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Expression of ADHD symptoms may confer risk for increases in internalizing outcomes over time. One potential explanation is the presence of hostile attribution bias: this social processing deficit has been observed in populations with ADHD and has also been shown to predict increases in anxiety over time in community samples. Given that children with ADHD often experience poor relations with peers, and significant evidence links low social preference and later anxiety, low social preference may experience amplified risk for later anxiety.

The current study used a sample of 362 participants to test 1) whether expression of symptoms associated with ADHD in childhood predicts increases in anxious symptoms in emerging adolescence, 2) whether this association is mediated by hostile attribution bias in childhood, and 3) whether social preference in childhood moderates this mediation. Results revealed a significant longitudinal association between ADHD symptoms and increases in anxious symptoms in emerging adolescence, but hostile attribution was not found to mediate this association. Additionally, low social preference was not found to exacerbate risk for later anxiety. Given that findings of the present study were nonsignificant, future research should consider other potential mechanisms of risk from ADHD to later anxious symptoms in order to inform interventions for children with ADHD who may be at risk for developing internalizing symptoms later in development.

LONGITUDINAL LINK BETWEEN ADHD AND ANXIETY FOR CHILDREN WITH LOW SOCIAL PREFERENCE: THE MEDIATING ROLE OF HOSTILE ATTRIBUTION BIAS

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CHAPTER I

INTRODUCTION

ADHD SYMPTOMS

Attention-Deficit/Hyperactivity Disorder (ADHD) is a functionally impairing externalizing disorder characterized by two symptom dimensions: hyperactivity, evident in high energy levels and impulsive behaviors, and inattention, which manifests as low levels of sustained focus and organization (American Psychiatric Association, 2013). Children can present with varying degrees of both ADHD symptom dimensions, and the expression of hyperactive and/or inattentive symptoms can change over time; some children "outgrow" hyperactive behavior but continue to experience impairment characterized by inattention into adulthood (Larsson et al., 2011).

Reviews estimate the current global prevalence rate of ADHD to be about 5%, with an additional 5% exhibiting sub-threshold, yet significant, clinically relevant ADHD symptoms (Sayal et al., 2018). Children who express subclinical manifestations of ADHD-like behaviors, such as impulsivity, inattention and hyperactivity, have been shown to demonstrate impairment across school and social domains at comparable rates to their peers with clinical ADHD diagnoses (Hoza, 2007). Moreover, while levels of hyperactivity, impulsivity and inattention observed in community samples are usually not sufficient to breach the threshold required for a clinical diagnosis of ADHD, previous studies have indicated a concurrent link between behavioral characteristics associated

with ADHD and social impairment in non-clinical samples (DeHaas, 1986; Pelham & Bender, 1982).

Children with ADHD have been shown to express multifinality, or the longitudinal development of different outcomes resulting from a common pathway depending on the influence of contextual factors conferring risk or resilience (Rutter & Sroufe, 2000). Significant efforts have been dedicated to studying how individual and contextual differences contribute to differing developmental pathways for children with ADHD, as children with ADHD have been shown to be at risk for maladaptive outcomes later in development (Steinberg & Drabick, 2015).

Many studies have investigated the longitudinal association between ADHD symptoms and negative outcomes in adulthood. For example, children with ADHD are at an increased risk for experiencing negative outcomes in adulthood such as vocational problems, antisocial behaviors, heightened interpersonal conflicts, and a host of other maladaptive outcomes (Steinberg & Drabick, 2015). Subclinical expression of ADHD symptomatology has also been shown to relate to negative social and functional outcomes in adulthood, such as increased risk for financial and work problems, substance use, and general functional impairment (Boot, Nevicka & Bass, 2007; Bussing, et al., 2010). In addition to impairment in adulthood, some research suggests that impairment can begin even earlier; specifically, adolescents and young adults who express clinical and subclinical levels of ADHD symptoms have been observed to be at increased risk for experiencing academic problems, developing comorbid mental health conditions, and

increased risk for social, emotional and legal problems (Bussing et al., 2010; Spencer et al., 2007).

These facts suggest that, for both clinical and community samples, expression of ADHD symptoms may confer risk for a range of maladaptive outcomes, which can begin early as adolescence. With expression of ADHD symptomology affecting such a large percentage of children, it is important to investigate factors that contribute to differential trajectories for children with ADHD to discover mechanisms that account for why children with ADHD are at greater risk for maladaptive outcomes later in development, in order to inform potential interventions for at-risk children.

As ADHD has traditionally been conceptualized as an externalizing disorder characterized by disruptive and impulsive behaviors, most outcomes for children with ADHD have been studied within the context of externalizing behaviors, focusing on outward demonstrations of impulsive and unregulated behaviors. More recently, however, researchers have begun to investigate internalizing outcomes as well, as high rates of internalizing disorders and ADHD have been observed to co-occur across the lifespan (Armstrong et al., 2015; Jarrett & Ollendick, 2008). Specifically, current estimates report that 25% of youth and 50% of adults with ADHD experience comorbid ADHD and anxiety, with a steeper increase across the course of development (Biederman, 2005; Krone & Newcorn, 2015). Given the high rates of comorbidity between anxiety and ADHD, significant work has been dedicated to understanding the longitudinal association between ADHD and anxiety; one hypothesis suggests that, as ADHD is a neurodevelopmental disorder and is therefore present from birth (American

Psychiatric Association, 2013), ADHD symptoms precede increases in anxiety symptoms (Jarrett & Ollendick, 2008; Murray et al., 2020; Steinberg & Drabick, 2015).

Several studies support the hypothesis that ADHD symptoms precede the onset of anxious symptoms; in a longitudinal study tracking mental health outcomes for children with clinical ADHD, findings revealed that prevalence of comorbid anxiety and mood disorders increased from 17% of girls and 21% of boys in childhood, to 50 and 24% respectively, by the time children reached adolescence (Szatmari et al., 1989). Additionally, another study tracking outcomes for children with clinical ADHD found greater rates of anxiety and depressive disorders in adolescence, compared to a non-ADHD comparison group (Biederman et al., 1996). Findings across these studies suggest that ADHD symptoms may confer risk for the development of additional anxious symptoms over time, in addition to the well-studied, additional externalizing outcomes for children with ADHD.

Despite high rates of comorbidity between ADHD and internalizing disorders (Biederman et al., 1996; Szatmari et al., 1989), potential causes of this association are not well understood; moreover, few studies have investigated mechanisms of risk through which expression of ADHD symptoms in childhood confers risk for increases in anxious symptoms. It is important to study mechanisms explaining the linkage between ADHD and later anxiety disorders because individuals with ADHD and comorbid disorders show global functional impairment, higher rates of substance use, and respond worse to treatment (Biederman, 2004). Expanding the conceptualization of developmental mechanisms leading from ADHD to include internalizing outcomes, in addition to well-

studied externalizing outcomes, can provide an explanation for why some children with ADHD go on to develop an additional anxiety disorder later in development. Moreover, identifying contributing factors that confer risk or resilience for children with ADHD can provide intervention opportunities for children with ADHD who are at greater risk for later anxiety disorders.

SOCIAL INFORMATION PROCESSING THEORY

One proposed explanation for why some children with ADHD go on to develop increased symptoms of anxiety is the development of bias at one or more steps within the cascade of social information processing. Proposed by Crick and Dodge (1994), Social Information Processing (SIP) Theory suggests that in order to navigate social situations, individuals go through six interdependent steps: (1) taking in and encoding stimulus information; (2) interpreting stimulus cues; (3) goal orientation (4) generating potential responses or solutions; (5) deciding on a response; and lastly, (6) reacting behaviorally. These steps occur in conjunction with memories of previous social experiences readily available to the child that guide the processing of social cues. Over time, patterns of specific thoughts and attributions emerge as the child learns to make sense of their world, and the processing of social events can become anticipatory, such that the child relies on previous experiences to assess and respond to future social interactions that may or may not be related (Dodge & Crick, 1990). Along these lines, certain aspects of social interactions can trigger automatic, or script-based processing, called social information processing bias, where certain emotionally salient social stimuli lead the child to engage in inappropriate behavioral responses, such as aggression (Crick & Dodge, 1994). Biases

in social information processing have been shown to emerge in elementary-aged youth (Crick & Dodge, 1994; Luebbe et al., 2010).

While SIP models have been primarily studied in aggressive populations, increasing evidence suggests that SIP bias is expressed by children with ADHD as well. Across several studies, children clinically diagnosed with ADHD were found to exhibit several aspects of SIP bias, including social cue encoding deficits (Milich & Dodge, 1984), compromised generation of potential solutions by impulsive reactions to ambiguous social situations (King et al., 2009; Milich & Dodge, 1984) and increased reliance on using intent attributions to guide interpretation and response to social cues (King et al., 2009; Milich & Dodge, 1984). Additionally, in a study looking at children's responses to stories with positive, negative and neutral social outcomes, children clinically diagnosed with ADHD detected fewer cues across all types of stories, generated fewer potential responses to social problems, and lastly, reported more negative and less positive attributions of intent for characters in the stories (Andrade et al., 2012).

Evidence across these studies suggests that children with ADHD exhibit compromised social informing processing, evident in their attending to fewer social cues in social situations, as well as the tendency to attribute less positive and more negative intent in ambiguous situations. As social impairment has been consistently observed for children with ADHD across hyperactive, inattentive and a combination of these symptom dimensions (Hoza, 2007), deficits in social information processing may explain the social difficulties of children with ADHD. With this in mind, investigating more specific

aspects of social information processing deficits for children who express ADHD symptoms may be key in understanding the ways in which social information processing can predict later socio-emotional outcomes for children with ADHD.

HOSTILE ATTRIBUTION BIAS

One specific type of deficit observed within the social information processing styles of children with ADHD is hostile attribution bias (Andrade et al., 2012; King et al., 2009), which is defined as the tendency to make negative and intentional attributions about ambiguous social situations or provocation (Crick & Dodge, 1996). For example, a child who has experienced negative interactions with peers may interpret ambiguous acts from peers to be hostile or intentionally hurtful, as opposed to a child who hasn't experienced such interactions and therefore does not automatically assume malintent from peers. Measures assessing hostile attribution bias typically present stories describing a social interaction between characters with a resultant negative outcome where the provocateur's intent is ambiguous. Children are asked to imagine themselves in the scenario and then interpret the intent of the provocateur. One potential outcome assessed by the ambiguous stories is hostile intent attributions made by the child, despite the ambiguous nature of the provocateur's intent (Crick & Dodge, 1996).

Previous literature has documented consistent linkages between hostile attribution bias and externalizing outcomes characterized by aggression, suggesting that aggressive children act aggressively due to disproportionate perceptions of hostility within the actions of others, and this misperception of hostility triggers them to respond with

antisocial behaviors (De Castro et al., 2002). Within aggressive populations, hostile attribution bias has been found to predict disruptive behavior disorders, criminal activity, and other deviant behaviors (Crick & Dodge, 1994; Dodge et al., 1990). While the connection between aggressive behaviors and hostile attribution bias is well documented and supported, recent evidence suggests that hostile attribution bias is also predictive of increases in internalizing symptoms in both clinical and nonclinical populations (Bar-Haim et al., 2007; Bell-Dolan, 1995; Prinstein et al., 2005), suggesting that attributions of hostility may lead to outcomes beyond externalizing behaviors.

Biases in social information processing have been primarily investigated in and have been consistently observed within elementary-aged youth (Crick & Dodge, 1994; Luebbe et al., 2010). Additionally, previous findings suggest that social information processing bias tends to crystallize before children enter adolescence (Bell-Dolan & Wessler, 1994). As adolescence is a time characterized by emergence of anxiety disorders (Costello et al., 2011), an investigation into the potential influence of hostile attribution bias on increases in increases in anxious symptoms as children enter emerging adolescence is warranted. Further, measuring hostile attribution bias before the child enters adolescence will be imperative to establishing the argument that social information processing problems via hostile attribution bias temporally precedes later increases in internalizing symptoms, such as anxiety.

Along these lines, examining the influence of hostile attribution bias on a variety of developmental outcomes may help explain how cognitive biases associated with externalizing behaviors may also predict internalizing outcomes as well. Thus, future

investigation into the association between hostile attribution bias and internalizing outcomes is warranted.

HOSTILE ATTRIBUTION BIAS AND ANXIETY

In addition to the well-documented associations between hostile attribution bias and externalizing behaviors associated with ADHD and aggression, several studies that have observed hostile attribution bias and other manifestations of hypersensitivity to threat within both child and adult populations, as well as within clinical and subclinical levels of anxious symptoms (Bar-Haim et al., 2007; Bell-Dolan, 1995; Prinstein et al., 2005).

Many theoretical models have been proposed to explain why anxious individuals disproportionately attend to threat-relevant stimuli; Beck's (2005) cognitive theory of anxiety suggests that the cognitive focus of anxiety involves threat and danger. Specifically within Beck's model, an anxious individual misperceives environmental cues, experiences maladaptive cognitions, and then engages in stereotyped, inflexible patterns of response behavior (2005). Since the publishing of Beck's model, significant empirical work has been gathered in support of the idea that anxious individuals exhibit threat-related bias when assessing their environment; for example, in a large meta-analysis, threat-related attentional bias was found to be a robust phenomenon within anxious individuals, holding across community samples expressing elevated anxious symptoms and across clinical diagnoses of different types of anxiety disorders (Bar-Haim et al., 2007). Results from the meta-analysis also revealed that level of threat-related bias was not affected by age, as both anxious children and adults showed significant levels of

threat-related bias, though studies testing presence of threat-related bias in adults were far more numerous than studies with child samples (Bar-Haim et al., 2007). In a study specifically investigating threat-related biases within social scenarios, college undergraduate participants exhibiting symptoms consistent with generalized anxiety disorder reported more perceived threat in vignettes describing ambiguous social situations, as well as attributed greater hostile intent among provocateurs in vignettes whose intent was ambiguous, compared to non-anxious controls (Deschenes et al., 2015). Finally, in another study looking at differences in interpretations of social cues between anxious and non-anxious children recruited in 4th and 5th grade, anxious children were more likely to have threat-related interpretations of hypothetical, ambiguous scenarios, as well as being more likely to perceive hostility in the provocateur, compared to non-anxious participants (Bell-Dolan, 1996). Findings across these studies suggest that, when interpreting social cues, anxious children and adults tend to engage in automatic perceptions of threat and hostility, such as hostile attribution bias.

Despite observation of concurrent associations between hostile attribution bias and elevated anxious symptoms in previous studies within both child and adult populations (Bar-Haim et al., 2007; Bell-Dolan, 1996; Deschenes et al., 2015), as well as theories suggesting that overinterpretation of threat can evince anxiety over time (Beck, 2005), few to no studies have looked at the longitudinal connection between these two variables. The present study was conducted under the assumption that presence of hostile attribution bias accounts for increases in later anxious symptoms for children who express ADHD symptoms, controlling for the influence of anxiety at earlier points in

development. Controlling for the influence of anxious symptoms at earlier time points is crucial to supporting the argument that anxious symptoms result from hostile attribution bias, as previous literature has indicated bidirectional relationships between types of SIP biases and internalizing outcomes (Luebbe et al., 2010).

THE MEDIATING ROLE OF HOSTILE ATTRIBUTION BIAS

As social problems are consistently linked with ADHD behaviors, even across varying degrees of hyperactive and/or inattentive symptom manifestation (Hoza, 2007), children with ADHD may internalize their social failures over time and learn to anticipate hostility in all social interactions. Supporting this explanation, previous literature has linked ADHD and hostile attribution bias in child samples (Andrade et al., 2012; King et al., 2009). Moreover, as social processing biases, such as hostile attribution bias, have been shown to predict anxious symptoms in middle childhood (Luebbe, 2010), hostile attribution bias may explain why the expression of behaviors associated with ADHD in childhood, such as hyperactivity, impulsivity and inattention, are consistently associated with outcomes of elevated, comorbid anxiety in emerging adolescence.

As previous work has suggested that anxiety disorders tend to emerge in adolescence (Hoff et al., 2017), the current study assessed anxious symptoms during this time period. Early adolescence is defined to begin at age 11 (Curtis, 2015) and is characterized by increasingly complex peer relationships, greater emphasis of the importance of social comparison, and increase in social skills demands; as children learn to navigate social demands, negative peer interactions may be taken more seriously, due to increased emphasis of social relationships that is typical of this developmental time

period (Prinstein & Aikins, 2004). Moreover, social navigation in adolescence may be even more difficult for children who express hostile attribution bias, as misinterpretation of social cues will likely result in maladaptive problem-solving strategies and social behaviors (Bell-Dolan, 1996).

While pathways to externalizing outcomes have been well studied in ADHD populations, the longitudinal association between ADHD symptoms and later internalizing outcomes, such as increases in anxiety, is still not well understood. Hostile attribution bias may provide one explanation of why some children with ADHD go on to develop increased anxious symptoms later in development, as this bias has been observed among children who express ADHD symptoms (Andrade et al., 2012; King et al., 2009), as well as the bias being theorized to precede increases in later anxiety (Beck, 2005). Finally, as the present study investigated this explanatory mechanism within a community sample, results could provide evidence for subclinical manifestations of ADHD symptoms leading to increases in anxious symptoms later in development.

THE MODERATING ROLE OF SOCIAL PREFERENCE

Children with ADHD have been consistently documented to exhibit compromised social functioning, and in turn, experience elevated rates of rejection and lower reported social preference among peers (Hoza, 2007). Potential origins of social impairment for children with ADHD have been hypothesized to result from both hyperactive/impulsive and inattention symptom dimensions of the disorder. Regarding the inattentive symptoms of ADHD, poor sustained attention removes learning opportunities for children to observe the demonstration of social skills (Cunningham et al., 1985), while in day-to-day

functioning, poor attentional control can result in the child not paying attention to relevant social cues (Singh et al., 1998), which are necessary to successfully navigate social interactions. Moreover, children who demonstrate high levels of hyperactivity and impulsivity are often perceived to be overbearing and aversive by peers (Nijmeijer, 2008), also resulting in impaired social functioning.

Given the likelihood of compromised social functioning that results from both symptom dimensions of the disorder, it is unsurprising that children with ADHD have been observed to experience lower rates of social preference among peers, less reported dyadic friendships and greater levels of rejection amongst peers (Hoza et al., 2005). Implications for poor relations with peers extend beyond daily distress for children with ADHD; in a longitudinal study looking at the long-term effects of peer rejection and few dyadic friendships within a sample of children with ADHD, outcomes were shown to include global functional impairment, internalizing symptoms and delinquency by the time these children entered late adolescence (Mrug et al., 2012).

In addition to considering peer context in order to fully understand the experiences and longitudinal development of children with ADHD, it will be necessary to situate the proposed mechanism within a developmental context, as many physical, social and emotional changes occur during the transition from childhood into early adolescence. Elaborating on a specific developmental shift that occurs in middle to late childhood, children are observed to undergo a normative transition from parent-centered social support to finding social support among peers instead (Blos, 1967). This developmental shift is also characterized by children's increasing sense of autonomy, as well as

increased conflict with parents, and increased negative affect during time spent with family (Larson & Richards, 1991; Steinberg, 2001). Children's peer relationships become increasingly important as the child enters the socially tumultuous time of early adolescence (Larson & Richards, 1991; Steinberg, 2001). In addition to providing social support, peer relationships are necessary for the learning and modeling of normative social behaviors, and early friendships have been shown to calibrate later social skills, social decision-making and social adjustment (Glick & Rose, 2011).

With this in mind, considering the well-documented social skills deficits of children with ADHD (Hoza, 2007), independence from parents' social support without the support of a peer group may prove to be detrimental to children's mental health during emerging adolescence, a time when individuals often use opinions of their peers to calibrate their self-concept and self-esteem (Tanti et al., 2011). Considering both the developmental features of late childhood, as well as compromised social functioning observed in children with ADHD, expression of ADHD symptoms and accompanying low social preference among peers may lead to amplified distress as the child enters adolescence, leading to maladaptive outcomes further along in development, such as the acquisition of anxious symptoms.

Summing across developmental literature, evidence suggests that several relevant developmental tasks and shifts have been observed to occur within the age range captured by the current study; therefore, a developmental perspective on the proposed explanatory mechanism may provide insight into why some children with ADHD are at a greater risk for later increases in anxious symptoms. Moreover, given that peer difficulties have been

consistently shown to predict internalizing outcomes, such as anxiety, for children with ADHD (Mrug et al., 2012), low social preference among peers may strengthen the association between ADHD symptoms and later anxious symptoms, through hostile attribution bias. As such, the present study postulated that social preference moderates the proposed indirect effect of ADHD symptoms, such that when children have low social preference, children's expression of ADHD symptoms has a stronger positive association with increases in anxiety through increases in hostile attribution bias.

GOALS AND HYPOTHESES

While previous research has well-documented the risk pathways from ADHD to various externalizing outcomes (Larsson et el., 2011; Steinberg & Drabick, 2015) and some early literature connects ADHD and increases in internalizing symptoms (Biederman et al., 1996; Szatmari et al., 1989), the mechanisms of risk associating childhood ADHD to later anxious symptoms are not well understood. The current study considers the potential mediating role of hostile attribution bias in the longitudinal connection between ADHD and increases in anxiety, postulating that the presence of hostile attribution bias may account for a risk mechanism that is distinct for children with ADHD who go on to develop additional anxious symptoms in emerging adolescence. Further, the present study tested whether the association between ADHD symptoms and later anxiety, as explained by hostile attribution bias, is amplified in the context of children's low social preference among peers.

The overarching goal of this study is to investigate a potential explanatory mechanism through which elevated ADHD symptoms assessed at age 6 confer risk for

increased anxiety symptoms at age 11, mediated by hostile attribution bias at age 7 and moderated by children's social preference at age 6 (Figure 1). It is hypothesized that 1) given existing evidence of the longitudinal association between ADHD and anxious symptoms (Biederman et al., 1996; Szatmari et al., 1989), elevated ADHD symptoms assessed at age 6 will predict increases in anxious symptoms at age 11 2) hostile attribution bias assessed at age 7 will partially account for increases in anxious symptoms and 3) social preference assessed at age 6 will moderate the indirect effect of ADHD symptoms, such that when children have low social preference, children's expression of ADHD symptoms has a stronger positive association with increases in anxious symptoms through increases in hostile attribution bias. Anxious symptoms were controlled for at age 6 to prevent the potential confounding influence of undiagnosed anxious symptoms in childhood, as the current study specifically predicts that anxious symptoms will increase as a result of hostile attribution bias.

CHAPTER II

METHODLOGY

RECRUITMENT AND ATTRITION

The current study used data from the RIGHT Track study, an ongoing longitudinal study investigating socioemotional development [NIMH 55625, NIMH 55584 & NIMH 58144]. The goal for study recruitment was to gather a sample of children who were representative of the surrounding North Carolina community, specifically regarding racial-ethnic and socioeconomic status (SES) characteristics, and who were also at risk for developing future externalizing disorders. All cohorts of children were recruited through the local Women, Infants, and Children (WIC) program, the County Health Department, or through local day care centers. Participants for cohorts 1 and 2 were recruited at 2 years old (recruited 1994-1996 for cohort 1, and 2000-2001 for cohort 2) and were screened for mother-reported externalizing behaviors using the Child Behavior Checklist (CBCL 2-3; Achenbach, 1992). Children were identified as being at risk for developing external disorders if they received a T-score of 60 or above on the externalizing subscale, and attempts were made to equally recruit males and females. A total sample was recruited of 307 participants. Cohort 3 was recruited in 1998 when children were approximately 6 months of age based on children's' levels of frustration based on mother report and laboratory observation; children from cohort 3 whose mothers completed CBCL measures at age 2 were included in the larger study (N = 140). Of the entire sample (N = 447), 37% of children were identified as being at risk

for the development of future externalizing disorders based on early screening methods. There were no significant sex differences between cohorts, $\chi 2(2, N = 447) = .63$, $p = .73$, race, $\chi 2(2, N = 447) = 1.13$, $p = .57$, or two-year SES, $F(2, 444) = .53$, $p = .59$.

Across all cohorts of children enrolled in the study ($N = 447$), six families did not proceed in the study because they did not participate in data collection at age 2; 12 families did not participate at age 2 but participated at later points of assessment.

PARTICIPANTS

The current study uses data from teacher report questionnaires filled out when participants were in first grade (average age = 6.85 years old) and parent and child report questionnaires filled out during lab visits which were conducted when children were ages 6, 7 and 11. Originally, the present study considered assessing ADHD symptoms in 2nd grade, hostile attribution at age 11 and anxious symptoms at age 15; however, bivariate correlations run during preliminary analyses revealed weak to nonexistent associations between main study variables at these time points (Table C1). Thus, the decision was made to shift the developmental timeline earlier, as hypothesized relations among study variables still held at the earlier timepoints, and bivariate correlations revealed stronger associations among main study variables (Table C3). Bivariate correlations from the original timepoints can be found in Table C1.

Data came from questionnaires completed either in in-person lab visits or completed by submission of questionnaires, if teachers, parents, and/or participants did not come to lab in person. Out of the original 447 participants across all three cohorts of

participants, 19% (N = 85) had missing data on all study variables, and therefore the final sample size for the present study included 362 participants.

The present sample included 193 females (53.3%), 169 males (46.7%); 238 white (66%), 102 African American (28%), 14 of mixed race (3.9%), and 8 who identify their race as "other" (2.2%)]. Families were economically diverse based on Hollingshead (1975) scores at the 6 year assessment (Min-Max = 14-66, M = 46.16, SD = 10.46), 7 year assessment (Min-Max = 9-66, M = 44.86, SD = 11.63), and 11 year assessment (Min-Max = 12-66, M = 44.36, SD = 44.36), thus representing families from each level of social strata typically captured by this scale. Hollingshead mean scores ranging from 40 to 54 reflect minor professional and technical occupations considered to be representative of middle class.

PROCEDURES

Each child and one parent, typically the mother, participated in lab assessments conducted at the University of North Carolina at Greensboro Psychology department at ages 2, 4, 6, 7, 11, 15, and 17, but only time points assessed when children were ages 6, 7, and 11 were considered in the current study. If participants were not able to physically come to lab, questionnaires were sent to them to be completed at home and then sent back. Additionally, some questionnaires were filled out at participants' school by teachers, and the present study utilized teacher report of children's ADHD symptoms when children were in 1st grade (average age = 6.85 years old). Consent and assent were collected prior to data collection, and questionnaires were completed by child and mother to assess demographics, behaviors, emotions and other variables of interest.

MEASURES

ADHD Symptoms. ADHD symptoms were assessed using teacher report on the ADHD Rating Scale IV: School Version (DuPaul et al., 1998) when children were in preK, kindergarten, 1st, 2nd 5th, 10th and 12th grades. The mean age of child participants when ADHD symptoms were assessed (during the 1st grade assessment) was 6.85 years old; ADHD symptoms have been shown to robustly emerge around this time across varying degrees of inattentive and/or hyperactive symptom manifestations (Gaub & Carlson, 1997). Items measure symptoms of both inattention and hyperactivity-impulsivity, as this measure is based on the DSM-IV criteria, and for the purposes of this study, a score summing total ADHD symptoms per participant, across symptom dimensions, was used. Symptom dimensions were combined due to 1) concerns of maintaining sufficient statistical power during analyses due to smaller sample sizes and 2) the use of a total score of ADHD symptoms is consistent with methods in other studies (Mokrova et al., 2010). Studies support the ADHD Rating Scale IV: School Version as a reliable and valid measure and indicate reliability and predictive validity of ADHD symptoms in children aged 7-18 (DuPaul et al., 1998).

The ADHD rating scale consists of 18 items measured on a 4-point Likert scale ranging from 0 to 3, with 0 indicating that the behavior has occurred "never or rarely," and 3 indicating that the behavior has occurred "very often" (1 denotes "sometimes" and 2 denotes "often"). The ADHD Total Scale, which is calculated by summing individual item scores, was used in the current study; the possible range is 0 to 54. The average score in the present sample is 11.43, which is lower than the average score of 14.56

obtained by utilizing the same teacher reported measure within a large community sample of boys and girls aged 5-7 years old (Du Paul et al., 1997). Sex differences in the present sample are reflective of those reported in other samples, specifically where boys demonstrate higher scores across both ADHD symptom dimensions (Table C6) and within each hyperactive and inattentive symptom dimension, compared to same-age female peers (Du Paul et al., 1997). Total scores ranging from 26.6 - 48.9 indicate clinically relevant levels of ADHD symptoms for ages 5-7 (90^{th} and 98^{th} percentiles within the community sample respectively; Du Paul et al., 1997). Internal consistency for ADHD Total Scale in the present sample was .96.

Hostile Attribution Bias. Hostile Attribution bias was assessed in the RIGHT Track study using child self-report on the Intent Attributions & Feelings of Distress (IAFD) measure (Crick, 1995), at time-points 7, 11, 15, and 17. The mean age of participants at the time when hostile attribution bias was assessed was 7.5 years old. The current study specifically assessed hostile attribution bias at age 7 because biases in social information processing have been primarily investigated in and have been consistently observed within elementary-aged youth (Crick & Dodge, 1994; Luebbe et al., 2010) and social information processing biases, such as hostile attribution bias, have been theorized to crystallize before children reach adolescence (Bell-Dolan & Wessler, 1994).

The IAFD measure assesses children's attributions of hostile intent and their reported feelings in response to stories of socially ambiguous situations in which the intent of the provocateur is ambiguous (Crick, 1995). There are five stories total: stories

1, 3 and 5 depict instrumental provocation focusing on acts of potential overt aggression (e.g., One's radio is broken by a peer), and stories 2 and 4 depict relational provocation focusing on potential rejection (e.g., discovering that a friend is playing with someone else). For each story, the child must indicate a reason for the provocation (hostile vs. benign; question 1), whether the provocative behavior was meant to be mean or not mean (question 2), if the situation would create distress (question 3), and lastly indicate how the child would experience if the events in the story happened to them (question 4). Stories and questions are provided in Appendix B.

The current study does not consider reports of distress when reporting scores of hostile attribution bias for each participant for two reasons: 1) Social Information Processing Theory stresses the importance of cognitions when individuals navigate social situations, and within this framework, hostile attribution bias is conceptualized as a cognitive bias through which an individual interprets the ambiguous intentions of others to be hostile (Crick & Dodge, 1994). To maintain the theoretical consistency of hostile attribution bias, only cognitive aspects of hostile attributions were measured, excluding emotional distress. 2) Previous studies investigating hostile attribution bias in externalizing populations utilized a cognitive measure of attribution bias, without a measure of emotional distress (Crick & Dodge, 1996; Lansford et al., 2010).

Consistent with previous methods of assessing hostile attribution bias in child populations (Crick, 1995), questions 1 and 2 administered after each story assessed children's attributions of hostile intent of story provocateurs. Answers coded as a 1 indicate presence of hostile attributions, while 0 indicates no presence of hostile

attributions. The total hostile intent score sums all 10 hostile intent items (Sum of scores for questions 1 & 2 per 5 stories), and possible sum scores of hostile intent per participant range from 0 to 10, with higher scores indicating a higher likelihood as perceiving negative events as having hostile intent. Previous studies support the IAFD as a valid and reliable measure; Cronbach alpha reported for hostile intent scales of instrumental and relational aggression situations were reported to be .86 and .78 respectively (Crick et al., 2002). Internal consistency for Total Hostile Intent in the present sample was .784.

Anxious Symptoms. Anxious symptoms were assessed in the RIGHT Track study via child self-report at ages 11, 15, and 17 on the subset of questions contributing to the Anxiety subscale on the Behavior Assessment System for Children, Second Edition (BASC-2 SRP-C). The Anxiety subscale assesses a child's frequency and level of perfectionism, nervousness, and feelings of worry and fear (Reynolds & Kamphaus, 2004). The mean age of participants at the time when anxious symptoms were assessed was 10.7 years old; previous studies report marked increases in anxious symptoms in emerging adolescence, postulating that increased importance of peer relations and magnification of social fears that occur during adolescence may exacerbate cognitive vulnerabilities in at-risk adolescents (Costello et al., 2011; Hoff et al., 2017).

The BASC-2 SRP-C is the child version for ages 8-11 and includes 139 items. There are true/false questions and scale questions (0=never, 1=sometimes, 2=often, and 3=almost always). The anxiety subscale includes items 8, 37, 55, 65, 83, 86, 93, 104, 111, 114, 121, 132, 139, and the current study utilized a T score combined by sex to represent anxiety symptoms exhibited by the child, as reported by the child at age 11. T scores

combined by sex on the BASC-2 SRP-C do not take sex differences into account when calculating T scores representing each subscale (Reynolds & Kamphaus, 2004); the current study considers sex as a covariate, so it is necessary to use anxiety subscale T scores that are not influenced by sex differences so that the influence of sex is only removed once via the external covariate of sex.

Previous studies support the BASC-2 SRP-C as a valid and reliable measure and indicate reliability and predictive validity of the anxiety subscale; Cronbach alpha reported for the anxiety subscale was reported to be .86 (Reynolds & Kamphaus, 2004). Internal consistency for Anxiety General T Score combined by sex in the present sample was .889.

Social Preference. Children's social preference was assessed in the RIGHT Track study via sociometric procedures, which were administered when study participants were in kindergarten, 1st, 2nd and 5th grade. In kindergarten, 1st, and 2nd grade, researchers dropped off packets to each RIGHT Track participants class that included parental consent forms for the teacher to hand out and a teacher packet for the teacher to complete about the RIGHT Track participant. Teachers collected returned consent forms and scheduled in-class interviews after at least 75% of a classroom's consents were returned (number of yes vs. no consents did not matter). Prior to the interviews being conducted, researchers took pictures of each child whose parents consented for the child to participate. These pictures were brought by the researchers to assist children with their nominations. All children were trained on a "3-face" rating scale: Smiling=likes a lot (3); Frowning=don't like (1), and a middle face=ok (2). Then the researcher asked, "Do you

know___?" If yes, then "how much do you like to play with this child?" If no, no rating is made. Children were then asked to nominate peers based on behavioral descriptors (questions for each grade are listed below). Children can say their peers name or point to their picture to nominate a peer for a behavioral descriptor. A minimum of three nominations per item was encouraged. Scores were calculated as the sum of all nominations within each category and then were standardized using Z score transformations so that cross-grade comparisons could be made independently of class size (Coie et al., 1982).

The current study only considers sociometric data gathered in 1st grade (average age = 6.85), and specifically, the social preference score was used to measure children's social standing among peers. Social preference scores were calculated by subtracting children's nominations within the "Liked the most" by peers category, from their total nominations within the "Liked the least" by peers category. To control for differences in classroom sizes, positive and negative nominations were standardized within class by converting them to z scores. For each child, this resulted in a standardized positive nomination score (PN) and a standardized negative nomination score (NN). Subsequently, social preference scores (SP) were calculated by subtracting the standardized negative nomination scores from the standardized positive nomination scores. As such, higher social preference z scores indicate higher levels of social preference among peers (Coie et al., 1982). Previous studies support the use of peer nominated sociometric status as a valid and reliable measure and indicate reliability and predictive validity of the social preference subscale; Cronbach alpha reported for "Liked

the most" and "Liked the least" subscales within sociometric peer nomination procedures were reported to be .65 (Coie et al., 1982; Roff et al., 1972).

CHAPTER III

RESULTS

PRELIMINARY ANALYSES

Preliminary analyses were conducted using SPSS version 23. Preliminary analyses included running descriptive statistics, bivariate correlations, and group mean comparisons on study variables, as well as assessing normality of data. Descriptive statistics for all study variables are listed in Table C2.

Bivariate correlations were performed between main study variables (Table C3). Significant bivariate correlations were observed to exist between ADHD symptoms and social preference ($r = -0.525$, $p = <.001$), and between ADHD and anxious symptoms ($r = .230$, $p = 0.002$). No other significant correlations were found, but the direction of associations between social preference and hostile attribution bias ($r = -0.196$, $p = 0.058$), and between hostile attribution bias and anxious symptoms ($r = 0.107$, $p = 0.193$) were in the hypothesized directions. No association was found between hostile attribution bias and ADHD symptoms ($r = 0.08$, $p = 0.436$; Table C3).

Additionally, bivariate correlations were compared between males and females (Table C4). Significant negative correlations between ADHD symptoms and social preference were observed within both sex groups (males: $r = -0.576$, $p < .001$; females: $r = -0.443$, $p < .001$; Table C4). One notable difference between sexes includes a significant negative correlation observed between hostile attribution bias and social preference for males ($r = -0.323$, $p = 0.037$), but not females ($r = -0.074$, $p = 0.601$; Table

C4). Next, a significant bivariate correlation between ADHD and anxious symptoms was observed for females ($r = 0.347$, $p < .001$), but not males ($r = 0.182$, $p = 0.107$; Table C4). No other significant differences were observed.

Covariates. Many prior studies have observed sex differences in ADHD, specifically evidencing that males more commonly express ADHD symptoms, both in terms of severity and in number of symptoms, (Gaub & Carlson, 1997; Gershon, 2002). In the present sample, independent t tests identified statistically significant sex differences for ADHD symptoms, $t (175.313) = 4.309$, $p < 0.001$, where males were found to exhibit more ADHD symptoms compared to females (Table C6). There were no sex differences observed for anxious symptoms, which is somewhat surprising, as increased risk for girls begins in middle childhood (Altemus et al., 2014; Lewinsohn et al., 1998; Table C6). Given that sex differences have been identified in previous literature for both anxiety and ADHD (Costello et al., 2011; Gaub & Carlson, 1997; Gershon, 2002), and considering the significant sex differences of ADHD symptom expression evidenced in the present sample (Table C6), sex was considered as a covariate in the present study, as the mechanism of risk is hypothesized to exist across sex categories.

The current study sought to identify increases in anxious symptoms over time that are not explained by earlier levels of anxious symptoms, and thus, anxious symptoms reported by the parent at age 6 was considered as the final covariate.

Missing Data. Full information maximum likelihood (FIML) was used to account for missing data on questionnaire measures for participants who had data collected from

at least one timepoint. Those with partial data were included in analyses, and based on Little's MCAR test, data were missing at random, $\chi 2$ (50) = 45.447, $p > .05$.

MAIN ANALYSES

Main analyses were completed in Mplus (Version 8; Muthén & Muthén, 2017), and a moderated mediation path analysis was examined. A bias-corrected boot strapping procedure (10,000 draws) was used to test indirect effects of ADHD symptoms on increases in anxious symptoms through hostile attribution bias. Bootstrapping has been shown to generate 95% confidence intervals for indirect effects, reducing Type I error rates and increasing power over other similar tests (MacKinnon et al., 2004). Model fit was examined using the comparative fit index (CFI; Marsh & Hau, 2007), the standardized root-mean-square residual (SRMR), and the root mean square error of approximation (RMSEA; Cole & Maxwell, 2003). CFI values close to or greater than .95 indicate good model fit, RMSEA values less than .06 indicate good model fit, and SRMR values less than or equal to 0.08 indicate good model fit (Hu & Bentler, 1999).

Specifically, path analyses of a moderated mediation model tested whether 1) ADHD symptoms at age 6 predicted increases in anxious symptoms in emerging adolescence, 2) whether ADHD symptoms indirectly predicted increases in anxious symptoms through hostile attribution bias and lastly 3) whether social preference moderates the indirect effect of ADHD on increases in anxious symptoms, as explained by increases in hostile attribution bias. Anxious symptoms assessed at age 6 and sex were considered as covariates in the paths to anxious symptoms at age 11.

Moderated Mediation Analyses. First, an interaction term was created to test the influence of the moderator, social preference, on the indirect effect of ADHD symptoms, by multiplying ADHD symptoms by social preference. Next, to assess conditional direct, indirect and total effects at different levels of the moderator, three different levels of social preference were calculated by splitting the distribution of social preference scores into tertiles and then using the mean of each tertile to represent social preference at high, medium and low levels, respectively (N of high, medium and low levels of social preference = 68, 69, 68; means of high, medium and low levels of social preference = 1.07762, 0.03042, -0.92568). Conditional indirect effects, conditional direct effects, and conditional total effects for each combination of moderator values were calculated for each combination of moderator values (high, medium and low levels of social preference).

Upon testing model fit, fit indices indicated adequate fit; model chi-square (X^2_{Model}) and RMSEA fit statistics suggest that the present model fits the data well (X^2_{Model} [11] = 25.252, p =0 .0084, RMSEA = .000, 90% CI [0.000, 0.095]) suggesting close model fit. Similarly, the TLI value of 1.000 suggested a perfectly fitting model. Further evidencing good model fit, the comparative fit index estimate (CFI = 1.000) indicated improved model fit relative to the baseline model and the SRMR suggested good fit, with the model explaining the correlations to within an average error of 0.015 (Table C7).

Direct Effects. Assessing direct effects in the present model tested the significance of the relation between predictors of ADHD symptoms (the main predictor)

hostile attribution bias (the mediator), social preference (the moderator) and the interaction term between ADHD x Social preference (the interaction term) with anxious symptoms (the outcome). As hypothesized, teacher report of children's ADHD symptoms at age 6 was significantly and positively predictive of children's self-reported anxious symptoms at age 11 ($\beta = 0.308$, S.E. = 0.109, $p = 0.005$) (Figure 3). Additionally, female sex membership was also significantly and positively predictive of children's anxious symptoms at age 11 ($\beta = 0.190$, S.E. = 0.060, $p = 0.002$) (Figure 3). In regard to conditional direct effects, as the interaction term of ADHD x Social preference was found to be non-significant (Figure 3), conditional direct effects of ADHD on increases in anxiety at low, medium and high levels of social preference were not be interpreted. No other paths were significant. See Figure 1 for an illustration of the conceptual model and Figure 3 for a statistical diagram with all standardized path coefficients and standard errors.

Indirect Effects. In order to test the hypothesis that ADHD symptoms have an indirect effect on increases in anxious symptoms through hostile attribution bias, as well as a moderated indirect effect in combination with social preference, indirect effects were examined. Tests of indirect effects have been shown to generate product terms that are asymmetrically distributed, and therefore, standard significance testing, which assumes normality, may produce biased results (MacKinnon et al., 2004). Thus, bias-corrected bootstrapped confidence intervals of the unstandardized parameter estimates are reported in the present study (Table C8), in addition to reporting standardized path coefficients and significance levels (Table C9). 95% bias-corrected bootstrapped confidence intervals

and unstandardized parameter estimates of indirect effects are listed in Table C8, and confidence intervals that contain the value of zero indicate non-significant indirect effects (MacKinnon et al., 2004). Maximum likelihood parameter estimates of path coefficients are listed in Table C9 for comparison, and indirect effects were found to be non-significant across both reporting methods.

In testing whether ADHD symptoms were indirectly related to later anxious symptoms through hostile attribution bias, results revealed no evidence of an indirect effect (β = -0.010; S.E. = 0.022; 95% CI: B = [-0.065, 0.014]; Table C8). There was also no conditional indirect effect observed after testing whether ADHD x social preference predicted increases in anxious symptoms through hostile attribution bias (β = -0.013; S.E. = 0.028; 95% CI: B = [-0.076, 0.006]; Table C8). These results indicate that there is insufficient evidence to support the association between 1) ADHD symptoms and increases in anxious symptoms through hostile attribution bias, as well as between 2) ADHD in the context of the moderator, social preference, and increases in anxious symptoms, through hostile attribution bias.

POST HOC ANALYSES

Upon finding insignificant indirect effects, which suggest that neither ADHD symptoms alone, nor in combination with differing levels of social preference, predict increases in anxiety, as explained by hostile attribution bias, post hoc analyses were conducted to investigate different aspects of the proposed model.

Testing Simple Mediation. Given that the addition of social preference into the initial model did not yield a significant indirect effect, a simple mediation model was

conducted to test whether the relation between ADHD symptoms and anxious symptoms is significant via the mediating factor of hostile attribution bias without the influence of the moderator, social preference. Path analyses testing the simple mediation model were conducted using Mplus (Version 8; Muthén & Muthén, 2017). Consistent with the initial model, sex and parent report of children's anxious symptoms at 6 year were considered as covariates. Also consistent with the initial model, a bias-corrected bootstrapped confidence interval of the unstandardized parameter estimate was tested; if the confidence interval contained the value of zero, it was considered to signify a non-significant indirect effect (MacKinnon et al., 2004). Standardized path coefficients and significance levels are also reported (Table C11).

Fit indices for the simple mediation model suggest adequate model fit: model chi-square (X^2_{Model}) and RMSEA fit statistics suggest that the present model fits the data well (X^2_{Model} [7] = 19.492, p = 0.0068, RMSEA = 0.000, 90% CI [0.000, 0.094]) suggesting close model fit. Similarly, the TLI value of 1.000 suggested a perfectly fitting model. Further evidencing good model fit, the comparative fit index estimate (CFI = 1.000) indicated improved model fit relative to the baseline model and the SRMR suggested good fit, with the model explaining the correlations to within an average error of 0.020. See Table C10 for all reported model fit indices.

Assessing direct effects in the simple mediation model tested the direction and strength of the relation between ADHD symptoms and anxious symptoms. Results were consistent with the initial model: ADHD symptoms were found to be significantly and positively predictive of later anxiety (β = 0.266, S.E. = 0.083, p = 0.001; Figure 3). See

Figure 3 for an illustration of this model with all standardized path coefficients and standard errors. Assessing indirect effects in the simple mediation model tested whether the relation between ADHD symptoms and anxious symptoms is significant via the mediating factor of hostile attribution bias. Results from the simple mediation model mirror findings from the initial model in that indirect effects were not found to be significant (β = 0.008; 95% CI: B = [-0.009, 0.068]), further suggesting that insufficient evidence to support that the association between ADHD and later increases in anxious symptoms can be partially explained by hostile attribution bias. Maximum likelihood parameter estimates of path coefficients are listed in Table C11 for comparison; results were consistent across both methods for assessing significance of indirect effects.

Testing Moderation of Social Preference. Given that indirect effects were not evidenced to partially explain the association between ADHD and later increases in anxious symptoms, a moderation analysis was conducted using SPSS version 23 to test whether the association between ADHD and increases in anxiety is exacerbated at differing levels of children's social preference. Evidence from previous studies suggests that children's low social preference may increase risk for development of later internalizing symptoms (Gazelle & Ladd, 2003; Mrug et al., 2012; Sentse et al., 2017), and this association may be stronger for children with ADHD who have been observed to have lower social preference compared to peers who do not express ADHD symptoms (Cunningham et al., 1985; Hoza, 2007; Hoza et al., 2005; Singh et al., 1998). Given strong evidence in the literature, it was hypothesized that the association between ADHD behaviors (teacher-reported when children were age 6) and increases in later anxiety

(self-reported at age 11) would be exacerbated by children's lower levels of social preference (assessed via peer nomination sociometric procedures in 1st grade classrooms). Despite strong conceptual justification, testing the moderation effect of social preference (by regressing anxious symptoms at age 11 onto the interaction term of ADHD x social preference at age 6, controlling for anxious symptoms at age 6 and sex) was found to be nonsignificant ($\beta = 0.028$, S.E. = 0.028, $p = 0.739$).

Testing the Effects of Aggression. Hostile attribution bias has traditionally been studied in the context of aggression (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990). As the initial model did not consider the influence of aggression on the proposed explanatory mechanism, a post hoc moderated mediation analysis was conducted in which the initial moderated mediation model was preserved, except the original moderator, social preference, was replaced by parent report of children's aggression. In sum, this post hoc analysis tested whether the association between ADHD and later increases in anxious symptoms can be partially explained by hostile attribution bias, in the context of a new moderator, aggression. Sex and earlier levels of anxious symptoms were considered as covariates. Aggression was assessed at age 6 using parent report of children's aggressive symptoms on the BASC-2 SRP-C; specifically, aggression symptoms were measured using a T score combined by sex representing the Aggression subscale, which assesses argumentativeness, revenge seeking behavior, frequency of intentional, hurtful behaviors like bullying and violence, and how quickly one loses his or her cool (Reynolds & Kamphaus, 2004). Descriptives of and bivariate correlations for aggression and main study variables can be found in Table C12.

Consistent with methods in the initial model, an interaction term was created to test the influence of the moderator, aggression, on the indirect effect of ADHD symptoms, by multiplying ADHD symptoms by aggression. Next, to assess conditional direct, indirect and total effects at different levels of the moderator, three different levels of aggression were calculated by splitting the distribution of aggression scores into tertiles and then using the median of each tertile to represent aggression at high, medium and low levels, respectively (N of high, medium and low levels of aggression = 106, 105, 115; medians of high, medium and low levels of aggression = 39, 43, 54). Conditional indirect effects, conditional direct effects, and conditional total effects for each combination of moderator values were calculated for each combination of moderator values (high, medium and low levels of aggression). Next, a loop plot was used to plot conditional indirect effects of ADHD symptoms on later anxious symptoms at low, medium and high levels of aggression. Despite conceptual support for the influence of aggression on main study variables (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990), fit indices suggest poor model fit, and thus, results cannot be interpreted (Table C13).

Additionally, aggression was considered in post hoc analyses via two other methods to exhaust the possibility that the association between ADHD and anxiety is more greatly impacted and/or explained by aggression over and above hostile attribution bias and social preference. First, a moderation analysis was conducted using SPSS version 23 to test whether the association between ADHD and increases in anxiety is exacerbated at differing levels of children's aggression. It was hypothesized that the

association between ADHD behaviors (teacher-reported when children were age 6) and increases in later anxiety (self-reported at age 11) would be exacerbated by children's aggression (assessed via parent report on the BASC-2 SRP-C). Despite strong conceptual justification, testing the moderation effect of aggression (by regressing anxious symptoms at age 11 onto the interaction term of ADHD (age 6) x aggression (age 6), controlling for anxious symptoms at age 6 and sex) was found to be nonsignificant (β = -0.058, S.E. = 0.006, p = 0.440).

Next, a simple mediation analysis was conducted to test whether the relation between ADHD symptoms and anxious symptoms is significant via the mediating factor of aggression at age 7. Path analyses testing the simple mediation model were conducted using Mplus (Version 8; Muthén & Muthén, 2017), and sex and parent report of children's anxious symptoms at the 6 year assessment were considered as covariates. Despite evidence in the literature supporting the influence of aggression on main study variables (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990), fit indices suggest poor model fit, and thus results cannot be interpreted (Table C13).

Given the lack of evidence across several different attempts to incorporate and account for aggression in the association between ADHD and increases in anxiety, results across these attempts suggest that aggression does not play a strong role within the present sample, and supports use of the initial model, which does not incorporate aggression.

CHAPTER IV

DISCUSSION

Despite elevated rates of anxiety reported for individuals who express ADHD symptoms beginning in as early as adolescence (Biederman, 2005; Krone & Newcorn, 2015), mechanisms explaining this association are not well understood. The present study sought to test if children's ADHD symptoms assessed at age 6 predicted increases in later anxious symptoms in emerging adolescence (age 11), as explained by the influence of hostile attribution bias at age 7, and whether this explanatory mechanism was exacerbated in the context of children's low social preference among peers at age 6.

In testing the first goal of the study, it was hypothesized that elevated ADHD symptoms would predict the expression of later elevations in anxious symptoms in emerging adolescence. As hypothesized, a main effect was found between ADHD symptoms at age 6 and increases in anxious symptoms at age 11, after controlling for earlier anxious symptoms. This finding is consistent with literature linking externalizing behavior to the later acquisition of internalizing symptoms (Jarrett & Ollendick, 2008; Mrug et al., 2012; Sobanski, 2006), and more specifically, is in line with previous studies that have linked ADHD and increases in anxiety over time (Biederman et al., 1996; Szatmari et al., 1989). No other direct effects were observed in the present model. The lack of main effect between hostile attribution bias and anxiety is surprising, as previous

studies have evidenced linkages between threat-related biases, like hostile attribution bias and anxious symptoms (Bar-Haim et al., 2007; Bell-Dolan, 1995; Prinstein et al., 2005).

Next, the second goal assessed whether the presence of hostile attribution bias accounted for increases in anxious symptoms for individuals who express ADHD symptoms. Specifically, it was hypothesized that the presence of hostile attribution bias will partially account for the association between ADHD symptoms and increases in anxiety, such that the positive longitudinal association between ADHD and later increases in anxiety will be explained by greater hostile attribution bias. Evidence across the literature supports this hypothesis. First, several studies have observed social information processing biases, such as hostile attribution bias, within populations of children with ADHD; more specifically, hostile attribution bias was observed to affect children's socio-cognitive perceptions, as well as their subsequent behavioral responding (Andrade et al., 2012; King et al., 2009; Milich & Dodge, 1984). Next, across numerous studies, anxious individuals have been observed to exhibit threat-related biases such as hostile attribution bias, especially when interpreting social cues (Bar-Haim et al., 2007; Bell-Dolan, 1996; Deschenes et al., 2015), and theoretical models have proposed that that disproportionate attention to threat-relevant stimuli can account for later anxious symptoms (Beck, 2005). Despite strong evidence for the association between ADHD and hostile attribution bias, and between hostile attribution and later anxiety, results from the present study did not support the proposed hypothesis that hostile attribution bias accounts for increases in anxious symptoms for individuals who express ADHD symptoms.

There are several potential reasons for this null finding. First, variability in participants' hostile attribution bias scores was limited in the present sample. Specifically, the mean of hostile attribution scores in the present sample was 2.30, on a possible scale of 0-10 (Table C2), likely weakening the likelihood of evidencing significant associations observed between hostile attribution bias and other variables as scores indicating relatively low overall presence of hostile attribution bias scores in the present sample. Additionally, given the weak associations observed between hostile attribution bias and other study variables evidenced by bivariate correlations in the preliminary analyses, as well as the lack of a main effect observed between hostile attribution bias and later anxious symptoms, it is likely that the restricted range of hostile attribution bias scores in the present sample decreased the likelihood of evidencing an association between hostile attribution bias and other main study variables. Converging evidence in the literature supported the proposed hypothesis that hostile attribution bias accounts for increases in anxious symptoms for individuals who express ADHD symptoms; however, due to the potential influence of low variability of hostile attribution scores, results did not support this hypothesis.

The final goal of the study tested whether the proposed explanatory mechanism was exacerbated in the context of children's peer nominated social preference when children were age 6. Specifically, it was hypothesized social preference moderates the proposed indirect effect of ADHD symptoms, such that when children have low social preference, children's expression of ADHD symptoms has a stronger positive association with increases in anxiety through increases in hostile attribution bias. In support of this

hypothesis, many studies testing mental health outcomes of children with ADHD have been considered in the context of peer relationships, as children who express ADHD-like behaviors have been consistently observed to be demonstrate social skills impairments (Cunningham et al., 1985; Hoza, 2007), leading to poor relations with and worsened social preference among their peers (Hoza, 2007; Hoza et al., 2005; Nijmeijer, 2008). Moreover, studies looking at the long-term effects of peer rejection within a sample of children with ADHD showed increased risk for later internalizing symptoms by the time children enter adolescence (Mrug et al., 2012).

Given support in the literature for the influence of peer relations on risk of internalizing outcomes for children who express ADHD-like behaviors and often experience low levels of social preference among peers, children's peer nominated social preference was considered as a moderator in the present study, specifically positing that low social preference will further strengthen the indirect effect of ADHD behaviors on increases in anxious symptoms through increases in hostile attribution bias. Despite strong support in the literature, as well as strong associations observed between social preference and study variables including ADHD and anxious symptoms evidenced via bivariate correlations in preliminary analyses (Table C3), results from the present study do not support the proposed moderated mediation model. Similar to the discussion of the mediation model, it is likely that the distribution of hostile attribution scores affected the chances of evidencing support for the proposed moderated mediation, as low scores indicating muted presence of hostile attribution bias in the present sample ultimately limited the potential for any emerging relationships among main study variables.

POST HOC ANALYSES

Given that the proposed moderated mediation model was not supported by study results, several post hoc analyses were conducted to further probe relationships among study variables. First, a simple mediation model tested whether the relation between ADHD symptoms and anxious symptoms is significant via the mediating factor of hostile attribution bias without social preference in the model. Findings were consistent with those evidenced by the indirect effects assessed in the initial moderated mediation analysis: a main effect was found between ADHD and increases in anxiety (Figure 3), but indirect effects were not evidenced to partially explain the association between ADHD and later increases in anxious symptoms.

Next, a moderation analysis tested whether the association between ADHD and increases in anxiety is exacerbated at differing levels of children's social preference, and this model was found to be insignificant as well. While results revealed that low social preference did not exacerbate the association between ADHD and increases in anxiety, the nonsignificant association between the interaction term, ADHD x Social preference, and later anxious symptoms assessed by the moderation could be attributed to low overall presence of ADHD symptoms in the present sample. Specifically, the average total score ADHD symptoms in the present sample was 11.43, which is lower than the average score of 14.56 obtained by utilizing the same teacher reported measure within a large community sample of boys and girls aged 5-7 years old (Du Paul et al., 1997); therefore, lower manifestation of ADHD symptoms in the present sample, compared to what has been reported in other community samples, may have decreased the likelihood of

evidencing support for the present model. Further, associations between ADHD symptoms and negative outcomes, such as anxious symptoms, have been evidenced in community samples (Bussing et al., 2010; Spencer et al., 2007), but this association may only come online if ADHD symptoms are stronger; thus, a limitation of the present study was fewer overall manifestations of ADHD symptoms in the community sample.

Aggression. Previous literature has observed consistent linkages between hostile attribution bias and externalizing outcomes such as aggression, suggesting that aggressive children act aggressively due to disproportionate perceptions of hostility within the actions of others, and this misperception of hostility triggers them to respond with antisocial behaviors (De Castro et al., 2002). However, recent evidence suggests that hostile attribution bias is also predictive of increases in internalizing symptoms, suggesting that attributions of hostility may lead to outcomes beyond externalizing behaviors, such as the acquisition of internalizing symptoms like anxiety (Bar-Haim et al., 2007; Bell-Dolan, 1995; Prinstein et al., 2005).

Given that hostile attribution bias has primarily been studied within aggressive populations (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990), post hoc analyses tested the potential influence of aggression on relationships among main study variables from several different angles. First, post hoc analyses tested whether the association between ADHD and later increases in anxious symptoms can be partially explained by hostile attribution bias, in the context of the moderator, aggression. Given evidence in the literature suggesting a strong positive association between hostile attribution bias and aggression (Crick & Dodge, 1994; Dodge et al., 1990), it was

hypothesized that the relationship between ADHD and increases in anxiety would be strengthened in the context of elevated levels of aggression, as partially explained by hostile attribution bias. Given that fit indices for this model were poor, model results were not able to be interpreted (Table C13).

Next, aggression was tested as a simple mediator; specifically, analyses tested whether the relation between ADHD symptoms and anxious symptoms is significant via the mediating factor of parent-reported aggression when children were age 7. Again, despite evidence in the literature supporting the influence of aggression on main study variables (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990), fit indices suggest poor model fit, and thus results cannot be interpreted (Table C14). Finally, a moderation analysis was completed to test whether the association between ADHD and increases in anxiety is exacerbated at differing levels of children's aggression; results for this analysis were found to be nonsignificant. Given the lack of evidence across several different attempts to incorporate and account for aggression in the association between ADHD and increases in anxiety, results across these attempts suggest that aggression does not play a strong role in the proposed mechanism, at least within the present sample.

There are several potential explanations for why aggression was not found to be significant across several post hoc analyses. First, it is possible that effects on anxious symptoms and hostile attribution bias are more likely to be evidenced within populations who express greater levels of aggression, and thus the present community sample featuring low levels of aggression was less than ideal in evidencing hypothesized effects. Next, more specifically, within the moderated mediation model that tested whether the

association between ADHD and later increases in anxious symptoms can be partially explained by hostile attribution bias, in the context of aggression, it is likely that the lack of presence of hostile attribution bias lessened the likelihood of evidencing a significant indirect effect, regardless of the influence of a moderator, for aforementioned reasons. However, null findings resulting from the simple mediation of ADHD to increases in anxiety as explained by aggression, and moderation of ADHD to increases in anxiety in the context of aggression, converge to suggest that aggression, despite strong evidence in the literature (Crick & Dodge, 1994; De Castro et al., 2002; Dodge et al., 1990), simply had less of an effect on the association of ADHD symptoms to increases in anxiety than what would be expected, at least within the present sample.

STRENGTHS AND LIMITATIONS

There are several strengths in the present study that warrant mentioning, as well as some limitations. First, strengths of the present study include the use of a large sample of study participants who were representative of the surrounding community, specifically regarding racial-ethnic and socioeconomic status (SES) characteristics of the Greensboro, NC area at the time of study recruitment, which occurred from the late 1990's into 2004. Next, the design of the RIGHT Track project allowed the present study to assess study variables through the use of multi-informant reporting, including teacher, parent and child self-report on numerous questionnaires, as well as peer nomination via sociometric procedures in assessing study participants' ranking of social preference among classmates. Additionally, participant data gathered across RIGHT Track cohorts was assessed at multiple increments across participants' lifespan, including early childhood

up through emerging adulthood. Further, assessment of participants' demographics, behaviors, emotions and other variables of interest at different timepoints allows for temporal relationships between study variables to be tested, and the data amassed by the RIGHT Track Project across multiple timepoints allowed for the present study to test whether anxious symptoms increase over time as a result of the influence of other variables such as social preference, hostile attribution bias, and ADHD symptoms.

In addition to numerous strengths, one aforementioned limitation lies within low variability of hostile attribution bias in the present sample; specifically, the mean of hostile attribution bias scores among study participants was 2.30 out of a possible score of 10 (on a scale of 0-10), where higher scores indicate greater presence of hostile attribution bias), indicating relatively low presence of hostile attribution bias assessed via the self-report measure at age 7. It is likely that low variability in hostile attribution bias scores at least partially accounted for the weak associations observed between hostile attribution bias and other study variables evidenced by bivariate correlations in the preliminary analyses, as well as the lack of a main effect observed between hostile attribution bias and later anxious symptoms. Additionally, ADHD symptoms were also muted, compared to reports of symptom manifestations reported in other community samples (Du Paul et al., 1997), which likely impacted the likelihood of evidencing significance between ADHD and other study variables. Thus, low manifestations of ADHD symptoms and hostile attribution bias in the present sample are considered as limitations of the present study.

FUTURE DIRECTIONS

Given that results from the present study did not support the proposed moderated mediation model, there are several recommendations for future directions in which relationships between main study variables may still be evidenced. First, hostile attribution bias was assessed using child self-report on the Intent Attributions & Feelings of Distress (IAFD) measure, which assesses children's attributions of hostile intent and their reported feelings in response to stories of socially ambiguous situations in which the intent of the provocateur is ambiguous (Crick, 1995). While hostile attribution bias has been traditionally assessed using self-report measures utilizing vignettes describing ambiguous social interactions to assess participants' hostile attribution bias (Tuente et al., 2019), use of other types of measurement tools may be advantageous; specifically, some studies have used videotapes and photographs depicting social interactions that were neutral, ambiguous or aggressive in nature (Chen & Matthews, 2003; Coccaro et al., 2009; Dill et al., 1997). While the use of vignettes has been shown to be effective in assessing hostile attribution bias within child populations (Crick, 1995), using videos and photographs as visual aids may be particularly helpful for child participants in accurately interpreting ambiguous social scenarios, as children may exhibit lesser imaginative abilities compared to adult counterparts (Chen & Matthews, 2003). Thus, future studies assessing hostile attribution bias in children should consider incorporating visual aids into presentations of study stimuli to further increase the accuracy of assessment of children's hostile attribution bias.

Additionally, given that hostile attribution bias accounted for a small portion of the variance explained in testing the longitudinal association between ADHD symptoms and increases in anxiety, other potential mediators, in addition to aggression, which was tested in post hoc analyses, certainly warrant investigation. First, children's early levels of behavioral regulation may account for the longitudinal association between ADHD symptoms and increases in anxiety. Some theories suggest that children with ADHD and anxiety, who express greater behavioral control, may represent a variant of ADHD that is distinct from their peers with ADHD who express low behavioral regulation (Bubier & Drabick, 2009). Children who demonstrate overregulation of behavioral control are less likely to engage in reward-seeking behavior, such as approaching and engaging socially with peers; as a result of approach avoidance, the child doesn't learn the social skills necessary to engage with peers, and failed social experiences result in increases in anxiety over time (Bubier & Drabick, 2009). Conversely, behaviorally under-regulated children with ADHD may also uniquely fit within the proposed model; children with ADHD who express hyperactivity/impulsivity tend to exhibit compromised social skills, resulting in many children with ADHD experiencing greater levels of peer rejection (Hoza, 2007). Again, failed social experiences via peer rejection result in increased anxiety over time. Summing across both theories, levels of behavioral regulation may therefore uniquely contribute to the present model and thus warrants future consideration as a potential mediator in the longitudinal association between ADHD symptoms and increases in anxiety.

Other potential factors that may also warrant investigation include children's temperament style and emotion regulation ability. First, significant evidence within the field of temperament research suggests that children's temperament styles shape how they respond to environmental factors, ultimately altering risk for later maladaptive outcomes (Oldehinkel et al., 2004). Additionally, findings from numerous studies have evidenced specific relationships between temperament styles and increased risk for later internalizing symptoms (Pérez-Edgar & Fox, 2005; Williams et al., 2009). In the present study, children with temperament styles that render them more sensitive to low social preference among their peer relationships may be at increased risk for developing anxious symptoms; thus, a model that accounts for the effect of temperament in response to socio-environmental factors by taking children's temperament style into account may be warranted. Next, emotion regulation may also play an important role in the development and acquisition of anxious symptoms over time; evidence across numerous studies has shown that poor early emotion regulation ability is a risk factor for later anxiety (Armstadter, 2008). Thus, a measure of emotion regulation may also warrant consideration, such that emotion regulation may account for increases in anxiety over time, and therefore should be considered as a potential factor in the mechanism of risk for increases in anxiety for children who express ADHD symptoms in childhood.

Additionally, future studies may consider retesting the proposed model at later points in development. Specifically, despite some evidence supporting the longitudinal association between ADHD and increases in anxious symptoms in as early as childhood (Biederman, 2005; Krone & Newcorn, 2015), prevalence of anxiety disorders has been

showed to sharply increase after adolescence (Jarrett & Ollendick, 2008). Therefore, it may be warranted to shift the proposed timeline later to capture increases in anxious symptoms that have been shown to occur around this developmental time period (Jarrett & Ollendick, 2008), which may be further amplified for individuals who express ADHD symptoms.

Finally, future research may consider incorporating a measure of rejection sensitivity to more accurately capture the social experiences of children with ADHD. Social skills deficits observed in populations of children with ADHD have been well-documented (Hoza, 2007), and one proposed explanation for this association is amplified sensitivity to rejection by peers, which increasingly sabotages success of future social interactions with peers by resulting in outcomes such as increased anticipation of negative social experiences, and poor social problem-solving (Babinski et al., 2019). Specifically, increased rejection sensitivity may lead to amplified risk for hostile attribution bias for children with ADHD, as greater emotional reactivity to rejection for children with ADHD may lead to increased attributions may about the hostile intent of others (Matthys et al., 1999), therefore resulting in the acquisition of anxious symptoms over time. With this in mind, incorporation of rejection sensitivity into the proposed model may capture the unique experiences of children with ADHD over time, as this population has been observed to experience both early peer rejection (Hoza, 2007) and expression of hostile attribution bias in late childhood (Andrade et al., 2012; King et al., 2009), thus potentially explaining children's acquisition of additional anxious symptoms over time.

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APPENDIX A.

ADHD RATING SCALE IV: SCHOOL VERSION

Circle the number that best describes your child's home behavior over the past 6 months.

Note: Even numbered questions assess Hyperactivity/Impulsivity, and odd numbered assess Inattention

Never or Rarely	Sometimes	Often	Very Often
0	1	2	3

1. Fails to give close attention to details or makes careless mistakes in schoolwork.
2. Fidgets with hands or feet or squirms in seat.
3. Has difficulty sustaining attention in tasks or play activities.
4. Leaves seat in classroom or in other situations in which remaining seated is expected.
5. Does not seem to listen when spoken to directly.
6. Runs about or climbs excessively in situations in which it is inappropriate.
7. Does not follow through on instructions and fails to finish work.
8. Has difficulty playing or engaging in leisure activities quietly.
9. Has difficulty organizing tasks and activities.
10. Is "on the go" or acts as if "driven by a motor."
11. Avoids tasks (eg, schoolwork, homework) that require sustained mental effort.
12. Talks excessively.
13. Loses things necessary for tasks or activities.
14. Blurts out answers before questions have been completed.
15. Is easily distracted.
16. Has difficulty awaiting turn.

17. Is forgetful in daily activities.

APPENDIX B.

INTENT ATTRIBUTIONS & FEELINGS OF DISTRESS (IAFD)

STORY 1: MP3 Player

Imagine that you brought your new MP3 Player to school. You saved up to buy the MP3 Player and you are showing it to some students at school. You let someone play with it for a few minutes while you go get a drink of water. When you get back, you realize that the student has broken your MP3 Player.

1. Why did the student break your MP3 Player? *Remember to circle the letter for your answer.*
   A. The MP3 Player wasn't well made.
   B. It was an accident.
   C. The student was mad at you.
   D. The student was jealous of you.
2. In this story, do you think the student was
   A. Trying to be mean.
   B. Not trying to be mean
3. How upset would you be if the things in this story really happened to you?
   A. Not upset at all.
   B. A little upset.
   C. Very upset.
4. How mad would you be if the things in this story really happened to you?
   A. Not mad at all.

B. A little mad.

C. Very mad.

STORY 2: LUNCH BREAK

Imagine that you are looking for your friend in the cafeteria during your lunch break. You can't wait to find your friend because you have an important secret to share. By the time you find your friend, your friend is already sitting at a fully occupied lunch table with someone else— someone you don't like very much.

Why did your friend decide to sit with someone else, instead of you?

A. Your friend was mad at you.

B. Your friend didn't know that you wanted to sit with (him/her).

C. Your friend wanted to get back at you for something.

D. Your friend didn't see you at lunch.

1. In this story, do you think your friend was

   A. Trying to be mean.

   B. Not trying to be mean.

2. How upset would you be if the things in this story really happened to you?

   A. Not upset at all.

   B. A little upset.

   C. Very upset.

3. How mad would you be if the things in this story really happened to you?

   A. Not mad at all.

   B. A little mad.

C. Very mad.

STORY 3: SODA STORY

Imagine that you are sitting at the lunch table at school, eating lunch. You look up and see another student coming over to your table with an extra large cup filled with soda. You turn around to eat your lunch, and the next thing that happens is that the class mate spills all the soda over your back. The soda gets your shirt all wet.

1. Why did the student spill the soda all over your back?
   A. The student slipped on something.
   B. The student just does stupid things like that to you.
   C. The student wanted to make fun of you.
   D. The student wasn't looking where (he/she) was going.
2. In this story, do you think the student was
   A. Trying to be mean.
   B. Not trying to be mean.
3. How upset would you be if the things in this story really happened to you?
   A. Not upset at all.
   B. A little mad.
   C. Very mad.
4. How mad would you be if the things in this story really happened to you?
   A. Not mad at all.
   B. A little mad.
   C. Very mad.

STORY 4: HALLWAY STORY

Imagine that you are standing in the hallway one morning at school. As you are standing there, two students from your homeroom walk by. As they walk by you, the two look at you, whisper something to each other, and then they laugh.

1. Why did the two classmates laugh when they walked by you?
   A. The classmates were making fun of you.
   B. The classmates were laughing at a joke that one of them told.
   C. The classmates were just having fun.
   D. The classmates were trying to make you mad.
2. In this story, do you think the classmates were
   A. Trying to be mean.
   B. Not trying to be mean
3. How upset would you be if the things in this story really happened to you?
   A. Not upset at all.
   B. A little upset.
   C. Very upset
4. How mad would you be if the things in this story really happened to you?
   A. Not mad at all.
   B. A little mad.
   C. Very mad.

STORY 5: SHOES STORY

Imagine that you are walking to school and you're wearing your new shoes. You really like your new shoes and this is the first day you have worn them. Suddenly, you are bumped from behind by another student. You stumble and fall into a mud puddle and your new shoes get muddy.

1. Why did the student bump you from behind?
    A. The student was being mean.
    B. The student was fooling around and pushed too hard by accident.
    C. The student was running down the street and didn't see you.
    D. The student was trying to push you down.
2. In this story, do you think the student was
    A. Trying to be mean.
    B. Not trying to be mean.
3. How upset would you be if the things in this story really happened to you?
    A. Not upset.
    B. A little upset.
4. How mad would you be if the things in this story really happened to you?
    A. Not mad at all.
    B. A little mad.
    C. Very mad.

APPENDIX C.

BEHAVIOR ASSESSMENT SYSTEM FOR CHILDREN, SECOND EDITION (BASC-2 SRP-C)

Anxiety subscale Items: 8, 37, 55, 65, 83, 86, 93, 104, 111, 114, 121, 132, 139

Directions:

This booklet contains sentences that young people may use to describe how they think or feel or act. Read each sentence carefully. For the first group of sentences, you will have two answer choices: T or F. Circle T for True if you agree with a sentence, or circle F for False if you do not agree with a sentence. For the second group of sentences, you will four answer choices: N, S, O, and A.

Circle N if the sentence never describes how you feel.

Circle S if the sentence sometimes describes how you feel.

Circle O if the sentence often describes how you feel.

Circle A if the sentence describes almost always how you feel.

Give the best response for you for each sentence, even if it is hard to make up your mind. There are no right or wrong answers. Please do your best, tell the truth, and respond to every sentence.

Items in Anxiety Subscale:

(T/F answering options are for sentences 1-51; N, S, O, A answering options are for sentences 52-139)

8. I worry about little things.

37. I often worry about something bad happening to me.

55. I am bothered by thoughts about death.

65. I am afraid something bad might happen.

83. I get nervous.

86. I am bothered by not getting enough sleep.

93. I am afraid of a lot of things.

104. Little things bother me.

111. I worry but I don’t know why.

114. I worry when I go to bed at night.

121. I get so nervous I can’t breathe.

132. I worry about what is going to happen

139. I get nervous when things do not go the right way for me.

Table C1

Bivariate Correlations among study variables

Variable	1	2	3
1. ADHD, age 6	—	.038	-.068
2. HAB, age 11		—	.-086
3. Anxiety, age 15			—

Note. ADHD = Sum of total ADHD symptoms assessed in 2nd grade (age 6). HAB = hostile attribution bias score assessed at age 11. Anxiety = T scores of Anxious symptoms combined by sex, assessed at age 15. *$p < .05$. **$p < .01$.

Table C2

Descriptive Statistics of Study Variables

Variable	N	Mean	SD	Min-Max	Skew	Kurtosis
ADHD, age 6	219	11.43	12.24	0-53	1.164	.576
Soc Pref, age 6	205	.061	.908	-2.4-2.3	-.126	-.406
HAB, age 7	169	2.30	2.27	0-9	.977	.216
Anxiety, age 11	288	46.98	9.99	34-86	.994	.645

Note. Current Study $N = 362$. ADHD = Sum of total ADHD symptoms. Soc Pref = Peer-nominated social preference score. HAB = hostile attribution bias score. Anxiety = T scores of Anxious symptoms combined by sex.

Table C3

Bivariate Correlations among study variables

Variable	1	2	3	4
1. ADHD, age 6	—	-0.525**	0.080	0.230**
2. Soc Pref, age 6		—	-0.196	-0.133
3. HAB, age 7			—	0.107
4. Anxiety, age 11				—
Valid *N*	219	205	169	288

Note. ADHD = Sum of total ADHD symptoms. Soc Pref = Peer-nominated social preference score. HAB = hostile attribution bias score. Anxiety = T scores of Anxious symptoms combined by sex. *$p < .05$. **$p < .01$.

Table C4

Bivariate Correlations among study variables split by sex

Variable	1	2	3	4
1. ADHD, age 6	—	-0.576**	0.179	0.182
2. Soc Pref, age 6	-0.443**	—	-0.323*	-0.061
3. HAB, age 7	-0.103	-0.074	—	0.166
4. Anxiety, age 11	0.347**	-0.202	0.114	—
Valid *N*	219	205	169	288

Note. Correlations for males listed above the diagonal, and correlations for females are listed below the diagonal. ADHD = Sum of total ADHD symptoms. Soc Pref = Peer-nominated social preference score. HAB = hostile attribution bias score. Anxiety = T scores of Anxious symptoms combined by sex. *$p < .05$. **$p < .01$.

Table C5

Bivariate Correlations between ADHD Dimensions and Anxiety

Variable	1	2	3	4
1. Anxiety, age 11	--	.017	.000	.230**
2. ADHD Hyper, age 6		--	.722**	.140
3. ADHD InAtt, age 6			--	.139
4. ADHD Total, age 6				--

Note. Anxiety = T scores of Anxious symptoms combined by sex. ADHD Hyper = ADHD Hyperactive/Impulsive symptoms. ADHD InAtt = ADHD Inattentive symptoms. ADHD Total = Total ADHD symptoms. *p < .05. **p <.01.

Table C6

Independent sample T tests probing sex differences in all study variables

Variable	F	Sig.	t	df	Sig.
1. ADHD, age 6	26.558	<.001	4.309	175.313	<.001**
2. Soc Pref, age 6	.000	.982	-1.691	203	.092
3. HAB, age 7	.058	.811	1.206	167	.230
4. Anxiety, age 11	7.610	.006	-1.953	285.995	.052

Note. ADHD = Sum of total ADHD symptoms. Soc Pref = Peer-nominated social preference score. HAB = hostile attribution bias score. Anxiety = T scores of Anxious symptoms combined by sex. *p < .05. **p <.01.

Table C7

Values of Fit Statistics for Proposed Moderated Mediation

Fit Statistic	Value
$X^2_{Baseline\ \text{Model}}$ (*df*)	25.252 (11)
X^2_{Model} (*df*)	1.464 (2)
RMSEA [90% CI]	0.000 [.000, .095]
CFI	1.000
TLI	1.000
SRMR	0.015
AIC	9608.726
BIC	9737.150

Table C8

Unstandardized estimates and CI's for Moderated Mediation Model

Indirect Effects on Anxious Symptoms	Unstandardized Estimates	Lower CI	Upper CI
ADHD → Hostile Attribution Bias → Anxious symptoms	-0.010	-0.065	0.014
ADHD X Social Preference → Hostile Attribution Bias → Anxious symptoms	-0.013	-0.076	0.006
ADHD X Low Social Preference → Hostile Attribution Bias → Anxious symptoms	-0.010	-0.251	0.178
ADHD X Medium Social Preference → Hostile Attribution Bias → Anxious symptoms	-0.012	-0.071	0.017
ADHD X High Social Preference → Hostile Attribution Bias → Anxious symptoms	-0.197	-0.641	0.089

Note. ADHD = ADHD symptoms. Anxious symptoms = T scores of Anxious symptoms. No indirect effect met the test of statistical significance, as all CI's included zero.

Table C9

Maximum Likelihood Estimates for Moderated Mediation Model

Direct Effects on Anxious Symptoms	Unstandardized Estimates	SE	Standardized	*p* Value
ADHD → ANX10**	0.254	0.109	0.308	0.005
ADHD X SP → ANX10	0.047	0.140	0.076	0.585
HAB → ANX10	0.564	0.089	0.128	0.149
SP → ANX10	-0.179	0.112	-0.016	0.886
Sex → ANX10**	3.808	0.060	0.190	0.002
ANX5 → ANX10	0.029	0.066	0.032	0.628
Indirect Effects on Anxious Symptoms				
ADHD → HAB → ANX10	-0.010	0.022	-0.012	0.590
ADHD X SP → HAB → ANX10	-0.013	0.028	-0.021	0.455

Note. Value labels are as follows: ANX10 = Anxious Symptoms at age 11; ANX5 = Anxious Symptoms at age 6; HAB = Hostile Attribution bias reported at age 7; ADHD = ADHD symptoms reported in 1st grade; SP = Social Preference in 1st grade. *$p < .05$. **$p < .01$.

Table C10

Values of Fit Statistics for Simple Mediation (N = 362)

Fit Statistic	Value
$X^2_{Baseline\ \text{Model}}$ (*df*)	19.492 (7)
X^2_{Model} (*df*)	1.416 (2)
RMSEA [90% CI]	0.000 [0.000, 0.094]
CFI	1.000
TLI	1.000
SRMR	0.020
AIC	7622.036
BIC	7634.980

Table C11

Maximum Likelihood Estimates for Simple Mediation Model

Direct Effects on Anxious Symptoms	Unstandardized Estimates	SE	Standardized	*p* Value
ADHD → ANX10**	0.219	0.109	0.266	0.000
HAB → ANX10	0.506	0.089	0.115	0.142
Sex → ANX10**	3.801	0.060	0.190	0.001
ANX5 → ANX10	0.030	0.061	0.032	0.595
Indirect Effects on Anxious Symptoms				
ADHD → HAB → ANX10	0.219	0.014	0.010	0.494

Note. Value labels are as follows: ANX10 = Anxious Symptoms at age 11; ANX5 = Anxious Symptoms at age 6; HAB = Hostile Attribution bias reported at age 7; ADHD = ADHD symptoms reported at age 6; SP = Social Preference reported at age 6. *$p < .05$. **$p < .01$.

Table C12

Descriptives and Bivariate Correlations with Aggression

Variable	1	2	3	4
1. ADHD	—	.171*	.080	.230**
2. Aggr		—	.080	.015
3. HAB			—	.107
4. Anxiety				—
Aggression	Mean (Min-Max)	SD	Skew	Kurtosis
N = 209	45.963 (30-90)	9.4631	1.107	2.424

Note. ADHD = Sum of total ADHD symptoms. Soc Pref = Peer-nominated social preference score. Aggr = Aggression assessed by parent report at age 6. HAB = hostile attribution bias score. Anxiety = T scores of Anxious symptoms combined by sex. *p < .05. **p <.01.

Table C13

Values of Fit Statistics for Moderated Mediation with Aggression

Fit Statistic	Value
$X^2_{Baseline\ Model}$ (*df*)	573.666 (13)
X^2_{Model} (*df*)	548.955 (3)
RMSEA [90% CI]	0.709 [0.660, 0.760]
CFI	0.026
TLI	0.000
SRMR	0.140
AIC	14500.522
BIC	14660.079

Table C14

Values of Fit Statistics for Mediation by Aggression

Fit Statistic	Value
$X^2_{Baseline\ \text{Model}}$ (*df*)	66.314 (7)
X^2_{Model} (*df*)	37.306 (2)
RMSEA [90% CI]	0.218 [0.160, 0.281)
CFI	0.405
TLI	0.000
SRMR	0.075
AIC	9204.848
BIC	9218.328

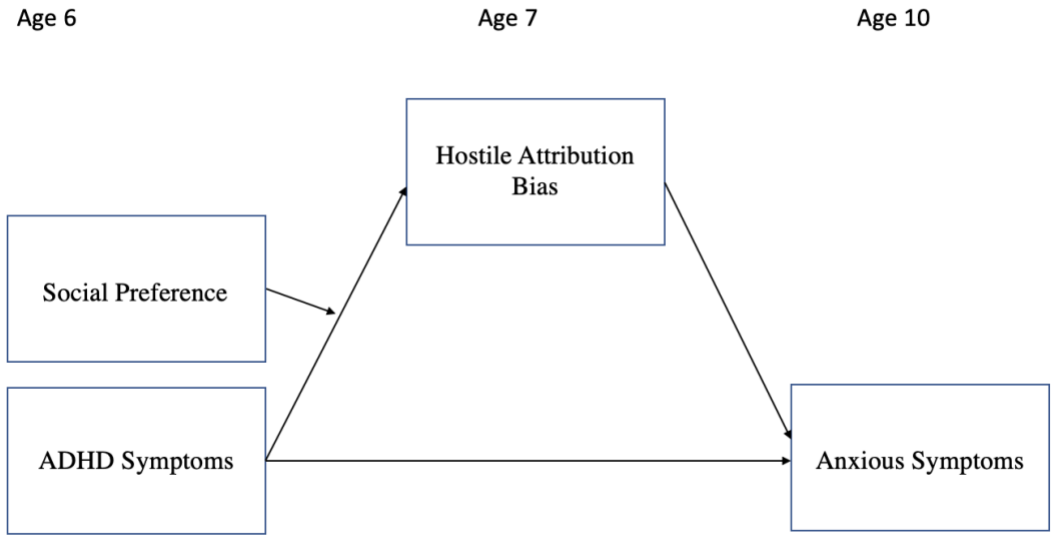

Figure C1. Conceptual Model. The Moderating Role of Social Preference on the Indirect Effect of ADHD Symptoms on Increases in Anxious Symptoms, as Explained by Increases in Hostile Attribution Bias.

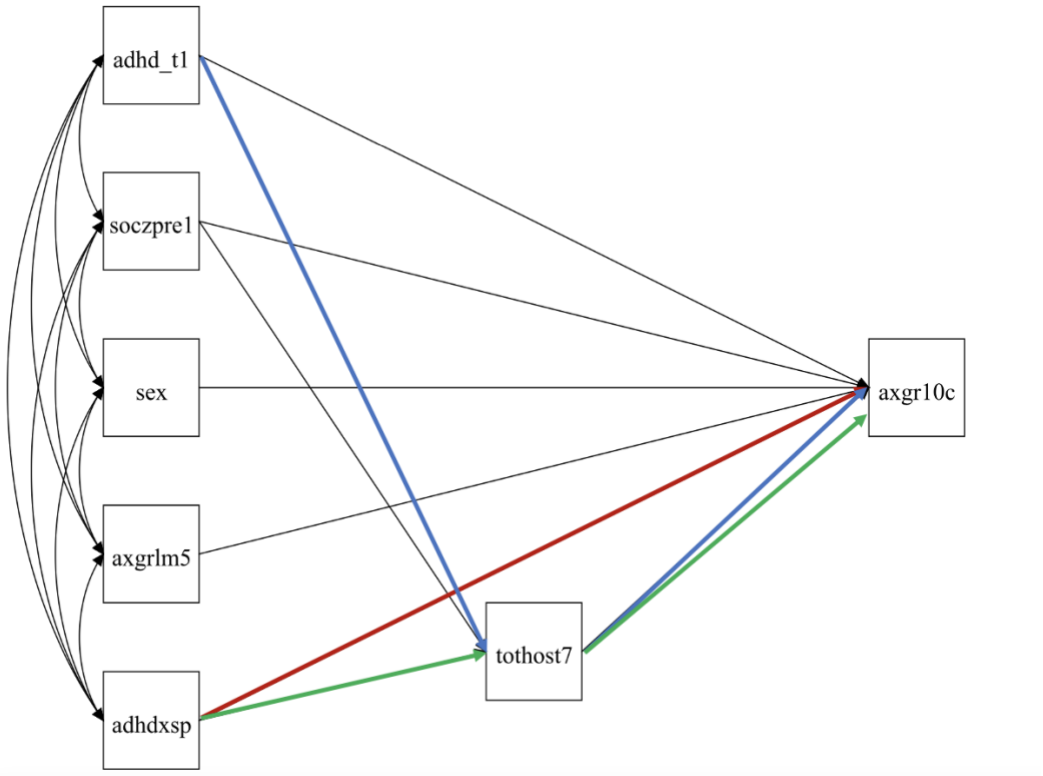

Figure C2. Statistical Moderated Mediation Model. Value labels are as follows: Soczpre1 = Social Preference; Axgrlm5 = Anxiety at age 6; ADHDxSP = Interaction term of ADHD X Social Preference; Axgr10c = Anxious symptoms at age 11. Sex and Anxiety at age 6 are considered as covariates in the present statistical model. Hypothesis 1 (in red): Main Effect between ADHD and anxiety. Hypothesis 2 (in blue): Indirect Effect of ADHD on anxiety through hostile attribution bias. Hypothesis 3 (in green): Indirect Effect of ADHDxSocial Preference on anxiety through hostile attribution bias.

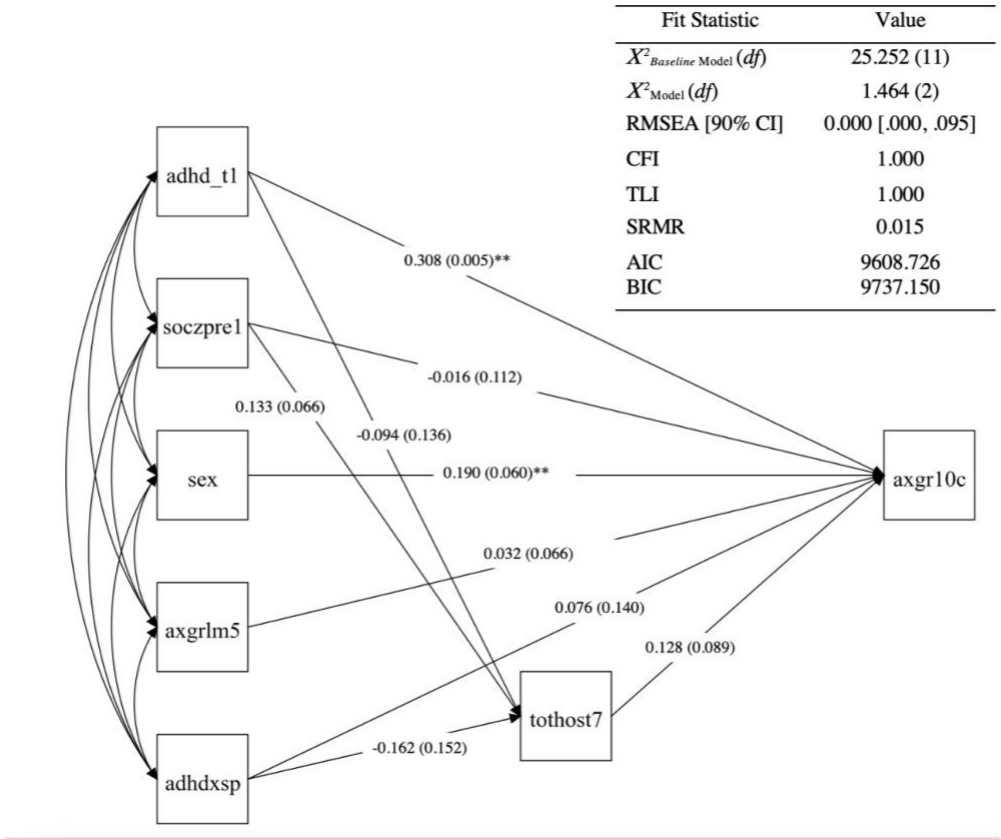

Figure C3. Moderated Mediation Model with Standardized Path Coefficients and (Standard Errors). Value labels are as follows: Soczpre1 = Social Preference; Axgrlm5 = Anxiety at age 6; ADHDxSP = Interaction term of ADHD X Social Preference; Axgr10c = Anxious symptoms at age 11. Sex and Anxiety at age 6 are considered as covariates in the present model. *$p < .05$, **$p < .01$, ***$p < .001$.

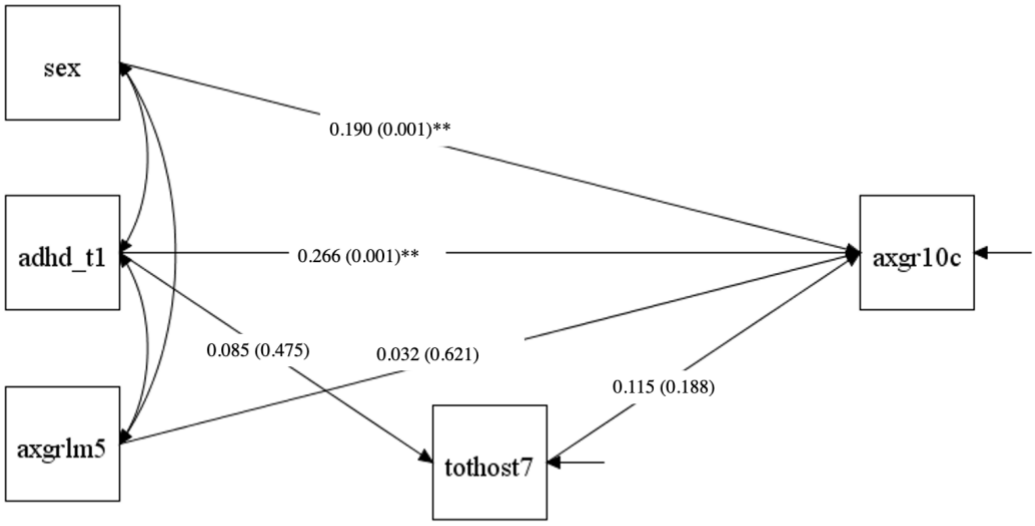

Figure C4. Simple Mediation Model with Standardized Path Coefficients and (Standard Errors). Value labels are as follows: Axgrlm5 = Anxiety at age 6; Axgr10c = Anxious symptoms at age 11. Sex and Anxiety at age 6 are considered as covariates in the present model. *$p < .05$, **$p < .01$, ***$p < .001$.