 (2.889)
R^2	.027
F Δ	F (2, 99) = 1.352
Step 2:	
Anxiety	.421 (.073)**
Block Design	.084 (.423)
IQVCPS	.014 (.055)
R^2 Δ	.173
Significant F Δ	F (3, 96) = 6.913**
Step 3:	
Anxiety x Block Design	.568 (.027)
IQVCPS x Anxiety	-.409 (.003)
IQVCPS x Block Design	.551 (.010)
F Δ	F (3, 93) = .683
Step 4:	
Block Design x IQVCPS x Anxiety	8.482 (.001)**
R^2 Δ	.048
Significant F Δ	F (1, 94) = 5.949**

Total statistics for model: R^2 = .514, F (9, 101) = 3.673, p = .001.
* p < .05, ** p < .01

Table 6

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Picture Concepts Scores, and Cognitive Functioning Controlling For Block Design and Matrix Reasoning

Step 1	β (*SE B*)
Block Design	.175 (.420)
Matrix Reasoning	-.086 (.379)
R^2	.146
F Δ	F (2, 95) = 1.029
Step 2:	
Picture Concepts	.198 (.391)
R^2 Δ	.032
F Δ	F (1, 94) = 3.210
Step 3:	
Anxiety	.405 (.069)**
IQVCPS	.044 (.061)
R^2 Δ	.155
Significant F Δ	F (2, 92) = 9.029**
Step 4:	
IQVCPS x Anxiety	-.610 (.003)
Picture Concepts x Anxiety	1.173 (.028)
Picture Concepts x IQVCPS	.082 (.012)
R^2	.030
F Δ	F (3, 89) = 1.170
Step 5:	
Picture Concepts x IQVCPS x Anxiety	-1.451 (.001)
R^2 Δ	.011
F Δ	(1, 88) = .173

Total statistics for model: $R^2 = .490$, F (9, 97) = 3.093, p < .01.
* p < .05, ** p < .01

Table 7

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Matrix Reasoning Scores, and Cognitive Functioning Controlling For Block Design and Picture Concepts

Step 1	β (*SE B*)
Block Design	.066 (.370)
Picture Concepts	.169 (.380)
R^2	.041
F Δ	F (2, 95) = 2.037
Step 2:	
Matrix Reasoning	-.138 (.385)
R^2 Δ	.012
F Δ	F (1, 94) = 1.232
Step 3:	
Anxiety	.405 (.069)**
IQVCPS	.044 (.061)
R^2 Δ	.155
Significant F Δ	F (2, 92) = 9.029**
Step 4:	
IQVCPS x Anxiety	.782 (.003)
Matrix Reasoning x IQVCPS	.919 (.010)
Matrix Reasoning x Anxiety	-.531 (.025)
R^2	.022
F Δ	F (3, 89) = .861
Step 5:	
Matrix Reasoning x IQVCPS x Anxiety	-4.649 (.001)
R^2Δ	.011
FΔ	(1, 88) = 1.288

Total statistics for model: $R^2 = .242$, $F (9, 97) = 3.126$, $p < .01$.
* $p < .05$, ** $p < .01$

Table 8

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Block Design Scores, and Cognitive Functioning Controlling For Picture Concepts and Matrix Reasoning

Step 1	β (*SE B*)
Picture Concepts	.066 (.370)
Matrix Reasoning	.169 (.380)
R^2	.042
F Δ	F (2, 95) = 2.070
Step 2:	
Block Design	-.138 (.385)
R^2 Δ	.012
F Δ	F (1, 94) = 1.168
Step 3:	
Anxiety	.405 (.069)**
IQVCPS	.044 (.061)
R^2 Δ	.155
Significant F Δ	F (2, 92) = 9.029**
Step 4:	
Anxiety x Block Design	.782 (.003)
IQVCPS x Anxiety	.919 (.010)
Block Design x IQVCPS	-.531 (.025)
R^2	.026
F Δ	F (3, 89) = 1.006
Step 5:	
Block Design x IQVCPS x Anxiety	-4.649 (.001) †
R^2Δ	.030
FΔ	(1, 88) = 3.536

Total statistics for model: R^2 = .514, F (9, 97) = 3.513, p < .01.
* p < .05, ** p < .01, †p = .06

Table 9

Hierarchical Multiple Regression Analyses Predicting Social Skills From Anxiety, Block Design Scores, and Cognitive Functioning Controlling For ASD Diagnoses

Step 1:	β (*SE B*)
Dummy Code 1	.178 (2.413)
Dummy Code 2	.182 (.3.135)
R^2	.039
F Δ	F (2, 99) = 1.989
Step 2:	
Anxiety	.437 (.066)
Block Design	.098 (.401)
IQVCPS	-.051 (.057)
R^2 Δ	.189
Significant F Δ	F (3, 96) = 7.819***
Step 3:	
Anxiety x Block Design	.672 (.026)
IQVCPS x Anxiety	-.483 (.003)
IQVCPS x Block Design	.469 (.010)
R^2 Δ	.019
F Δ	F (3, 93) = .799
Step 4:	
Anxiety x Block Design x IQVCPS	8.192 (.001)*
R^2 Δ	.045
Significant F Δ	F (1, 92) = 5.890*

Total statistics for model: R^2 = .292, F (9, 101) = 4.219, p < .001.
* p < .05, ** p < .01

Figures

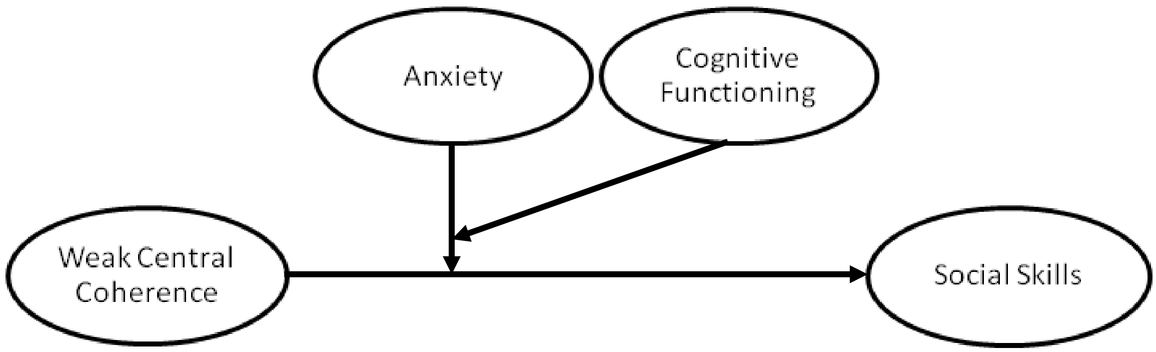


Figure 1. Moderation model being tested.

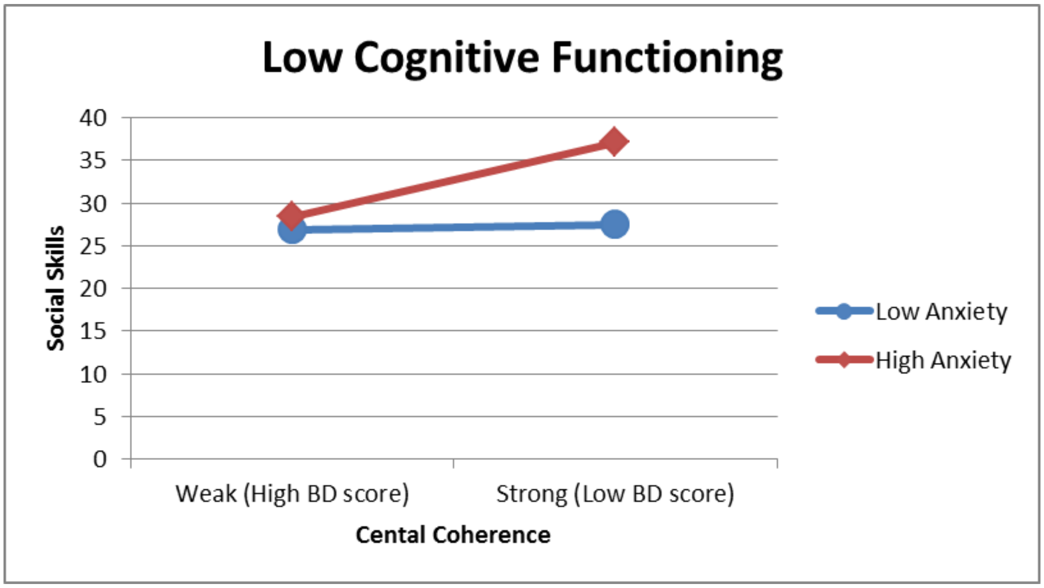


Figure 2. Graph of the three-way interaction between anxiety, cognitive functioning, and central coherence for children with low cognitive functioning.

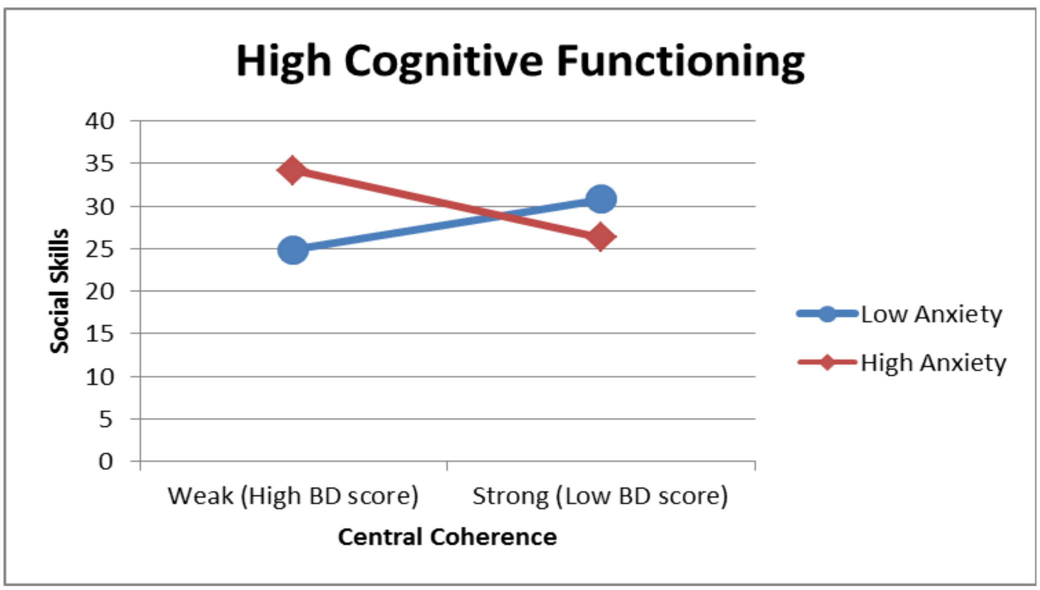
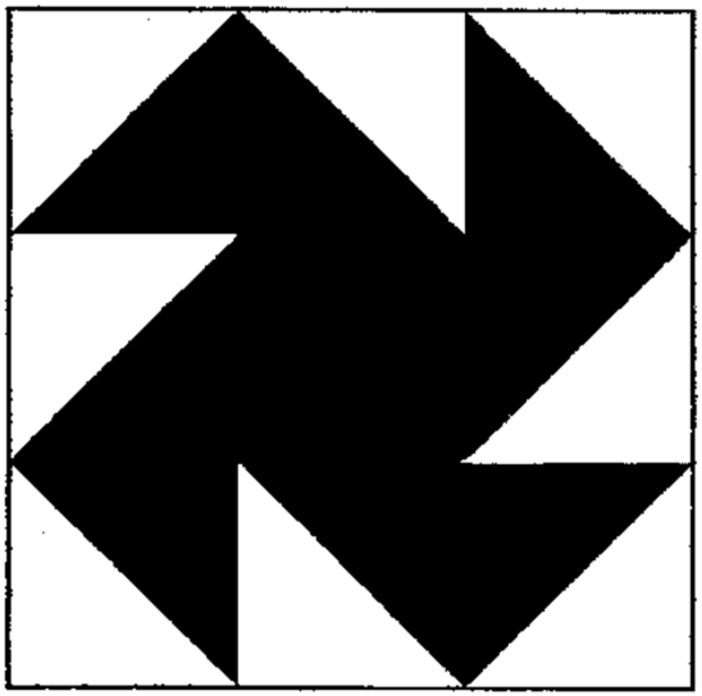


Figure 3. Graph of the three-way interaction between anxiety, cognitive functioning, and central coherence for children with high cognitive functioning.

Appendix



WISC-IV Block Design 9

Biography

Trenesha Hill was born in Baton Rouge, Louisiana. After graduating with her high school diploma in 2006 from Woodlawn High School, she attended Tulane University for her undergraduate degree. She received her Bachelor of Science in Psychology and Cellular and Molecular Biology in 2010. In August of 2012, she joined the graduate program at Tulane University for her Master's degree in Psychology. Her research focused on anxiety and social skills in children with Autism Spectrum Disorders.