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Evidence from the field of developmental psychopathology suggests that a diathesis-stress model is one effective way to investigate pathways to maladaptive outcomes. Social anxiety, defined as fear experienced during social interaction because of concern of being judged negatively or humiliated by others, is one maladaptive outcome that emerges in adolescence and interferes with adaptive social and academic functioning. Social anxiety is thought to result from a combination of factors, which can include withdrawn behavior and negative social experiences. However, greater weight, traditionally considered a risk factor for physical health problems, also functions as a precipitating factor in childhood for the development of social anxiety in adolescence. The current study used a path analysis to examine the indirect effect of social withdrawal on the association between greater weight at age 10 and increased social anxiety at age 17, and whether this indirect effect was conditional on the child's self-report of social stress at age 10. Weight was assessed through BMI. Social anxiety was assessed via self-report scores on the MASC Social Anxiety scale. Social withdrawal was assessed through mother report on the CBCL Withdrawn/Depressed scale. Social stress was assessed using the self-report form of the BASC-2 Social Stress scale. Although an indirect effect of BMI on social anxiety was initially found through withdrawal, a multigroup analysis by sex demonstrated that while higher BMI predicted greater social withdrawal for boys, this path was not significant for girls. Differently, while greater withdrawal predicted greater

social anxiety for girls, this effect was not found for boys. BMI did not interact with social stress to predict withdrawal for boys or girls, nor did BMI at age 10 predict social anxiety at age 17. Implications for future research examining the role of weight in understanding the development of social anxiety through the social domain are discussed.

WEIGHT IN CHILDHOOD AND ITS ASSOCIATION WITH SOCIAL ANXIETY IN ADOLESCENCE: PATHWAYS EXAMINING WITHDRAWAL AND SOCIAL STRESS

by

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CHAPTER I

INTRODUCTION

Statement of the Problem

Anxiety, a fear response, is broadly conceptualized as a tripartite system that consists of physiological reactions, cognitive distress (i.e. interpretation of an event that elicits distress), and behavioral avoidance (Lang, 1968). These three components work in tandem to exacerbate or ameliorate symptoms. Social anxiety in particular describes the fear experienced during social interaction or performance from heightened concern of being judged negatively by others or being humiliated; social anxiety can negatively impact development (Mesa, Nieves, & Beidel, 2011; Wong & Rapee, 2015). In fact, social anxiety typically emerges in adolescence and often interferes with adaptive functioning across peer and academic domains (Ranta, La Greca, Kaltiala-Heino, & Marttunen, 2015).

Evidence from the field of developmental psychopathology suggests that a diathesis-stress model is one effective way to investigate pathways to maladaptive outcomes (Gazelle & Rubin, 2019; Ollendick, Benoit, & Grills-Taquechel, 2014). This approach considers an individual's personal characteristics and how those characteristics impact functioning in the context of environmental stressors (Gazelle, 2013). Social anxiety is thought to result from a combination of factors, including individual risks, such as an early inhibited temperament, as well as external stressors, such as intrusive or

overprotective parenting, the tendency to engage in rumination before and after social events and other negative or embarrassing social experiences. While many risk factors for social anxiety have been established, consistent with the principle of equifinality, individual physical factors have yet to be fully examined in understanding whether and how they may influence social anxiety.

In recent years, greater interest has been directed at one physical attribute that has been associated with maladaptive psychosocial outcomes, obesity. Excess weight, which is often considered a risk factor for physical health problems, also functions as a precipitating factor for socially anxious behavior in adolescents (Ozkan et al., 2016). Although obesity is associated with social anxiety in youth, explanatory mechanisms for the association between weight and social anxiety have not been evaluated (Burke & Storch, 2015).

Social withdrawal is one mechanism that could explain why obesity is a risk factor for later social anxiety. Withdrawal, defined as interacting with others less frequently than expected, is associated with increased social anxiety among youth (Rapee & Spence, 2004; Rubin, Coplan, & Bowker, 2009). In the context of a society that stigmatizes greater weight (Puhl & Latner, 2007; Puhl & Luedicke, 2012), an adolescent may choose to withdraw from peers as a coping mechanism. In fact, we know that adolescents who are overweight or obese spend less time with friends and are more likely to experience peer victimization (Puhl & Latner, 2007; Gray, Kahhan, & Janicke, 2009; Falkner, Neumark-Sztainer, Story, Jeffery, Beuhring, & Resnick, 2000). Children with extra weight may be more likely to become withdrawn if they believe that they are

perceived negatively by others, using withdrawal either as a safety behavior or as the response to developing low expectations for positive peer interactions (Spence & Rapee, 2016). This risk may be heightened during the developmental period of adolescence as this period is marked by an increased importance on the opinions of peers as young people shape their identity (Harter, 2012).

Given this background, this project attempted to explain how social withdrawal may serve as an explanatory mechanism in the relation between one childhood physical characteristic, weight, and later social anxiety in adolescence. This project further assessed whether this explanatory mechanism is further conditional on the child's report of their own social stress, such that greater weight and greater social stress would result in greater levels of withdrawal.

Description of Social Anxiety

According to the American Psychiatric Association (2013), social anxiety disorder is the fear of embarrassing oneself or being judged negatively when in social situations. These fears can be so intense that the individual experiences distress that is functionally impairing and will typically avoid situations that provoke this anxiety. Alternatively, individuals may endure feared social situations despite experiencing significant anxiety instead of avoiding those circumstances. Although the average lifetime prevalence rate of social anxiety disorder among U.S. samples of children and adolescents is between 5% and 16% (Essau et al., 1999; Nelson et al., 2000), many youth experience symptoms of social anxiety that do not meet clinical levels of impairment. For example, among a sample of over 10,000 adolescents aged 13-18 years old, 46.7% of

these teenagers rated themselves as shy, while only 12.4% met criteria for a lifetime diagnosis of social phobia according to a DSM-IV diagnostic interview (Burstein, Ameli-Grillon, & Merikangas, 2011). Although shyness is often not impairing and is considered to fall on the mild end of the social anxiety continuum (Rapee & Spence, 1997), the high frequency of shyness within this sample suggests that a subgroup may experience social anxiety that is distressing but does not meet criteria for diagnosis. Additionally, most adults with social anxiety disorder report experiencing social anxiety symptoms before age 18, demonstrating that worries about social situations often initially manifest in youth and can persist over time (Kessler et al., 2005; Nelson et al., 2005). Even with a subclinical presentation, individuals may experience symptoms that impact functioning. and may avoid eye contact, speak less or very softly, or brush hair in front of their face, as was found among a sample of 8-13 year old children with social anxiety disorder and subclinical social anxiety symptoms (Kley, Tuschen-Caffier, & Heinrichs, 2012). Further, children with social anxiety disorder and children with subclinical social anxiety both reported more negative thoughts about themselves and greater self-focus during a performance task, such as thinking about what they would do or say next, compared with non-socially anxious children (Kley et al., 2012).

The emergence of symptoms of social anxiety typically occurs in early adolescence, around the ages of 10 to 13 (Knappe, Sasagawa, & Cresswell, 2015). One retrospective report among adults found that the average age of onset for both girls and boys is 14 years old (Yonkers, Dyck, & Keller, 2001). Among adolescents, physical symptoms of social anxiety include blushing, sweating, and perceiving increased heart

rate. Of note, adolescents with social anxiety have often reported increased heart rate during social interaction, yet differences in heart rate or blood pressure have not been found between socially anxious and non-socially anxious teens during speech and conversation tasks (Anderson & Hope, 2009). Cognitions relevant to social anxiety typically include assumptions of inability to succeed prior to social interaction (Hodson et al., 2008), negative thoughts about the self during interaction (Alfano, Beidel, & Turner, 2006; Kley et al., 2012), self-focused attention on performance and physiological response, and perceptions of poor performance after interaction (Blöte, Miers, Heyne, Clark, & Westenberg, 2014) . Avoidance of social situations (e.g., not talking to classmates during downtime, averting gaze away from others, not raising hand in class) or the use of safety behaviors (e.g., wearing baggier clothes to not show sweat) and behavioral symptoms is consistent with social anxiety. Socially anxious behavior during adolescence places young people at risk for additional maladaptive outcomes personally and academically by limiting their opportunities for skill development and functioning in a social world.

Among community samples, females are about twice as likely to experience clinical levels of social anxiety compared to males (Merikangas, Avenevoli, Acharyya, Zhang, & Angst, 2002; Merikangas et al., 2010; Wittchen, Stein, & Kessler, 1999), although gender differences are less clear among clinical samples of anxious individuals (Knappe, Sasagawa, & Creswell, 2015). Further, girls are more likely than boys to experience symptoms of social anxiety in both childhood and adolescence (Rapee &

Spence, 2004). Girls may be more likely to develop social anxiety in adolescence because of the way gender socialization emphasizes peer relationships in girls more than in boys.

Cultural differences may also impact symptom presentation and severity. Despite previous lack of support for differences in social anxiety between adolescents who identify their race as White or African American (Burke & Storch, 2015; Ohannessian, Cavanaugh, & Cheeseman, 2017), a large community sample found evidence of lower rates of social anxiety among African American adults than among White adults (Breslau et al., 2006).

Social Anxiety and Functioning in Adolescence

Adolescents with social anxiety are more likely to experience difficulty with social functioning. They have fewer friends compared to their non-anxious peers, endorse lower social competence, and endorse greater levels of loneliness (Spence, Donovan, and Brechman-Toussaint, 1999; Beidel, et al., 1999). Basic social skills are typically less developed than expected, as youth with social anxiety have greater difficulty introducing themselves and respond less frequently to formal and informal social prompts from others (Scharfstein & Beidel, 2015). Youth with social anxiety speak less and have greater latency to speech (Alfano et al., 2006; Scharfstein & Beidel, 2015), and they are less likely to have had a romantic relationship by late adolescence and are more likely to lack close peer friendships (Ranta et al., 2016). Social anxiety also leads to academic impairment, as typical social tasks such as reading aloud, giving presentations and asking teachers for help are more intimidating in nature (Beidel, et al., 1999; Beidel et al., 2007). Social anxiety in youth has further been associated with the development of depression,

substance use in adolescence, and increased school dropout rates and delayed marriage (Alfano & Beidel, 2011). Taken together, children and adolescents with social anxiety are less likely to have close friends or be perceived as likeable to peers, and are more likely to encounter academic challenges when projects or assignments involve group work or presentations, and this has implications for functioning across the lifespan, affecting the psychological, interpersonal, academic, and professional domains (Ranta et al., 2016; Alfano & Beidel, 2011). Understanding how social anxiety develops can lead to recognition of risk and protective factors that may be help develop strategies to intervene and limit distress and impairment.

Models of Social Anxiety

Two major explanatory frameworks for social anxiety in adolescence exist: developmental psychopathology (Sroufe & Rutter, 1984), which focuses on the etiology of social anxiety by examining predisposing, precipitating, and maintenance factors that interact within and across stages of development to produce symptoms, and the seminal cognitive behavioral approach (Clark & Wells, 1995; Rapee & Heimberg, 1997; Rapee & Spence, 2004), which considers the physiological, cognitive, and behavioral responses that work in tandem during social interactions to promote and maintain symptoms of social anxiety. Both of these perspectives can inform models of social anxiety development.

Developmental psychopathology. The developmental psychopathology framework emphasizes the investigation of the cumulative effects of cross-domain constructs, as opposed to within-domain influences only, in order to understand the

developmental pathways to both adaptive and maladaptive outcomes (Masten & Cicchetti, 2010; Blandon, Calkins, Grimm, Keane, & O'Brien, 2010). This framework emphasizes the dynamic, explanatory, and interactive influence of both typical and atypical factors across infancy, childhood, and adolescence, and examines how these factors increase or buffer against risk for social anxiety.(Higa-McMillan & Ebesutani, 2011; Ollendick et al., 2014). Developmental psychopathology can consider biological, temperamental, cognitive, parental, peer, academic, cultural, and socioeconomic factors to understand how a child develops. Particular emphasis is placed on what typically occurs during each developmental period in childhood and adolescence, and how developmental stage plays a critical role in understanding when and how risk and protective factors become relevant. Factors that increase the risk for social anxiety include predisposing factors, such as heritability, an inhibited temperament, and an overprotective parenting style. Precipitating factors include impactful negative social experiences and subsequent conditioning. Lastly, factors that maintain social anxiety include social skill deficits and negative cognitions or biases about the self in social situations (Higa-McMillan & Ebesutani, 2011; Rapee & Spence, 2004; Elizabeth et al., 2006). The developmental psychopathology framework provides a broad yet complex overview of how a maladaptive outcome is the result of a combination of risk and protective factors across the lifespan. This allows for a deeper, more nuanced understanding of development that can result in prevention techniques specific to the age and stage of the individual.

Cognitive behavioral models and development. In contrast, cognitive behavioral models traditionally consider thoughts and actions that occur during social interaction at one time point that lead to symptom maintenance. However, the components of cognitive behavioral models may also be relevant to the onset of social anxiety in adolescence, as a heightened sense of an "invisible audience" and the increased concern about negative judgment from others may exacerbate social fear.

Most cognitive behavioral models of social anxiety were shaped using evidence gathered largely from adults, despite the knowledge that almost all adults with social anxiety report experiencing symptoms during adolescence. In these models, emphasis is placed on the maintenance of social anxiety during a brief snapshot in time. For example, the discrepancy between an individual's "perception of the demands of the social world and his or her perceived ability to meet those demands" is a characteristic that drives social anxiety in the cognitive behavioral models of Clark and Wells and Rapee and Spence (Clark & Wells, 1995; Spence & Rapee, 2016; Wong, Gordon, & Heimberg, 2014). According to these models, not only do socially anxious individuals estimate their social abilities to be compromised or deficient in some way, but they also overestimate the expectations of others and underestimate their performance when confronted with social interaction. Cognitive behavioral models place additional focus on the presence of maladaptive cognitions that impact social interactions (e.g., distorted self-reflection, unrealistic standards for social performance, unrealistic anticipated consequences for failure). Both models describe heightened focus on internal cues of anxiety that are interpreted to signal failure, such as increased heart rate, sweat, or perceived stumbling

over words. Rapee and Heimberg's (1997) model additionally emphasizes the search for external cues of disapproval in others when in social situations. The interpretation of these cues as negative contributes to the use of safety behaviors and avoidance of social situations, which ultimately maintains fear of social interaction and perceived consequences. In 2004, Rapee and Spence encouraged the greater emphasis on longitudinal work beginning in childhood to elucidate etiological understanding of the development of social anxiety, including variables that mediate or moderate onset of symptoms. This study expands upon Rapee's earlier work (Rapee, 1995; Rapee & Spence, 2004), which proposed that social anxiety can best be understood as existing along a continuum, ranging from a complete lack of anxiety in social situations increasing to normative shyness and other typical concerns about the evaluations of others. Social anxiety at the high end of the continuum is described as an intense and generalized fear of social interaction that is impairing to daily functioning. Where an individual falls on this continuum is the result of the onset of risk, individual child characteristics and contextual factors that may exacerbate or ameliorate risk, which aligns with developmental psychopathology frameworks.

Recent evidence has indicated that defining characteristics of cognitive behavioral models as in the Clark and Wells' model (negative social cognitions, safety behaviors, self-focused attention, pre-event processing, and post-event processing) are present in both children and adolescents with social anxiety (McElhaney, Antonishak, & Allen, 2008). Therefore, models of social anxiety established through research with adults are relevant to understanding the development of social anxiety in adolescents.

Both models can be used to further our understanding of the emergence of social anxiety in adolescence. Developmental psychopathology provides a structure to examine how the factors implicated in the maintenance of social anxiety can be examined to clarify if they also accurately reflect longitudinal development of symptoms across adolescence. For example, youth who hold negative perceptions about themselves in relation to peers may be more likely to engage in avoidant or safety behaviors later in development, ultimately promoting social anxiety as social situations become increasingly unfamiliar and threatening.

Many individual and environmental characteristics have been examined as risk factors for social anxiety, including temperament, overprotective parenting, and negative peer experiences. However, few studies have considered physical attributes as risk factors for social anxiety. Weight is one such attribute that has been established as a risk factor for lower self-esteem and depression, but may also influence the development of social anxiety. Adolescents are particularly sensitive to the evaluation and opinions of others, especially those of their peers, making it a salient time to examine the association between physiological attributes such as obesity and psychological outcomes such as social anxiety.

Adolescence and developmental considerations. The transition to adolescence is a developmental period marked by increases in metacognitive ability and strengthened perspective-taking skills (Higa-McMillan & Ebesutanti, 2011; Harter, 2012). This development allows the adolescent to consider his or her own thoughts and behaviors, and then compare those to the perspectives and opinions of others. Young people develop

the capacity to consider how they are perceived by peers while at the same time place increasingly greater importance on friendships and romantic relationships (Harter, 2012). As a result, the stakes of social interaction may feel higher and may be more intimidating. The greater importance attributed to peer relationships during this time may lead to increased but typical levels of self-consciousness as teens look to the reactions of their peers as a source of information about their own burgeoning identity (Higa-McMillan & Ebesutanti, 2011; Harter, 2012). Further, peers become the primary source of social support in adolescence as autonomy from parents increases and more time is spent with friends (La Greca & Ranta, 2015; La Greca & Harrison, 2005). Social interaction is driven mainly by the adolescent during this period, as parents are no longer arranging play-dates and are less involved in activity planning. Peer relationships become increasingly important in early and middle adolescence as youth consult with friends to help make sense of their place in their social world (Harter, 2012).

During adolescence, among children who are shy, caution in their approach to new people may transition to worry about critique or embarrassment as they age, and while it is developmentally appropriate for adolescents to experience occasional worries about how they are perceived by others, greater and more frequent concern about negative evaluation can result in significant distress, leading to avoidance and subsequent impairment in social and academic functioning. Young people with additional vulnerabilities may have maladaptive peer experiences that further increase avoidance. Taken together, this suggests that adolescence may be a unique developmental period that is particularly sensitive to the influence of risk and protective factors for social anxiety.

In this project, obesity is considered to be a predisposing risk factor that increases risk for social anxiety in adolescence. Children who are overweight may have a unique experience navigating this transitional period of development compared to their non-obese peers.

Overweight and Obese Weight Status Among Youth

In the years 2011-2012, approximately 32% of youth aged 2 to 19 years old fell within the overweight or obese categories, as specified by CDC sex-specific BMI-for-age growth charts (Ogden, Carroll, Kit, & Flegal, 2014). Overweight or obese status describes an excess amount of total body fat relative to body weight (Heyward & Wagner, 2004; Burkhauser & Cawley, 2008). Body weight is comprised of fat mass (FM), which includes all lipids from adipose and other tissues, and fat free mass (FFM), which is comprised of skeletal muscle, organs, water, muscle, and connective tissues. FFM is thought to exhibit greater stability than FM, such that the amount of fat in an individual may vary over time, but organs and skeletal muscle are less likely to vary, particularly once adult height has been achieved (Heyward & Wagner, 2004; Chung, 2015).

BMI describes the ratio of weight to height and provides an approximate sense of the size of an individual. Obesity is often measured in the social sciences literature through the use of BMI, which is considered to be an estimation of body fatness and is calculated by dividing an individual's weight in kilograms by their squared height in meters, essentially adjusting the weight for the height of each person (Chung, 2015; Ogden, Carroll, Kit, & Flegal, 2014, Flegal & Ogden, 2011; Voelker, 2007; Dietz &

Robinson, 1998). However, it is perceived as a "noisy" measure in medical fields because it does not take body composition into consideration (Burkhauser & Cawley, 2008). BMI is the calculation of excess body weight, not necessarily excess body fat, and therefore does not definitely provide information on %BF (Burkhauser & Cawley, 2008), which is important when considering the relation between social experiences and obesity, as percentage of body fat may exert specific influence on how children are perceived by others. Percent body fat (%BF) is a term used to describe the degree of fat mass (FM) within an individual. It is expressed as a proportion of total body weight (Heyward & Wagner, 2004). Somewhat similarly, body composition describes where fat is distributed within an individual. Despite concerns regarding the validity of BMI as a measure of fatness, BMI has been shown in other research to be strongly associated with total body fat as well as with %BF, although wide confidence intervals suggest BMI may be better used as a substitute for %BF for groups or epidemiological studies rather than for individuals (Pietrobelli et al., 1998; Fonseca, Silva, Costa, Guera, & Gomes-Pedro, 2009). In addition, although BMI does not distinguish between lean and fat mass, a literature review examining the effects of physical activity on BMI found that results were similar in studies using BMI and another adiposity measure, regardless of the outcome measurement examined (Reichert, Menezes, Wells, Dumith, & Hallal, 2009).

Four trajectories of weight status have been described in the literature (Brault, Aime, Begin, Valois, & Craig, 2015). Children are assigned membership to a "normal" weight trajectory that slightly increases over time, an "overweight" trajectory that is either stable or quadratic, a "thin" trajectory that remains stable or increases over time, or

an “obese” trajectory that remains stable (Brault et al., 2015; Balistreri & Van Hook, 2011; Carter, Dubois, Tremblay, Taljaard, & Jones, 2012). The presence of unique trajectories that have minor increases or decreases over time suggests that there is utility in examining BMI as a continuous variable, to evaluate if maladaptive outcomes increase as BMI increases, rather than if only individuals with overweight or obese BMIs experience those outcomes. Taken together, it is clear that the conceptualization of excess weight is nuanced. When considering risk factors for social anxiety, weight-based stigma creates a context for vulnerability, and thus, the physical appearance of the child is most relevant to this project. Physical appearance is assessed using BMI in this project.

Weight as a Risk Factor for Social Anxiety

Overweight and obese weight status is concurrently associated with broad anxiety symptoms in children and adolescents (Anderson, Cohen, Naumova, & Must, 2006; Bell et al., 2011; Hillman, Dorn, & Huang, 2011). Longitudinal associations also exist such that adults and adolescents categorized as obese experience increased anxiety over time (Anderson, Cohen, Naumova, Jacques, & Must, 2007; Cilli et al., 2003). Moreover, obesity status and social anxiety have been found to be related during childhood as well as during adolescence (Asthana, 2012; Burke & Storch, 2015; Lanza, Echols, & Graham, 2012; Ozkan et al., 2016; Thompson, Phillips, McCracken, Thomas, & Ward, 2013). Despite the research indicating a relation between weight and social anxiety, few studies have investigated the mechanisms that explain this relation. The tendency for others to attribute negative characteristics to those who are overweight functions as a contextual

variable that affects children's social experiences and likely increases withdrawn behavior in adolescence.

The Context of Weight-Based Stigmatization

Weight-based stigmatization, an often un-tested contextual phenomenon, is the foundation from which the pathway from obesity to social anxiety may unfold. Defined by Puhl and Latner (2007, p 558), weight-based stigmatization is the "negative weight-related attitudes and beliefs that are manifested by stereotypes, bias, rejection, and prejudice toward children and adolescents because they are overweight or obese". Media portrayals of thinness as "good" and overweight status as indicative of negative characteristics, such as being weak-willed or out of control, suggests that the bias against a larger sized body exists widely and on a societal level. This increases the risk for discriminatory, stigmatizing behavior against the overweight group (Brondolo, Brady ver Halen, Libby, & Pencille, 2011). The widespread nature of stereotyping overweight people increases the likelihood that these individuals will internalize discriminatory biases over time. Further, since weight-based stigma has been noted in children as young as 3- years old (Cramer & Steinwert, 1998), the experience of peer victimization among children who are overweight or obese likely begins earlier than adolescence. Therefore, the association between carrying extra weight in late childhood and developing social anxiety in later adolescence may be explained by social withdrawal, a possible behavioral manifestation of weight-based stigma.

Socially withdrawn individuals are those who voluntarily interact with peers at a less than expected rate for their developmental level. Social withdrawal is an behavioral

term that can have various underlying motivations, including shyness, social avoidance, and/or social disinterest (Coplan & Armer, 2007). Shy children and adolescents experience conflicted approach and avoidance motivations, such that they may want to interact with others but become overwhelmed by the prospect of engaging socially (Rubin, Burgess, Kennedy, & Stewart, 2003). Withdrawal has been associated with greater loneliness in childhood, although most withdrawn children can identify one best friend (Coplan et al., 2001). However, these friendships are typically of lower quality, including less disclosure and less time spent together (Coplan et al., 2001). Less participation in social interaction further contributes to difficulties with peers because it limits opportunities to develop social skills (K. H. Rubin, Root, & Bowker, 2010). Certain risk factors, such as being overweight, may interrupt the child's ability to develop the social skills to interact comfortably in an expected manner.

Overweight children are at particular risk for increased withdrawn behavior because they experience more frequent victimization than their peers of average weight (Puhl & Latner, 2007). As early as late childhood, withdrawal is noted by the peer group as going against social norms (Rubin, Coplan, & Weeks, 2009; Biggs, Sampilo, & McFadden, 2011; Younger, Schwartzman, & Ledingham, 1985; Juvonen, 2013). In addition to the more commonly cited feared situations like attending parties, having conversations with others, and performing in front of others, adolescents who are overweight or obese may experience additional worries specific to their size that could lead to avoidance and withdrawal. For example, adults who are overweight or obese have experienced concerns about the amount of physical space they take up when in a location

with others (Owen, 2012). Adolescents who are overweight may worry about how much space they will take up at a desk, whether or not a gym uniform will fit, or how much space they take up when sharing the backseat of a car with friends. Taking up more space than the adolescent perceives as typical may generate concern about whether peers notice and judge them for this space difference, increasing avoidance of these potentially hurtful experiences.

Weight-based teasing and non-weight based teasing is, in fact, associated with a greater preference for solitary and sedentary activities and decreased engagement in physical activity (Hayden-Wade et al., 2005; Storch et al., 2007; Faith, Leone, Ayers, Heo, & Pietrobelli, 2002). It has been found that youth who experience victimization are at greater risk for withdrawing from peers over the course of 5th through 8th grade (Oh, Rubin, Bowker, Booth-LaForce, Rose-Krasnor, & Laursen, 2008). Overweight or obese adolescents may withdraw more from their peers to avoid the expected outcome of performing poorly or of being victimized by others due to their size. Increased withdrawal from others likely exacerbates fear about engaging socially, particularly if the adolescent has a history of victimization. This ultimately can lead to the development of distressing or impairing symptoms of anxiety. The most common coping strategy associated with weight-based teasing among adolescents was avoidance, such as avoiding gym class or avoiding being around peers in general (Puhl & Luedicke, 2011; Gray et al., 2008). Worries about judgment of peers was the strongest predictor of increased barriers to physical activity, which included worries about what others will think of the participant's body and expectation to be chosen last for teams (Gray et al., 2008).

Therefore, perceiving or anticipating a negative peer reaction may result in heightened withdrawal in adolescence as a strategy to avoid continued bullying or rejection.

The Conditional Effect of Social Stress on Withdrawal

Among adolescents who are overweight, awareness of less preferred status within the peer group may lead to expectations for social rejection or victimization from others, which perpetuates withdrawn behavior. A negative interpretation of social experiences affects future engagement in social interaction by increasing the likelihood of withdrawal. (Mesa, Nieves, & Beidel, 2011; Higa-McMillan & Ebesutani, 2011). Behaviors associated with social anxiety that lead to withdrawal include increased attention to socially threatening cues, a tendency to interpret ambiguous social situations as negative, and greater recall for negative social experience than for neutral or positive experiences (Higa-McMillan & Ebesutani, 2011). These tendencies increase the likelihood of poor performance during social interaction, reinforcing expectations for failure. Although negative cognitions are characteristic of social anxiety, the ability to interpret social interactions in a negative manner may onset prior to the emergence of social anxiety resulting from increased withdrawal. Self-report of peer victimization by adolescents is more strongly associated with greater self-reported internalizing symptoms than peer-report of victimization (Hawker & Boulton, 2000). Additionally, 13 and 14 year old students who felt positively about their social standing among their classmates evidenced better emotional well-being, regardless of whether or not they were objectively well-liked, as assessed through sociometric nominations. Teens who believed they were well-liked were additionally rated by their peers as becoming less withdrawn over time, while

adolescents who rated their social standing as low were reported by their peers to become increasingly withdrawn over time (McElhaney, Antonishak, & Allen, 2008). Among a sample of 10-12 year old children, participants who evaluated their social competence with a negative bias had greater preference for social avoidance at the end of the year (Leduc & Bouffard, 2017) Taken together, this suggests than an adolescent's perception of how they are treated by peers may be more relevant to understanding the development of withdrawal or internalizing symptoms among children with greater BMI than an objective report by peers or teachers. The development of metacognition and perspective taking skills during adolescence may drive avoidance and withdrawal from intimidating social experiences. For example, among a community sample of adolescents aged 9-21, negative "post-event" rumination measured after the completion of a speech task was associated with membership in the "increasing avoidance of social event" trajectory (Miers et al., 2014). This suggests that the interpretation of a social event affects future behavior, such that interpreting a social interaction as hurtful or embarrassing increases uncomfortable anticipation of future social events, and when this is combined with another risk factor like greater BMI, leads to avoidance of that specific experience.

Weight-Based Stigmatization, Peer Stress, and Adolescence

The tendency for others to perceive children and adolescents who are obese in an unfavorable light places this subset of youth at increased risk for peer rejection and victimization. Peer rejection describes the degree a child is negatively evaluated by the peer group, and how disliked the child is by others (Hymel, Vaillancourt, McDougall, & Renshaw, 2002). In contrast, victimization by peers is an acute harm directed towards an

individual, which can be overt, through hitting or name calling, or covert, through ignoring or rumor spreading. Peer victimization has been shown to be significantly associated with social anxiety among children and adolescents (Hawker & Boulton, 2000). Children who are overweight are significantly less preferred as playmates compared to average sized children and are less likely to have reciprocal friendships (Gray et al., 2009; Strauss & Pollack, 2003). Further, carrying extra weight is associated with greater peer victimization including increased teasing and being left out by peers (Puhl & Latner, 2007; Cramer & Steinwert, 1998; Latner & Stunkard, 2003; Penny & Haddock, 2006; Brondolo, Brady ver Halen, Libby, & Pencille, 2011). Victimization is a common response to overweight children and teens (Puhl & Latner, 2007). In fact, approximately 30% of girls and 24% of boys in a sample of middle and high school students (approximately aged 12 to 17) reported at least one episode of weight based teasing. Among adolescents with BMIs in the 85th percentile or greater, 74% of girls and 73% of boys experienced weight based teasing at least a few times a year. (Neumark-Sztainer et al., 2002). Victimization among overweight or obese individuals aged 7 to 17 is associated with maladaptive internalizing outcomes, including depression, loneliness, and low self-esteem (Lampard, MacLehose, Eisenberg, Neumark-Sztainer, & Davison, 2013; Eisenberg, Neumark-Sztainer, & Story, 2003; Jensen & Steele, 2011; Storch et al., 2007; Gray, Janicke, Ingerski, & Silverstein, 2008; Gray, et al., 2009; Hayden-Wade et al., 2005; Lim, Graziano, Janicke, Gray, Ingerski, & Silverstein, 2011).

Although some work indicates that victimization among obese children and adolescence appears to be more prevalent for girls than for boys (Qualter, et al., 2014)

and leads to maladaptive outcomes such as depression for obese girls but not for obese boys (Adams & Bukowski, 2008), other work has shown that victimization is associated with maladaptive emotional outcomes for both obese girls and boys (Lampard et al., 2014; Eisenberg et al., 2013; Storch, et al., 2007; Hayden-Wade et al., 2005).

Not only are adolescents with extra weight more likely to experience peer rejection and victimization, but they are also generally less preferred by their peers. An examination of social networks among high school students has demonstrated that adolescents who are obese have fewer reciprocal peer friendships. Obese adolescents have smaller social networks than their non-obese peers and are more likely to be on the fringes of the social networks to which they belong (Strauss & Pollack, 2003; Valente, Fujimoto, Chou, & Spruijt-Metz, 2009; Schaefer & Simpkins, 2014). As a result, these adolescents may spend less time with peers and may appear withdrawn due to greater difficulty establishing reciprocal friendships. Consequently, they may have fewer opportunities to interact with peers. Thus, greater weight may be a particularly salient risk factor for the development of social anxiety, as children who are overweight or obese are more likely to develop cognitions that they are disliked by others. These perceptions may persist into adolescence, creating context for increased withdrawal from others, which over time ultimately makes social interaction a more threatening, unfamiliar prospect.

The current project examines whether the association between obesity and social anxiety is explained through social withdrawal, which is further conditional on the perception of social stress. When individuals who experience social anxiety enter social

situations, negative beliefs about social interaction based on past events are triggered, which causes the situation to be perceived as intimidating or threatening (Clark & Wells, 1995). The perception of likeability among peers was the strongest predictor of self-report of social anxiety among children (Festa & Ginsburg, 2011), suggesting that the recollection of negative peer experiences may impact a child's perception of their overall social standing, contributing to withdrawn behavior. Anxiety occurs and is maintained through the interplay of factors including the subsequent heightened self-focus and biased processing of this information, engagement in safety behaviors to prevent feared outcomes, objective poorer social performance, and additional biased perception of the event after it has ended (Clark & Wells, 1995; Ranta et al., 2014).

Goals and Hypotheses

Cognitive behavioral models of social anxiety examine the concurrent thoughts and behaviors that maintain social anxiety, but less work exists that examines whether those maintaining factors also function as precipitating risk factors longitudinally. The developmental psychopathology framework of social anxiety posits that equifinality and diathesis-stress allow for the interaction of various risk and protective factors across domains and development to result in the onset of social anxiety in adolescence. Among the possible risks for social anxiety in adolescence, the role of obesity and weight has not been fully explored. The current literature examining obesity or weight and psychosocial outcomes often combines depression and anxiety into a single construct of internalizing symptomology. This can cloud the interpretation of whether and how obesity is specifically associated with social anxiety. Further, anxiety is more likely to be examined

as an outcome broadly, rather than examined as separate symptom types (distress-based difficulties like social anxiety and generalized anxiety versus fear-based anxiety, such as separation anxiety and specific phobias). Finally, literature on social anxiety often combines samples of children in late childhood and early adolescence, which increases complexity in understanding the developmental course of symptoms of social anxiety. Ultimately, this project seeks to understand one conditional indirect pathway in the relation between weight and social anxiety, specifically across youth through the examination of aspects of the social domain.

It is hypothesized that carrying greater weight in childhood sets the stage for future challenges within the social domain of functioning. Higher weight status in childhood affects experiences with peers such that rejection and victimization are more likely to occur, and the transition to adolescence exacerbates these challenges through increased typical self-consciousness and importance placed on peer relationships. Among children who carry extra weight, those who also perceive difficulties with peers may develop an expectation for failure when interacting with others. These children are more likely to experience higher levels of social withdrawal in adolescence. Withdrawal from peers diminishes opportunities to have adaptive social experiences, intensifying the fear and discomfort felt in peer interactions and leading to social anxiety in later adolescence.

Several hypotheses are described below in order to statistically evaluate the presence of a conditional indirect association of the above constructs. The statistical model posits that BMI in middle childhood (age 10) is directly associated with greater social anxiety in later adolescence (age 17). This direct association is explained through

increased withdrawal during middle adolescence (age 15), which is conditional on the child's perception of social stress among peers in middle childhood (age 10). Greater BMI is predicted to be associated with increased social withdrawal at age 15, and this effect is moderated such that the highest levels of withdrawal will be observed among children with higher BMI who also report greater social stress. Greater weight and lower levels of perceived peer stress are expected to result in lower levels of withdrawal than observed among children with high BMI and high social stress, while children with typical BMI and low social stress are expected to be the least withdrawn at age 15. Greater social withdrawal at age 15 is expected to be associated with greater social anxiety at age 17. Finally, there is some evidence to suggest that this indirect effect is more likely to be observed among girls than among boys. As such, effects of sex on outcome will be assessed. For some children with social anxiety, onset of symptoms occurs in childhood and remains persistent across adolescence. Race will also be included as a covariate, as differences in BMI and prevalence of social anxiety has been shown to differ in adolescents who are African American. However, specific hypotheses are not derived for race at this time based on the dearth of literature examining weight and social anxiety in the context of race. As the goal of this project is to evaluate a path to social anxiety among children who may not carry other predisposing risk factors for this outcome, social anxiety at age 10 will be included as a covariate.

CHAPTER II

METHOD

Recruitment and Attrition

The current study utilized data from three cohorts of children who are part of an ongoing longitudinal study of social and emotional development. The goal for recruitment was to obtain a sample of children who were at risk for developing future externalizing behavior problems, and who were representative of the surrounding community in terms of race and socioeconomic status (SES). All cohorts were recruited through child day care centers, the County Health Department, and the local Women, Infants, and Children (WIC) program. Potential participants for cohorts 1 and 2 were recruited at 2-years of age (cohort 1: 1994-1996 and cohort 2: 2000-2001) and screened using the Child Behavior Checklist (CBCL 2-3; Achenbach, 1992), completed by the mother, in order to over-sample for externalizing behavior problems. Children were identified as being at risk for future externalizing behaviors if they received an externalizing T-score of 60 or above. Efforts were made to obtain approximately equal numbers of males and females. This recruitment effort resulted in a total of 307 children. Cohort 3 was initially recruited when infants were 6 months of age (in 1998) for their level of frustration, based on laboratory observation and parent report, and were followed through the toddler period (see Calkins, Dedmon, Gill, Lomax, & Johnson, 2002, for more information). Children from Cohort 3 who completed the CBCL at two years of

age were then included in the larger study (N = 140). Of the entire sample (N = 447), 37% of children were identified as being at risk for future externalizing problems.

Of the 447 originally selected participants, six were dropped because they did not participate in any data collection at 2 years old. An additional 12 families participated at recruitment, did not participate at two-year, but did participate at later years. At age 10, 357 families participated, including 31 families that did not participate in the 7-year assessment. No significant differences were noted between families who did and did not participate in the 10-year assessment in terms of child gender, χ^2 (1, N = 447) = 3.31, p = .07; race, χ^2 (3, N = 447) = 3.12, p = .08; 2-year SES, t(432) = .02, p = .98; or 2-year externalizing T score, t (445) = -.11, p = .91. At age 15, 327 families participated, including 27 families that did not participate in the 10-year assessment. There were no significant differences between families who did and did not participate in the 15-year assessment in terms of race χ^2 (3, N = 447) = 3.96, p = .27; 2-year SES t (432) = -.56, p = .58; or 2-year externalizing T score t (445) = .24, p = .81. Boys were less likely to participate in the 15-year assessment χ^2 (1, N = 447) = 9.31, p = .002.

Participants

Participants will include three cohorts of children who attended laboratory assessments as part of the RIGHT Track Project at age 10, 15, and 17. Participants and their mothers completed questionnaires at the 10, 15, and 17 year visits as part of the RIGHT Track study.

The study utilized data from laboratory visits from the RIGHT Track Project during each of these time periods. Data from all cohorts was assessed and all available

data for each participant at each time point was included. The statistical program that used for analyses, MPlus Version 8 (Muthén & Muthén, 1998-2019), included all available information on all participants and estimated data for missing cases using full information maximum likelihood procedure (FIML).

Procedures

Each child and one parent, typically the child's mother, participated in laboratory assessments at various ages. Assessments were conducted at the University of North Carolina Greensboro at the 10, 15, and 17-year visits in the psychology department. A variety of self-report measures, described below, as well as height and weight, were collected at each of these assessment points. All assessments were conducted by trained graduate students and research assistants.

Consent and assent were collected by the experimenters at each visit prior to the start of any data collection. Questionnaires were completed by the participants and mothers at the 10, 15, and 17 year assessments. Time between data collection periods for each participant at the 15 and 17 year visits was at least 1 year. Measurements of height and weight at the 10-year lab visits were utilized.

Measures

Weight status. BMI was used to assess weight status. Height and weight were collected at all assessments and were utilized to calculate BMI at the 10-year assessment. Obesity is often measured in the social sciences literature through the use of BMI, which is considered to be an estimation of body fatness and is calculated by dividing an individual's weight in kilograms by their squared height in meters, essentially adjusting

the weight for the height of each person (Chung, 2015; Ogden, Carroll, Kit, & Flegal, 2014; Flegal & Ogden, 2011; Voelker, 2007; Dietz & Robinson, 1998). Obesity is defined for children and adolescents by the CDC as being placed at greater than the 95th percentile on BMI percentile growth curves. Falling between the 85th and 94th percentile is classified as overweight (Barlow and the Expert Committee, 2007). The BMI measurement was originally designed for use with adults, and has been adjusted through the introduction of age- and sex- based reference groups for use with children and adolescents, allowing for BMI percentile and z-scores to be determined (Ogden, Carroll, Kit, & Flegal, 2014; Flegal & Ogden, 2011; Chung, 2015). This was done in order to accommodate the developmental changes that influence the relation between body fat and BMI, including height increases and the onset of puberty and development of secondary sexual characteristics over time (Chung, 2015). However, raw BMI has been shown to be an adequate measure of adiposity, or fat mass, in children aged 8 to 17 who have BMI scores at the 85th percentile and above, suggesting that a higher BMI is indicative of greater amounts of fat mass among youth (Freedman, et al., 2005). Raw BMI scores were used in this study.

Social anxiety. Social anxiety, the outcome variable, was measured using the Social Anxiety subscale in the 39-item Multidimensional Anxiety Scale for Children (MASC). The MASC is a self-report measure completed by the adolescent at ages 10, 15, and 17. The social anxiety scale on the MASC has convergent and divergent validity in the prediction of social anxiety disorder (Anderson, Jordan, Smith, & Inderbitzen-Nolan, 2009; March, Parker, Sullivan, Stallings, & Conners, 1997; van Gastel & Ferdinand,

2008). The assessment asked the reporter to rate his or her own behavior and emotions on a 0 to 3 scale, with "0" indicating "Never true about me," "1" indicating, "Rarely true about me," "2" indicating "Sometimes true about me," and "3" indicating, "Often true about me." The Social Anxiety scale measures the extent to which the adolescent experiences social anxiety symptoms such as worrying about peers making fun of them and performing in public. The Social Anxiety scale includes 9 items in total, including 5 *Humiliation* subscale items and 4 *Performance Fears* subscale items. Possible scores ranged from 0 – 27. The 9 nine items were used to create a latent variable of social anxiety. Items that did not load onto the social anxiety latent variable were examined for theoretical consistency with the social anxiety construct. Reliability in this sample was high when including all 9 variables, with a Cronbach's alpha of .910.

Social withdrawal. There is a dearth of literature examining how withdrawal is assessed in adolescence, although it is a syndrome of behaviors considered to be moderately stable over time (Oh et al., 2008; K. H. Rubin & Coplan, 2010; K. H. Rubin, Coplan, & Bowker, 2009). Social withdrawal was also conceptualized as a latent variable in this project drawn from mother report of socially withdrawn behavior. The Withdrawn/depressed scale assesses socially reluctant behaviors by asking mothers to report on adolescent behavior on a 0-2 scale using descriptors. Qualitative descriptors used are "0" indicating that the behavior is not true about their child, "1" indicating that the behavior is sometimes true about their child, and "2" indicating that the behavior is very true or almost true about their child. This scale has been shown to effectively assess socially withdrawn behaviors in youth (Pérez-Edgar et al., 2010; Rubin, Althoff, Walkup,

& Hudziak, 2013) while also including items that reflect a sense of melancholy or anhedonia. It is widely accepted that there are a number of underlying motivations for withdrawn behavior (Rubin et al., 2009), and during the adolescent period it is relevant to consider potential experiences of sadness that may promote self-isolation. This may be particularly true when considering that withdrawal in adolescence is associating with past peer rejection. Further, the current assessment of withdrawal includes items that focus on the behavior of the adolescent rather than on the behavior of others directed towards the adolescent. This minimizes the risk of confounding withdrawal with social exclusion (Rubin, Root, & Bowker, 2010.). Examples of items on the CBCL withdrawn/depressed scale include "withdrawn, doesn't get involved with others", "too shy or timid", "secretive, keep things to self", "underactive, lacks energy", "unhappy", and "refuses to talk." The 8 items from the CBCL withdrawn/depressed scale were used to create a latent variable. Cronbach's alpha at age 15 on this measure was .802, indicating acceptable reliability.

Perceived social stress. Perceived social stress was included as a manifest variable in this project using all 8 items from the Social Stress subscale on the self-report form of the Behavior Assessment System for Children Second Edition (BASC2-SRP-C/A), collected at the 10 year old assessment. The BASC-2 is a widely accepted measure used to assess behavior in children (Reynolds & Kamphaus, 2004). The Social Stress subscale addresses perceived victimization and rejection experiences by asking children and adolescents to report the frequency of these experiences on a scale using the descriptors "Never", "Sometimes", "Often", and "Almost always". These qualitative

descriptors were converted to a 0 to 3 scale, with "0" indicating that the behavior never occurs, "1" indicating that the behavior sometimes occurs, "2" indicating that the behavior often occurs, and "3" indicating that the behavior almost always occurs. Eight items comprise the child scale (used at the 10 year time points). Examples of items include "people say bad things about me", "feel left out", and "others find things wrong with me". Cronbach's alpha for this sample was .862, indicating acceptable reliability

Statistical Analysis Plan

Preliminary analyses were conducted using SPSS version 23 prior to completing the primary analyses of the project. Missing data was addressed through both imputation and FIML. Data from the MASC Social Anxiety scale was imputed at the single item level to account for missing items (e.g. accidentally skipped items, choosing not to answer an item). The expectation maximization (EM) method was used, which involves removing cases with completely missing data and then using the remaining participants' data to complete imputation at the item level. Full information maximum likelihood estimation (FIML), coupled with bootstrapped confidence intervals, are effective and robust tools to address non-normality in data (Muthen & Muthen, MacKinnon, Lockwood, & Williams, 2004). Variable transformations were not conducted because of the selected plan to use FIML and bootstrapping, and transformations can distort linear relationships, particularly when violations of non-normality are moderate and not severe. (Gao et al 2008). Preliminary analyses were conducted by examining descriptive statistics on all study variables as well as assessing normality of data. Correlations between

variables were analyzed and reported. Child sex and social anxiety at age 10 were considered as covariates.

After the completion of preliminary analyses, main analyses were completed in Mplus 8 (Muthén & Muthén, 1998-2019). Models included an indirect effects model of weight predicting social anxiety through social withdrawal, followed by a conditional indirect effects model completed by adding the interaction of weight and perceived social stress in the prediction of withdrawal. Latent variables of social withdrawal and social anxiety were created in order to minimize measurement error. By calculating a latent variable and allowing items to covary only through the latent variable, the assumption that all items load on to the variable equally is removed and method error is minimized. Factor loadings for social anxiety and withdrawal were standardized and reported in Figures 1-5. Model fit was evaluated using several fit indices including the chi-square difference test, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the standardized Root Mean Square Residual (sRMSR). The chi-square difference test should be significant at the $p < .05$ level to accept a more complex model. Adequate fit was defined using the following parameters: RMSEA should be less than .08, CFI should be greater than .90 for acceptable fit and greater than .95 for good fit, and the sRMSR should be less than .06 (Bowen & Guo, 2011). A bootstrapping procedure was used for evaluation of all direct and indirect effects, as it accounts for non-normal distribution and increases power (Preacher & Hayes, 2004; MacKinnon, Lockwood, & Williams, 2004). Bootstrapping procedure was

performed with 10,000 draws for all analyses. When examining confidence intervals, an effect is considered significant if the 95% confidence does not include zero.

First, a base model evaluating the direct and indirect effects of obesity in childhood on social anxiety in adolescence through withdrawal at age 15 was examined. After establishing the presence of indirect effects by examining model fit and bootstrapped confidence intervals, a second model was evaluated to assess the conditional effects of perceived social difficulties on the indirect effect between obesity and social anxiety. A multigroup analysis by sex was conducted to assess for gender differences in the indirect effect model.

CHAPTER III

RESULTS

Descriptive Analyses

Descriptive statistics can be found in Table 1. Total raw scores for social anxiety at age 17 and withdrawal at age 15 are included in Table 1. Slight skew was defined by values between 1 and 2, while moderate kurtosis is considered to fall between 1 and 7 (Curran, West, & Finch, 1996; Gao, Mokhtarian, & Johnston, 2008). Skew and kurtosis fell within accepted ranges for BMI at age 10, perceived social difficulties at 10, and the total raw scores for withdrawal at 15 and social anxiety at 17 years old. When examining item-level descriptives, moderate positive skew was observed on CBCL items "withdrawn", "refuses to talk", "little enjoyment from most things", and "underactive". Moderate kurtosis was also observed for these items. Although the range of scores on the withdrawal scale included all possible scores (0-16), the mean score was 2.03 with a standard deviation of 2.57, indicating that the adolescents in this sample are reported to infrequently demonstrate withdrawn behaviors.

Preliminary Analyses

Bivariate correlations between study variables are included in Table 2. Overall, significant correlations between variables were small to moderate in strength. As expected, BMI was positively correlated with withdrawal. However, BMI was not significantly correlated with social anxiety or with perceived social difficulties, in

contrast to existing literature indicating significant association. Greater withdrawal at age 15 was significantly correlated with greater social anxiety at age 17, consistent with hypotheses. As expected, social anxiety at age 10 was positively correlated with social anxiety at age 17.

Additional analyses were conducted examining the association between these constructs at different ages than those proposed in the main analyses. Correlations between all study variables at 10, 15, and 17 years old can be found in Table 3. Correlations for boys (Table 4) and girls (Table 5) are also included in order to examine differences in relations between variables by gender. These correlations were completed in SPSS and thus, were included as manifest variables. Pairwise deletion was used to calculate Pearson correlations in SPSS, resulting in different n values for each pairing, while Mplus calculates correlations using all data through FIML. As all variables in the larger correlation table were not included in the main analyses, SPSS was used to assess relations between variables based on existing data. This results in correlations that are slightly different in strength between the main and large correlation tables (e.g., .043 in SPSS versus .089 in Mplus between age 10 BMI and age 17 social anxiety), but there were no differences observed in statistical significance among main study variables.

Each variable was significantly correlated with itself at all three timepoints in the positive direction. For example, BMI at 10 years old was significantly correlated with BMI at 15 at .745; BMI at 15 was correlated with BMI at 17 years old at .904; and BMI at 10 years old was correlated with BMI at 17 years old at .731. This suggests that in this sample, BMI is relatively stable over time. Correlations among social anxiety at age 10,

age 15, and age 17 and social stress at each age were moderate in strength, while correlations between withdrawal variables were moderate to strong. These patterns remained generally true for both boys and girls, although social stress at age 10 was not significantly associated with social stress at 17 for boys, suggesting that social experiences may change for boys across adolescence.

Unexpectedly, BMI at all ages was not associated with social anxiety at any age for the whole sample and for boys, but social anxiety at age 10 was significantly and positively correlated with BMI at age 17 among girls. This suggests that for girls early social anxiety may play a role in behaviors that contribute to greater weight relative to height at age 17.

BMI at 10 and 15 years old was both positively correlated with withdrawn behavior at 10 and 15 years old. BMI at 17 years was positively correlated with withdrawal at 15 and 17 years old. Among boys, BMI at age 10 was positively correlated with withdrawal at ages 15 and 17, while BMI at 15 was not associated with withdrawal at any age and BMI at 17 was associated with withdrawal only at age 17. Among girls, the only significant correlation was between BMI at age 15 and withdrawal at age 10. This may indicate that BMI has a greater impact on engagement with others for boys than for girls.

Among the full sample, social stress at age 10 was not correlated with withdrawal at any age, while social stress at age 15 was positively correlated with withdrawal at ages 15 and 17; social stress at 17 years old was positively correlated with withdrawal at all ages. Among boys, social stress at age 10 was unexpectedly correlated in the negative

direction with withdrawal at age 15. At age 15, social stress was only correlated with withdrawal at age 17. At age 17, social stress was associated with withdrawal at age 10 and 17, but not at 15 years old. Consistent with expectations, social stress at age 10 was significantly positively correlated with withdrawal at age 15 and 17 years old among girls. Social stress at 15 was associated with withdrawal at ages 15 and 17 years old among girls. Social stress at 17 was associated with withdrawal at age 17.

Withdrawal at 10 years old and at 15 years old was positively correlated with social anxiety at ages 15 and 17 in the full sample, although correlations were relatively weak in strength. Withdrawal at age 17 was positively correlated with social anxiety at all ages. Among boys, withdrawal at 10 years old was positively correlated with social anxiety only at age 17. Withdrawal at 15 was not associated with social anxiety at any age, while withdrawal at 17 was associated with social anxiety at 15 and 17 years old. Among girls, withdrawal at age 10 was correlated with social anxiety at age 17. At age 15, withdrawal was associated with social anxiety at age 15 and 17. At age 17, withdrawal was associated with social anxiety at all ages. Taken together, these correlations suggest the presence of complex patterns of influence of BMI on different aspects of social functioning by gender as well as differing patterns of influence of social variables on one another. The consideration of typical social, cognitive, and physical development is necessary to understand the temporal relation between these variables and evidences that childhood weight impacts later withdrawal, while withdrawal in childhood and adolescence may influence social anxiety in childhood and adolescence.

Possible external influences on project results, including sex and race, were examined. Differences in BMI and overall scores on the withdrawn/depressed scale by sex or race were not observed. Adolescents in this sample differed significantly on reports of social anxiety at age 17 by sex ($t(290.2) = -3.03$, p=.003) and by race ($t(217.1) = 2.93$, p=.004), such that girls reported significantly higher social anxiety than boys and African American adolescents reported significantly lower social anxiety than White adolescents. Therefore, race was included in subsequent analyses as a covariate in order to consider the potential influence of this characteristics and sex was considered through the use of 2-group analysis, as hypotheses included greater effect for girls than for boys. Social anxiety at age 10 was also included as a covariate so that increases in social anxiety could be examined.

Model fits for latent variables were adequate to good. Modification indices were examined and utilized in order to ensure that all items in each subscale are sufficiently related through the underlying constructs of withdrawal and social anxiety. This is done by allowing certain items to covary with one another, improving model fit. The hypothesized model for withdrawal, using all 8 items from the CBCL Withdrawn/Depressed scale, yielded overall good fit, χ^2 (19, N = 300) = 46.63, p = .00, CFI = .95, RMSEA = .07 [90%CI = .05, .10], sRMR = .04. The hypothesized model for social anxiety, using all 9 items from the MASC social anxiety scale, yielded overall good fit, χ^2 (25, N = 298) = 60.47, p = .00, CFI = .98, RMSEA = .07 [90%CI = .05, .09], sRMR = .04. Subsequent models included these latent variables to represent withdrawal at age 15 and social anxiety at age 17.

Main Analyses

Direct and indirect effects model. Unstandardized estimates for this model can be found in Table 6. The indirect effects model was tested using the full sample (n=447) and produced adequate fit, χ^2 (177) = 324.636, p = .00, CFI = .936, RMSEA = .043 [90% CI = .036, .051], sRMR = .053 (Figure 1). Contrary to hypothesis, a direct effect was not observed, as BMI at age 10 was not significantly associated with scores on the MASC social anxiety scale at age 17, per bootstrapped confidence interval [95% CI = -.116, .395]. However, a significant indirect effect from BMI at age 10 to social anxiety at age 17 through withdrawn behavior at age 15 was observed [95% CI = .002, .181], consistent with study hypotheses. When examining each pathway of the mediation individually, a significant positive association was found between BMI at age 10 and withdrawn behavior at age 15 [β=.144, p = .041; 95% CI = .021, .297]. Although the linear regression was not statistically significant (β=.379, p = .138), the pathway from withdrawn behavior to social anxiety is considered significant because the bootstrapped confidence interval did not include zero [95%CI = .006, 1.153]. Examining the covariates' associations with study outcomes indicated that sex (β=.219, p = .029), race (β=-.379, p = .000), and social anxiety at age 10 (β=.343, p = .001) all significantly predicted social anxiety at age 17. No covariates significantly predicted mother-reported withdrawal.

To further investigate the conditions of the observed indirect effect on social anxiety in late adolescence, this model was examined for moderation by sex (Figure 2 and 3) and by race by using multi group analyses. The model by sex produced adequate

fit, χ^2 (348) = 528.023, *p* = .00, CFI = .916, RMSEA = .055 [90%CI = .045, .064], sRMR = .078. The Wald Test of Parameter Constraints for the *a* path of the model (BMI→withdrawal) was significant (β = 3.901, p = .0483). This indicates that the effect of BMI on withdrawal differs by sex, such that greater BMI is associated with greater withdrawal for boys (β = .275, p = .002), but no significant association was found among girls. The Wald Test of Parameter Constraints was significant for the b path (β = 6.77, p = .009; withdrawal→social anxiety), indicating that this pathway is different for boys versus girls. Among girls, greater withdrawal was significantly associated with greater social anxiety (β = .895, p = .002), but this effect was not found among boys. Therefore, the initially observed indirect effect is better explained by two significant direct effects: BMI on withdrawal for boys and withdrawal on social anxiety for girls.

Adequate model fit was also found when examining the indirect effects by race χ^2 (350) = 566.038, *p* = .00, CFI = .901, RMSEA = .060 [90%CI = .050, .068], sRMR = .078. However, the Wald Test of Parameter Constraints was not significant for either path in the model, indicating a lack of evidence that the association between study variables differs by race.

Conditional indirect effects model. Subsequently, the conditional indirect effect model was evaluated with the full sample in order to determine if the interaction between BMI and social stress impacted the level of observed withdrawal and subsequently, the overall indirect effect of BMI on social anxiety as a single latent variable (Figure 4). When the full sample was utilized, model fit was adequate; χ^2 (83) = 149.826, *p* = .00, CFI = .960, RMSEA = .042 [90%CI = .031, .053], sRMR = .040. A main effect of BMI

on social withdrawal was observed [β=.098, p = .016; 95% CI = .015, .297], consistent with the indirect effects model, but a main effect of social stress on withdrawal was not observed. The interaction between BMI and social stress was not significantly predictive of later social withdrawal. As observed in the indirect effects model, greater withdrawal was associated with higher social anxiety [β=.043, p = .058; 95% CI = .015, .297].

Post Hoc Analyses

Subscales of anxiety. In order to ensure the best fit to the data, additional indirect effect analyses were conducted that separated items on the Social Anxiety scale into its two comprising subscales: Humiliation/Rejection and Performance Fears (Figure 5). Both subscales represent the underlying concept of social anxiety, but one specifies fearfulness about being humiliated or rejected by others (e.g., "worry about other people laughing at me") while the other emphasizes performance anxiety (e.g., "worries about being called on in class"). The introduction of the performance-only specifier in DSM-5 reflects the growing literature that adolescents with only performance fears represent a distinct population from those with general social anxiety (APA, 2013). Therefore, BMI and withdrawal may be differentially associated with general social anxiety and performance social anxiety.

The Performance and Humiliation constructs were conceptualized as latent variables in the post hoc model. Model fit was adequate and had a similar to slightly better fit than that of the original indirect effect model, χ^2 (170) = 275.592, p = .00, CFI = .954, RMSEA = .037 [90%CI = .029, .045], sRMR = .050. The bootstrapped 95% confidence interval analyzing the indirect effect of BMI on Performance Fears through

withdrawal was significant [95% CI = .007, .179]. Different from the main analysis, both the a and b paths were significant, with BMI predicting withdrawal ([β=.419, *p* = .073; 95% CI = .013, .303]) and withdrawal predicting social anxiety ([β=.143, *p* = .052; 95% CI = .057, .978].) Sex and race were not significantly associated with withdrawal, as previously observed, or with scores on the Performance Fears scale. However, because the main analyses indicated that BMI is significantly associated with withdrawal for boys but not girls, this indirect effect was probed by sex by running a 2-group analysis. The same effects from the main analyses were observed, such that BMI was associated with withdrawal for boys (β = .277, p = .002), and withdrawal was associated with social anxiety for girls (β = .945, p = .002).

Sex and race were significantly associated with scores on the Humiliation/Rejection scale. A significant indirect effect was not found for the Humiliation/Rejection Fears outcome [95% CI = .000, .177]. However, sex, race, and social anxiety at age 10 were all significantly associated with this outcome. Probing of sex effects on this indirect effect indicated significant differences between boys and girls on the b path only (Wald Test value: 6.421, p = .011), such that greater withdrawal among girls was associated with greater social anxiety (β = .295, p = .003). No significant effect was found among boys. Results remained the same when running separate analyses either Performance Fears or Humiliation/Rejection Fears as the outcome variable.

Broad anxiety. Past research has found support for an association between BMI and general anxiety (Anderson et al., 2007), indicating that greater weight may be associated with an broad anxious style rather than social anxiety specifically. A model

was evaluated using the total anxiety sum on the MASC at 17 years old, in order to determine if withdrawal is associated with broad symptoms of anxiety for boys. Previous findings were replicated, such that withdrawal was associated with anxiety only among girls.

Depression. Depression was additionally examined as a maladaptive outcome for children with extra weight, as research has found that greater BMI is associated with greater symptoms of depression among youth (Ames, Wintre, & Flora, 2015; Chang & Halgunseth, 2015; Lanza et al., 2013; Yang & Li, 2016). Research has also found that greater BMI is associated with lower self-esteem among adolescents (Rawana & Morgan, 2014; Witherspoon, Latta, Wang, & Black, 2013). As lower self-esteem and depression often co-exist, it was considered that higher BMI may be more likely to result in sadness or hopelessness after years of opportunity for victimization and withdrawal, rather than resulting in worry about future social experiences. Weight was not significantly associated with social anxiety through direct or indirect effects. However, weight was significantly associated with withdrawn behaviors that are risk factors for other emotional problems, including depression. There is evidence that greater weight and depression are associated in adolescence, and so a post hoc analysis was conducted using the same model of indirect effects described above, but using the depression subscale from the BASC-2 self report form at age 17 as the outcome. Covariates included sex, race, and depression at age 10. Model fit was adequate, χ^2 (55) = 104.109, p = .00, CFI = .927, RMSEA = .045 [90%CI = .031, .058], sRMR = .046. A significant direct effect was observed, such that greater BMI at age 10 was directly associated with depression at 17

years old (95%CI = .170, .2.678) with an estimate of 1.389. Indirect effects were not observed. While BMI at age 10 continued to predict withdrawal at age 15, significant associations between withdrawal and depression were not observed. Depression at age 10 was significantly associated with depression at 17; sex and race were not significantly associated with either outcome.

Cross-sectional considerations. Additionally, cross-sectional models were examined using the full sample at age 10, 15, and 17 years old to examine if the associations between weight, withdrawal, and social anxiety existed within the same developmental period. Cross-sectional models of direct and indirect effects preclude assumptions of causality. Thus, these models were examined for associations between constructs alone. Both models demonstrated slightly worse fit than the longitudinal model; age 10, χ^2 (49) = 134.895, p = .00, CFI = .829, RMSEA = .065 [90%CI = .052, .078], sRMR = .062; and age 15, χ^2 (157) = 365.386, p = .00, CFI = .873, RMSEA = .054 [90%CI = .047, .062], sRMR = .062. At 10 years old, no significant associations were observed. At age 15, a significant positive association was found between BMI and withdrawal. At age 17, model fit was adequate χ^2 (177) = 395.56, p = .00, CFI = .906, RMSEA = .053 [90%CI = .046, .060]. All paths were statistically significant, such that BMI at 17 was associated with withdrawal at 17 (Estimate: .168, 95%CI = .070, .283) and withdrawal at 17 was associated with social anxiety at 17 (Estimate: .572, 95%CI = .216, 1.045). Although causal conclusions cannot be drawn, these results suggest that BMI, withdrawal, and social anxiety are related to one another during this late adolescent period.

Weight status. Further, the present study examined weight as a continuous variable. Among the 268 children who had BMI calculated at age 10, 56 children had a BMI in the overweight or obese categories. Additional correlation analyses did not find significant associations between overweight/obese BMI and social anxiety at 10, 15, or 17 years old, or with social stress at 10 years old. Consistent with findings in the main analyses, overweight/obese BMI at age 10 was significantly associated with withdrawal at age 15 in the expected direction.

Consideration of weight status at age 15. Between ages 10 and 15 years old, some children experience changes to their BMI trajectory that may impact socioemotional outcomes. Most children undergo physical transformations associated with puberty, such that almost all girls will have completed puberty by age 15, while boys may continue to experience pubertal changes at age 15 for an additional few years. Therefore, an additional post hoc analysis was conducted including BMI at 15 as a covariate to account for BMI changes that may influence social behavior above and beyond BMI at 10 years old. Model fit was adequate χ^2 (191) = 334.87, p = .00, CFI = .937, RMSEA = .041 [90%CI = .034, .048], sRMR = .052. Direct and indirect effects were nonsignificant in this model, with confidence intervals crossing 0 (direct effect 95%CI: -.189, .832; indirect effect 95%CI: -.105, .202). Sex and race were not significantly associated with withdrawn behavior at age 15 in this model. Neither BMI at age 10 nor BMI at age 15 were significantly associated with withdrawal at age 15. In the previously described cross-sectional model, BMI at age 15 was associated with withdrawal at age 15, while BMI at age 10 was significantly associated with withdrawal

at age 15 among boys in the main analyses. BMI at age 10 and at age 15 are highly correlated and including both in the model may decrease the ability to detect significant associations. The standardized estimate of BMI at age 10 predicting withdrawn behavior at age 15 decreased from .207 to .103, which is considered a relatively small difference in size of change in withdrawn behavior as BMI changes by one unit. Therefore, despite lack of statistical significance with the addition of the covariate, the change in regression estimate is not appreciable. Consistent with previous models, withdrawal was significantly associated with social anxiety (95%CI: .022, 1.124).

Consideration of developmental period. Due to the lack of significant findings when BMI at age 10 and at age 15 were both included in the model, the transition from childhood to adolescence is thought to be particularly complicated with regards to simultaneous pubertal achievement and understanding the association between BMI and withdrawn behavior. Thus, a model examining associations in adolescence only was conducted, as almost all girls and many boys would have achieved pubertal development. BMI and withdrawal were included at age 15, and social anxiety was included at age 17. Model fit was adequate χ^2 (177) = 387.47, p = .00, CFI = .909, RMSEA = .052 [90%CI = .045, .059], sRMR = .062 and significant confidence intervals were observed associating BMI at 15 years old with withdrawn behavior at 15 years old (95%CI: .037, .308), similar to previous models. Withdrawal at 15 years old significantly predicted social anxiety at 17 years old (95%CI: .230, 1.065) while BMI did not significantly predict social anxiety. When BMI at age 10 was included as a covariate in order to consider previous weight status, model fit become poor χ^2 (177) = 538.18, p = .00, CFI = .786, RMSEA = .081

[90%CI = .073, .089], sRMR = .083. These results suggest that BMI in adolescence is simultaneously associated with withdrawn behavior, and that examining BMI during the adolescent time period may be the most parsimonious developmental stage, when not including change in BMI or information about pubertal status in the model.

CHAPTER IV

DISCUSSION

The current study examined whether children who have extra weight are more likely to develop social anxiety in adolescence. Weight-based stigmatization is thought to be the context in which risk for social anxiety in adolescence among children with extra weight is established. Although a direct link between greater weight and social anxiety has been found (Burke & Storch, 2015), the reasons for this association are less well understood. Withdrawal in adolescence was examined as one explanatory mechanism for the association between weight and social anxiety. This explanatory association was further investigated for the presence of a conditional effect, such that greater perceived social stress in childhood among children with extra weight resulted in the highest levels of adolescent withdrawal. Developmental considerations included the evolution of the "imaginary audience" which typically emerges in early adolescence (Harter, 2012) and subsequent increases in self-consciousness around others. It was hypothesized that in the context of this typical cognitive transition from childhood to adolescence, children with higher BMIs who also report more peer stress will have heighted withdrawal from others in adolescence, explaining the resulting greater social anxiety during later adolescence. As girls experience social anxiety more frequently than boys and are more likely to experience weight-based teasing than boys, models were examined separately for boys versus girls.

Preliminary Associations Among Study Variables Examined in Main Analyses

Preliminary analyses indicated that demographic variables (sex and race) were significantly associated with study variables. Girls reported significantly higher levels of social anxiety than boys at both 10 and 17 years old. This is consistent with the literature which finds higher rates of social anxiety in both adolescent and adult females as compared to males (Asher, Asnaani, & Aderka, 2017; Knappe et al., 2015; Wittchen et al., 1999; Xu et al., 2012). Consistent with expectations, a significant difference in weight between boys and girls at age 10 was not found, as measured by BMI. Significant differences between boys and girls were also not found for mothers' ratings of withdrawn behavior at age 15, which is consistent with literature using observational and parent report (Rubin et al., 2006). Girls and boys did not endorse significantly different levels of perceived social stress at age 10, which is somewhat inconsistent with the literature. Both boys and girls experience more interpersonal stress as they enter adolescence, however, girls experience more friendship stress than boys. Further, girls experience greater symptoms of anxiety and depression as a result of friendship stress, in part due to the greater value placed on peer relationships for girls and the subsequent threat that the potential loss of a friendship poses to a girl's perceived well-being (Hankin, Mermelstein, & Roesch, 2007; Rudolph, 2002a; Sontag, Graber, Brooks-Gunn, & Warren, 2008). Therefore, while it is expected that both boys and girls will report social stress, it is thought that this stress has a greater negative impact on emotional functioning in girls. However, much of the literature has used samples of pre-adolescents and adolescents aged 11 through 14, and although one paper included children from the 5^{th}-8^{th} grades, it is

possible that gender influences on the differential value of peer relationships may not have emerged by age 10.

With regard to sample differences between groups by race, White adolescents reported significantly greater social anxiety than African American adolescents. This is consistent with literature examining both clinical and community samples of adolescents as well as large adult samples (Asnaani, Richey, Dimaite, Hinton, & Hofmann, 2010; Breslau et al., 2006; Compton, Nelson, & March, 2000). African American girls with higher interpersonal skills in the fifth grade, as rated by teachers, were more likely to become or remain obese in the eighth grade (Chang & Halgunseth, 2015). The cultural context of African American community has found less value placed on thinness, with mothers of African American girls demonstrating greater support of physical build than mothers of white children (Brown, Schreiber, McMahon, Crawford, & Ghee, 1995). Although adolescents of African-American, Asian, and White racial groups all were at increased risk for lower emotional well-being when experiencing body dissatisfaction, African-American youth were less likely to experience body dissatisfaction related to greater weight than other groups (Bucchianeri et al., 2016). Therefore, higher weight does not necessarily confer the same psychosocial risk for this cultural group as compared to White youth, for whom body dissatisfaction may have greater impact on emotional well-being. However, it is important to consider how greater weight is conceptualized across racial and cultural groups.

Significant differences were not observed on measures of withdrawal or social stress between participants who identified as African American or White, although BMI

was significantly higher among African American children than among White children, which is consistent with epidemiological work examining the prevalence of obesity in children (Ogden, Carroll, Kit, & Flegal, 2014). Research examining differences in prevalence of withdrawn behavior between racial groups within the United States has been limited, while cross-cultural research examining groups that place more or less value on extraversion is more prevalent (e.g., comparisons between North American and Scandinavian or East Asian and North American cultural groups) (Chen & French, 2008). Thus, the lack of significant differences in withdrawn behavior between racial groups in the present study may be consistent with the rationale that both White American and African American cultural groups within the U.S. value sociable behavior and low withdrawal when among peers.

Preliminary Associations Among Study Variables Examined in Post Hoc Analyses

In light of a lack of significant direct and indirect effects, correlations between study variables at all ages were examined for the full sample and separately for boys and girls to further elucidate possible relations between these constructs. Moderate to high stability was found for all variables across time, with BMI demonstrating the strongest correlations across time. When examining contemporaneous correlations among the full sample, BMI was not significantly correlated with social anxiety at the same age and correlation strength was very low, ranging from -.049 to .001. Differently, social anxiety at age 10 was significantly and positively correlated with BMI at age 17 among girls. No other significant correlations between BMI and social anxiety were found for girls or boys. This suggests that for girls, early social anxiety may play a role in the development

of behaviors that contribute to greater weight relative to height at age 17, which is consistent with the hypothesized bidirectional effect of BMI and social anxiety on one another. This is hypothesized to be partially due to decreased activity level, eating for emotion regulation, and impact on hormones (Incledon, Gerner, Hay, Brennan, & Wake, 2013; Pizzi & Vroman, 2013). In addition, social stress at age 10 was associated with BMI at age 17 among girls, further indicating a relation between earlier social challenges and later higher BMI. Future research should examine how anxiety impacts later increases or decreases in BMI, particularly among girls, as the longitudinal relation between these constructs may exist in the opposite direction than predicted in the current study.

Although BMI at 10, 15, and 17 years old was significantly and positively correlated with withdrawal at the corresponding age in the full sample, most of these associations became non-significant when examining boys and girls separately. BMI and withdrawal at age 17 remained significant for boys. Withdrawal was correlated positively with simultaneous social anxiety among 15 and 17 years old adolescents, but withdrawal at 10 years old was correlated at almost 0 (.055) with social anxiety at age 10. Social anxiety typically onsets between the ages of 10 and 13, and among a community sample 10 years old may be too early in development to capture social anxiety appropriately.

Taken together, correlations tables reveal that BMI is not associated with other contemporaneous study variables or with social variables that occur later in development. In fact, the opposite is true, such that BMI at age 17 is associated with 10-year social stress and social anxiety, suggesting that future work should examine adolescent BMI as

an outcome for girls rather than a risk factor. Among boys, the pattern of correlations is somewhat less clear, although BMI at 10 years old was correlated with future withdrawal and future social stress and BMI at 17 was associated with concurrent social variables. Among boys, BMI may play a role as a risk factor in childhood for maladaptive social outcomes. Theoretical explanations for these correlations include the role of puberty, challenges with assessment, cultural and gender differences, and stability of BMI and are described below.

Direct Effect of BMI on Social Anxiety

Contrary to hypotheses but consistent with correlations, higher BMI in childhood did not predict greater social anxiety at age 17. Additionally, greater BMI at age 10 did not predict greater Humiliation and Rejection or Performance Fears, the two subscales that comprise the MASC Social Anxiety scale, at age 17. Given that previous research has demonstrated that greater weight is associated with social anxiety in youth (Asthana, 2012; Hartmann et al., 2010; Lanza et al., 2013; Ozkan et al., 2016; Thompson et al., 2013), the present null findings are somewhat surprising, although other papers have not found an association between BMI and social anxiety (Juvonen, Lessard, Schacter, & Suchilt, 2017; Lee & Yen, 2014; Thompson et al., 2013: among adolescents only). Comparing the current study to literature that found a significant association between BMI and social anxiety revealing some differences in methodology. All literature with significant findings was cross-sectional, while the present study attempted to understand a longitudinal association between BMI and social anxiety. However, this is also somewhat inconsistent with the correlational results in the current sample that did not

find cross-sectional associations between BMI and social anxiety at any age. One paper with significant findings included only adolescents in the sample aged 13-19 (Asthana, 2012), while Thompson and colleagues (2013) found significant associations between BMI and social anxiety among the elementary school group of obese children (aged 7-12) but not in their adolescent sample (aged 13-17). Ozkan and colleagues (2016) included a sample of children aged 7 to 17 years old, finding greater social anxiety symptoms in the obese group as compared to a non-overweight control group. While these studies drew from clinical samples of obese children, other studies examined BMI as a continuous variable (Hartmann et al., 2010; Lanza et al., 2013). Notably, higher BMI was associated with social anxiety for 6th grade girls only in the context of deviation from the BMI norm, in the direction of obesity, within the student's cultural group (Lanza et al., 2013). This suggests that using BMI as a continuous variable may be most useful in community samples with a large enough sample size to be able to detect small effects and consider the specific influences of both culture and gender. Overall, it appears that BMI may only be associated with social anxiety at very high BMI percentile scores, although a larger community sample may be able to detect the effects of BMI across the possible range. Finally, other studies included diagnostic interviews for anxiety disorders but predicted the risk for the development of any anxiety disorder in adulthood from adolescent BMI, making the fourfold increase in risk for obese girls more difficult to understand (Anderson et al., 2007). SES or an approximation, such as parental education level, was considered as a covariate in almost all projects. This should be considered in future work, as SES is significantly associated with the development of obesity. Further, assessment of

median SES within a child's school system or within their neighborhood may provide context for expectations surrounding weight and shape.

When considering non-significant findings in the current literature and present study, one recent longitudinal study similarly did not find a significant direct effect predicting social anxiety in 8th grade from BMI in the 6th grade, but an indirect effect was found through the adolescent's report of frequency of weight-based teasing in the 7th grade (Juvonen et al., 2017). This finding is consistent with the present paper's theoretical rationale, such that examining the impact of weight on social anxiety is relevant only in the context that greater weight functions as a stigmatized characteristic. Although weight-based stigmatization has been established as a typical phenomenon in the U.S. that can be observed in early childhood through adolescence and adulthood, the assumption that youth have endured stigma may limit the ability to draw conclusions about the relation between weight and social anxiety. Therefore, children who carry extra weight may develop discomfort or fear in social situations during adolescence specifically when they believe they will be rejected or embarrassed because the peer group judges them negatively for their weight. Generally, if a child with extra weight is teased or bullied, they are at increased risk for developing social anxiety in adolescence as they may come to expect rejection from others, making interaction a fearful undertaking that may result in avoidance. However, if the child is not victimized because of weight or does not identify that subtle exclusionary behaviors, such as being left out when groups form in class, are related to size, then a direct association between weight and later social anxiety is less likely to exist. Without the belief that maladaptive peer

experiences could be partially weight-based, carrying greater weight solely may not result in the pattern of heightened focus on one's behavior during interactions, negative appraisal of performance, and subsequent avoidant behaviors to address appraisals, a syndrome characteristic of social anxiety. Thus, the inability to include an assessment of weight based stigmatization felt by the youth in the current study is a limitation that should be evaluated for future research.

It may be particularly important in future research to assess the child's experience with weight-based stigma in frequency, degree of intensity, and method (e.g., direct or indirect teasing, teasing from a friend versus acquaintance) when determining the context that increases risk for social anxiety among children with extra weight. A few experiences of weight-based teasing by a relatively unknown peer could be less impactful on social behavior than weight-based stigma that comes from a valued peer. There may also be a differential impact on the type of emotional distress experience; while victimization from close friends may result in decreased self-esteem, more frequent victimization from multiple lesser known peers may specifically increase anxiety when in environments with unfamiliar young people, due to increased anticipation for judgement. Most adolescents who are overweight experience weight-based teasing at least a few times a year (Neumark-Sztainer et al., 2002) and although both adolescents and children attribute the same negative characteristics to overweight peers (Neumark-Sztainer et al., 2002), weight-based teasing in adolescence centers around covert relational aggression (e.g., commenting behind others' backs or masking insults as "advice" or "jokes") rather than direct name-calling (Taylor, 2011). Adolescents may be more reluctant to involve

authority figures like teachers in addressing weight-based teasing, limiting intervention, unlike in elementary or early middle school, where overt teasing may be more readily addressed. In fact, the odds of reporting weight-based teasing to a teacher or other school authority figure increased by only 4% with each incident among a sample of high school students (Puhl & Luedicke, 2012). Thus, the link between BMI and social anxiety as a function of stigma around weight may be stronger in adolescence, when stigmatizing behaviors could be more likely to persist because teens are developmentally more secretive and less likely to report victimization. However, concurrent assessment of BMI and social anxiety at ages 15 and 17 did not find significant association between BMI and social anxiety. Therefore, in addition to the importance of examining the culture of weight-based stigmatization within the adolescent's various environments, the way in which social anxiety should be assessed may also benefit from reconsideration.

An additional explanation for the lack of direct association between BMI and social anxiety is that the assessment of social anxiety may not adequately describe the unique aspect of social anxiety that can be influenced by weight. Among undergraduate women, BMI was not associated with general social anxiety among undergraduate women, but it was associated with appearance-based social anxiety specifically (Titchener & Wong, 2015). This suggests that weight contributes to social anxiety insofar as it relates to anxiety around other because of fear of judgment of size or shape. Social physique anxiety is a construct related to social anxiety defined as "the anxiety people experience in response to others' evaluations of their physiques", which includes body fat, muscle tone, and body composition and proportion (Hart, Leary, & Rejeski, 1989, p

94). This specific context for social anxiety may be a more appropriate outcome when considering the impact of having extra weight on comfort in social situations. Assessing social physique anxiety directly addresses how an individual's social worries may arise from their opinions about their own physicality, while indirectly evaluating how much they believe others assign value based on body appearance. In this way, subtleties about internalized weight stigma may be captured and could demonstrate the link between higher weight and higher social anxiety.

The Social Physique Anxiety Scale (SPAS) (Hart et al., 1989), originally created for adults but validated among adolescent samples across cultures (Hagger et al., 2007; Maïano et al., 2010; McAuley & Burman, 1993; Sáenz-Alvarez, Sicilia, González-Cutre, & Ferriz, 2013; Smith, 2004), uses a Likert scale to ask whether statements are characteristic of how the respondent generally feels. Items include worrying about wearing clothes that make their body look too thin or too large, feeling apprehensive about their physique around others, and being bothered by thoughts that other people are negatively evaluating weight or muscle development. Greater BMI is associated with higher scores on the SPAS among samples of adolescent athletes (Kosmidou, Giannitsopoulou, & Moysidou, 2017; McAuley & Burman, 1993), adolescent non-athletes (Hagger et al., 2007; Sicilia, Sáenz-Alvarez, González-Cutre, & Ferriz, 2014), and adults (Ersöz, 2016; Hausenblas & Fallon, 2002; Titchener & Wong, 2015). Social physique anxiety has predominantly been used in the kinesiology, exercise science, and eating disorder literatures, but may be especially useful in elucidating the relation between weight and anxiety as well as other psychosocial outcomes. Reports of peer

victimization were associated with greater social physique anxiety among a sample of 10-16 year old youths with BMIs at or greater than the 85th percentile (Storch et al., 2007). This suggests that, somewhat differently from described above, peer victimization may not need to be weight-based to be associated with social anxiety specifically related to physique. However, it is unknown if the victimization endorsed by participants in this study was or was not weight-based, although victimization was also associated with avoidance of areas that are likely common places that weight-based teasing may be experienced, such as the locker room or cafeteria. This suggests that the assessment of both general and weight-based victimization would allow for more specific conclusions about how greater weight may be associated with social anxiety in adolescence. In addition to assessment tools, the biological changes that typically occur during the transition from childhood to adolescence may be an additional factor that impacts the association between BMI and withdrawal and BMI and social anxiety.

The Impact of Physical Development

Greater BMI was conceptualized as a risk factor for later withdrawal and social anxiety because of the social and cognitive development that occurs in adolescence. Peer opinion and approval is increasingly important as young people develop the capacity to consider how others perceive them and use that information to form their individual identity. However, the physical changes that accompany adolescent development can also impact BMI and impact the social experiences of teens. During the transition to adolescence, children may lose or gain weight relative to their height such that they achieve a BMI that is noticeably different to peers. These changes may arise as the result

of puberty or from behavioral changes and can influence how an adolescent is treated by their peers. It has been shown that approximately 20-90% of the variance in body weight in a population is attributable to genetics, with twin studies showing greater heritability than family studies (Maes, Neale, & Eaves, 1997; Elks et al., 2012). There is a dearth of research examining the typical trajectories of BMI across adolescence, with the majority of studies focusing on BMI across childhood only or from adolescence to adulthood. Additionally, there is evidence to suggest that BMI stabilizes somewhat early in life, with one large study finding that infants show stability in BMI beginning at 24 months (Bradley, Houra, Nader, O'Brien, Belsky, & Crosnoe, 2008). This indicates that for many children, their weight trajectory is established prior to the start of formal schooling, thus making BMI a somewhat consistent risk factor for socioemotional challenges across childhood and adolescence. This coincides with the strong correlations among BMI at ages 10, 15, and 17 in this sample.

Further, some longitudinal work has not found a trajectory with increasing BMI or significant changes to BMI from childhood. A 4-trajectory model was found to be the best fit for both boys and girls who were initially assessed at ages 8-12 and followed annually for 3 years (Brault et al., 2015), including decreasing-thin, normal-low decreasing, normal-high decreasing, and steady overweight trajectories for boys and normal-low quadratic, decreasing-normal, steady-overweight, and persistent-obese for girls. By 10 years old, about 12% of boys and 30% of girls were overweight or obese and changes in BMI were not observed for the remainder of the study. However, despite findings of early stability of BMI, some youth will move from one weight class to

another during childhood or during the transition from adolescence to adulthood, as investigations of BMI trajectories have typically found three to six different classes. Results commonly include a class that increases over time in addition to a class that shows stability for average weight and/or for overweight or obese children and adolescents (Nonnemaker, Morgan-Lopez, Pais, & Finkelstein, 2009; Pryor et al., 2011; Lane, Blueston, & Burke, 2012; Chen & Brogan, 2012; Barraclough, et al., 2019). Among a sample of White girls whose BMI percentile was assessed every other year from age 5 to age 15, 20% fell in a quadratic weight trajectory that increased until age 9 and then decreased slightly through age 15 (Ventura, Loken, & Birch, 2012). Of the 15% of girls evidencing accelerated weight gain from 5 to 9 years old, 58% were classified as having average BMI at age 15 with the remaining girls being classified as obese. Among children assessed annually from age 2 to age 14, three weight gain classes were found, including a "Late Rising" group that comprised 32% of the sample and showed gains in BMI beginning at age 5 with an average BMI of 25 at age 14 (Barraclough et al., 2019). This suggests that for many of these children, overall BMI remained average in mid-adolescence despite BMI increases across childhood.

Taken together, it is reasonable to assume that some children will undergo a change in their BMI as they move through adolescence that is large enough to impact how they appear to others. The present study drew from a community sample and thus used a continuous BMI variable, in order to determine if increases in BMI are relevant to socioemotional outcomes, rather than strict membership to an overweight or obese weight category. In order to adequately consider typical development and how BMI impacts

socioemotional outcomes, future work should include a BMI change score across time points from childhood to adolescence or should utilize a time-varying covariate. When considering the implications of BMI and peer experiences in childhood on withdrawal in adolescence, it is relevant to consider potential changes in BMI that occur across this developmental period and future work should include a BMI change score across time points or utilize a time-varying covariate. An important consideration in understanding the lack of a significant indirect effect overall as well as the limited effect of BMI on withdrawn behavior is the role of puberty. Pubertal development and the resulting physical changes impact the reception that children receive from their peers, leading to different levels of risk for later withdrawal and anxiety, and also render BMI less meaningful without other measurements of body composition.

Puberty. Among the children in this study, development that occurs between the assessed time periods of 10 and 15 years old likely resulted in physical changes for almost all the girls and for many of the boys, potentially leading to different social and emotional outcomes. Historically, puberty was considered on time if secondary sexual characteristics were developed around age 12 or 13, but recent research work indicates that children are reaching puberty earlier. Fat mass increases in both boys and girls during the course of development, but percent fat mass increases in girls during puberty while it decreases in boys, as FFM, such as muscle mass, increases in males (Chung, 2015). Puberty leads to changes in body composition, such that fat distributions change in girls as secondary characteristics develop. Boys develop increased muscle and decreased percentage of body fat. Additionally, girls may experience a growth spurt that could

make them feel uncomfortable or self-conscious around others. Notably, being overweight or obese is a promoting factor in the development of "precocious puberty", or puberty that onsets much earlier than is typical, and therefore, puberty is important to consider in the relation between social anxiety and obesity (de sausmarez & Dunsmuir, 2011). Early pubertal status among both girls and boys has been associated with symptoms of depression and anxiety, although it has been better researched in girls (La Greca & Ranta, 2015). Among a sample of 9 to 11 year old children, the achievement of Tanner Stage II at age 9 was associated with greater levels of social anxiety among 11 year old girls but not boys (Deardorff et al., 2007). This same effect was found among slightly older girls as well, from ages 12 to 17. Other research has found this effect for boys, and still other work found an effect for late-onset puberty on the development of social anxiety in adolescence, suggesting that the role of puberty in the development of social anxiety is somewhat uncertain at this time (La Greca & Ranta, 2015).

The measurement used to assess body composition among adolescents is relevant in understanding the role of BMI in the development of anxiety. An adolescent girl who has achieved puberty could potentially fit in the overweight category according to accepted BMI ranges, but she could also have an average waist circumference, indicating the presence of a body composition that appears average to peers. This child may be less likely to experience weight-based victimization and withdrawal. Using only BMI to categorize this child would not convey the body composition of the child and therefore, would not appropriately describe this experience. When using BMI, individuals who have greater muscle mass, such as is observed in athletes, may have a similar BMI to those

who have less muscle mass but greater body fat percentage (Chung, 2015), and this could impact the statistical association between BMI and withdrawal. Gender norms and social desirability further impact this association. For example, teenage boys with higher BMIs (sometimes regardless of percent muscle mass) may be more likely to engage in contact sports such as hockey or football. For boys, participation in sports and membership to an athletic community may be protective against withdrawal and social anxiety. In the present study, BMI was associated with withdrawal only among boys. From age 10 to age 15, many boys will not have completed pubertal development, and their BMI may reflect fat mass more accurately than it would for girls, who will have likely completed pubertal development by age 15. Girls with greater BMI at age 10 may undergo puberty that impacts waist and hip circumference, influencing the association between BMI and withdrawal during this time period. Further, BMI and body composition may be more relevant in understanding maladaptive social outcomes for boys when assessed later in the teenage years, when puberty is expected to be complete.

The association between BMI and withdrawal for boys from ages 10 to 15 in this study may indicate increased avoidance from others due to greater physical deviations than expected by peers. As social stress was not associated with withdrawal, it is also possible that boys with higher BMIs may prefer solitary activities or may appear withdrawn to their mothers despite using technology at home to interact with peers. Ultimately, future research should account for puberty by including measurements of body composition such as waist circumference, Tanner stages of development, and hip

circumference, with greater emphasis placed on these measurements during the pre-teen and early teenage years for girls and during the mid to late teenage years for boys.

Direct Effects in Post Hoc Analyses

Children with greater weight have been shown to have increased risk for the development of various internalizing symptoms including loneliness, peer victimization, depression, general anxiety, and social anxiety (Eidsdottir, Kristjansson, Sigfusdottir, Garber, & Allegrante, 2014; Oddy et al., 2018; Puhl & Latner, 2007; Puhl & Luedicke, 2012; Witherspoon et al., 2013). Therefore, additional analyses beyond what was originally hypothesized were conducted to examine whether different internalizing outcomes at age 17 are predicted by greater weight at age 10. Broad anxiety, assessed through the total anxiety score on the MASC, includes symptoms of social anxiety, separation anxiety, specific phobias, panic, and generalized anxiety. Past research has found that generalized measures of anxiety have been specifically associated with greater weight in adults, and this additional analysis sought to determine if greater weight was associated with increased anxiety across subtypes of symptoms. BMI at age 10 was not significantly associated with total anxiety at 17 years old. Although withdrawal at 15 was associated with total anxiety at 17 among girls, this association was not found for boys.

Depression as an outcome. Depression was examined as a different potential outcome in adolescence as a result of greater BMI in childhood. Overweight and obese BMIs in children and adolescence have been linked to later symptoms of depression in adolescence and adulthood (Ames et al., 2015; Chang & Halgunseth, 2015; Lanza et al., 2013; Yang & Li, 2016). In the current study, greater BMI at age 10 was associated with

greater depression at age 17, which is consistent with the literature. Sex was not significantly associated with this pathway, which is somewhat consistent with existing literature, as some studies have found that BMI is associated with depressive symptoms among boys and girls while other studies have found this effect with girls only.

The differential finding that greater BMI is predictive of depressive symptoms but not of greater social anxiety symptoms is surprising, given the significant overlap in comorbidity between the two syndromes in adolescents and adults (Ehrenreich, Goldstein, Wright, & Barlow, 2009). One explanation may be that while a person with social anxiety experiences future-oriented, anticipatory fear about social failure and subsequent rejection (Wong et al., 2014), the experience of depressive symptoms may belie a stable, internal negative belief about the self that precludes fear because of a sense of hopelessness or helplessness (Abela, 2001). These characteristics are part of the theory of learned helplessness in depression (Abramson, Seligman, & Teasdale, 1978), and adolescents who had overweight or obese BMIs in childhood potentially had negative weight-based experiences with peers or parents that contributed to feelings of sadness and lower sense of self-worth that, over time, resulted in low expectations for improvement.

Similar to the literature reviewed which found that weight-based stigmatization explained the association between BMI and social anxiety (Juvonen et al., 2017), the perception of weight based stigmatization predicted greater symptoms of depression among a sample of adults, and this association was mediated by avoidant coping behaviors (Spahlholz, Pabst, Riedel-Heller, & Luck-Sikorski, 2016) Additionally, body satisfaction has been found to fully mediate the relation between BMI and depression

among a sample of 11-17 year old girls (Eidsdottir et al., 2014). Taken together, the link between greater BMI and depressive symptoms may reflect increasing stability of sad feelings or decreased self-esteem within the context of weight-based stigma and social experiences, which is similar to the possible explanation for why an indirect effect between BMI and social anxiety was not found in the present study.

Indirect and Conditional Indirect Effect Models from BMI to Social Anxiety

Contrary to expectations, the hypotheses for the indirect and conditional indirect effects model were non-significant. Results initially indicated that BMI at age 10 was associated with social anxiety at age 17 through the pathway assessing withdrawal at age 15. However, the significant association of sex with social anxiety prompted further investigation, and multi group analysis indicated that higher BMI in childhood is predictive of greater withdrawn behavior at age 15 for boys, this effect was not found for boys. Further, girls with higher levels of withdrawal at age 15 were more socially anxious at age 17, but this was not true for boys. Therefore, the indirect effect was washed out by sex differences. This differing pattern of findings remained when considering two subtypes of social anxiety: performance anxiety and fear of being rejected/humiliated, such that withdrawal was a risk for factor for girls for both types of social anxiety, but withdrawn boys continued to lack an association with social anxiety. A significant association between withdrawal and social anxiety is consistent with the literature, as less frequent interaction with others exacerbates the perceived risks of engaging socially later. Further, girls who are withdrawn may have smaller social networks, and different social environments could be unfamiliar to these adolescents, thus making the navigation of

social interaction intimidating. During social interaction, withdrawn adolescents may experience increased self-focus on their actions, thoughts, and appearance to others, questioning of they are meeting the social expectations of the peer due to lack of experience. These teens may perceive that they appeared awkward or embarrassing, potentially because of unrealistic standards they set for their own performance, or because of somewhat less developed social skills associated with withdrawal. It is thought that this process is so stressful that it eventually exacerbates avoidance behavior, which further exacerbates fear of social situations. However, this does not explain why the pathway was significant for girls but not for boys and examining gender roles may provide some insight.

Girls are socialized to place higher value on interpersonal relationships that boys. Self-construal theory states that while women define themselves in relation to their dyadic relationships with others, men place greater emphasis on "collectivism", such that they place greater emphasis on group membership (Cross, Hardin, & Gercek-Swing, 2011; Rudolph, 2002a). Girls who are withdrawn often have fewer friends than their non-withdrawn peers because of more limited social circles. Awareness of small social circles could be particularly distressing considering the importance placed on friendships in maintenance of identity. Further, identity formation is a hallmark of the adolescent developmental period, and withdrawal among girls may limit the manner in which girls search for and establish identity because of fewer intimate friendships. It is known that while withdrawn children have best friends, the friendships are more superficial and include less personal disclosure (Coplan et al., 2001), which would prohibit the

experience of deepening relationships during adolescence and learning how to relate to others in nuanced ways. This may result in greater insecurity around peers, leading to increased social anxiety. With regards to the nonsignificant pathway for boys from withdrawal to social anxiety, children have increased opportunities for varying their social networks as they enter into adolescence, as part-time jobs, classes with different children, sports, and other clubs become available. One possibility is that while boys who carry extra weight are more likely to become withdrawn, they may find that they are sought-after in mid adolescence for participation in sports teams or may find ways to feel they belong to a group through other means, such as video games or online communities. Virtual interaction in particular may be less intuitive for mothers who grew up prior to social media, and thus may rate their sons as higher on withdrawn behavior than is accurate. Taken together, this may provide one explanation for why greater withdrawal in boys in this sample is not associated with later social anxiety.

Unexpectedly, higher BMI in boys at age 10 predicted social withdrawal at age 15 but this pathway was not significant for girls. Greater social stress at age 10 was positively correlated with withdrawal at age 15 for girls (r= .206) but not for boys. Some work has indicated that when girls experience emotional distress, they are more likely to seek connection with others (Rudolph, 2002). These girls might seek support from one or two close friends but not expand their social network, ultimately leading to withdrawal. Differently, boys with higher BMIs may become more withdrawn and not seek support from others. These different coping styles would explain the different pattern of findings for girls and boys, as the underlying assumption for why higher BMI could lead to

increased withdrawal is the negative impact of weight-based stigmatization on social functioning.

Although unexpected, the lack of an indirect effect of withdrawal on weight and anxiety is somewhat consistent with previous literature, which did not find that disengaged and avoidant coping strategies mediated the effect between perceived social stress and anxiety/depression (Sontag & Graber, 2010). An additional unexpected finding was that social stress was not associated with withdrawal or with BMI for boys. According to Lazarus (1999), stress occurs when a person perceives than a particular situation is dangerous in some way or will require the use of too many emotional or cognitive resources. The BASC-2 Social Stress scale was validated with the assumption that is accurately assessed stress in the respondent's interpersonal relationships and thus, that the events endorsed are considered stressful to the child. Most of the items include phrasing like "I am bothered by" or "I am left out" which implies that the items describe problematic behavior. However, a child may report that other kids "say bad things to them" or "Act like they can't hear me" and may not find these events upsetting or stressful. Further, even the more overtly distressing items may occur sometimes but may elicit only mild distress. A better way to asses may be to use a tool like the Responses to Stress Questionnaire (RSQ); (Connor-Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000), which asks if the child has experienced social experiences similar to those on the BASC Social Stress scale (feeling left out, being teased, etc.) and then asks how stressful that event was for them. This would allow for more clarity in drawing conclusions not only about how well the child perceived they are liked by others, but also

how important it is to that child. Future research should also inquire about all possible sources of peers, as a child who endorses high social stress when thinking about classmates at school may report low stress when thinking about their cousins or teammates.

Summary, Limitations, and Additional Future Directions

Measurement of withdrawal. One notable limitation of this paper is the overall very low endorsement of withdrawn behaviors. The small range of behaviors made it challenging to detect the presence of significant associations with greater strength. It was initially thought that withdrawn behavior may not be developmentally appropriate to assess in adolescence, however, the withdrawn/depressed scale at age 10 also had very small range (mean score=1.186, SD= 1.75). Trajectories of withdrawal across childhood and adolescence have found evidence for increasing shy behavior from adolescence (ages 12-16 years old) through adulthood (Tang et al., 2017), and that members of this trajectory were at the highest risk for later social anxiety, as compared to a stable low and decreasing shy trajectories. This particular study used 3 items from the Withdrawn/depressed scale on the parent reported CBCL, combined with a different measure of shyness. Despite this small range of raw scores, corresponding T scores spanned the range from typical to clinical levels of behavior, with the average raw score corresponding to a T score of 54.9. This indicates that although withdrawal can increase over adolescence, even low levels of withdrawn behavior are considered developmentally atypical.

Withdrawal is a behavioral construct, and is typically assessed without consideration for the child's underlying feelings about social interaction. However, when trying to determine if a child is withdrawn, rejected, or both, the child's perspective is important when drawing conclusions. Although some literature on withdrawal has been able to utilize teacher report, and somewhat less frequently, peer nominations, additional work should be conducted considering the target's behavior and feelings about social interaction. This is particularly relevant when assessing withdrawal, because although the construct is defined by observed behaviors, by the adolescent period, it is challenging to parse apart the underlying emotional drive, and mothers may be more likely to accurately assess their teen's motivations for certain behaviors, as compared to teachers, based on the longevity of the relationship. Mothers are best equipped to understand underlying intentions of their children. However, limits to parent report include the fact that by adolescence, parents are not around for the majority of their child's social interactions. Further, responses may be skewed based on mother's own own biases. Overcontrolled parenting associated with fearfulness and withdrawn behavior in children. If parents are anxious themselves, then their mean viewpoint of what withdrawal looks like could be biased, and they may report lower scores. Parents have been found to report greater avoidance behaviors than their children have self-reported. Further, withdrawn behavior is often considered an indicator of depressed mood. By including symptoms of depression in the assessment of withdrawal, typical developmental expectations in adolescence for the relation between sadness and decreased engagement are taken into account. Overall, future research may address this limitation by including a factor score

of withdrawn behavior that considers both parent and peer report of withdrawal from others. This would minimize parental bias, provide some objective data in the peer environment, where withdrawal is most likely to impact functioning, and remain true to the idea that withdrawal is a behavioral construct.

Measurement of social anxiety. Future research should examine appearance-based social anxiety as an outcome in order to consider the nuances of the ways in which BMI, weight-based stigmatization, and anxiety are related. In some ways, the results of this project may indicate reason for optimism. The lack of findings on obesity predicting social anxiety across time and on obesity being significantly associated with social anxiety cross-sectionally suggest that this stigmatized characteristic is not impacting adolescents' ability to interact with others without fear.

Weight-based stigmatization. Weight-based stigma may present in subtle ways from peers and teachers, such as being a less preferred partner in class projects or being less likely to be called on during class, and some children may not draw the conclusion that the differential treatment could be related to weight. In numerous samples of participants ranging in ages from 4 to 11 years old, children assigned more negative attributes, including lazy, selfish, stupid, and more likely to lie, to children with extra weight using both checklists and observational tasks (Puhl & Latner). However, a subset of children aged 6-10 years old underestimate their weight across 6, 8, and 10 years old (Steinsbekk et al., 2017), suggesting that while children broadly hold less positive views of peers with extra weight, some children may not place themselves in this category. This is consistent with the positivity bias observed during childhood, in which children are

more likely to make positive attributions about themselves and other, although it is expected that this bias is somewhat attenuated by age 10 (Boseovski, 2010) This may partially explain lack of association with weight and social stress at age 10. Ultimately, future research should include an assessment of weight-based stigma across the home, school, and peer environments to have an objective understanding of how a young person's discrimination context increasing or buffers again risk.

The child's interpretation of their experiences plays a notable role across constructs considered in this project, from their reported experience of weight-based stigma to how much distress is caused by the behavior of peers. Similarly, perception of weight and size may play a greater role in the development of later withdrawal and social anxiety than an objective measurement of body composition. Among a large sample of adolescents aged 13 to 15 years old, 60% of teens who feel in the overweight or obese categories labeled themselves as "too heavy" and 39% of overweight or obese teens labeled themselves as "about the right weight" or "too thin" (Jackson, Johnson, Croker, & Wardle, 2015). Although the tendency to mislabel body size may not help adolescents make healthy eating or activity choices, it could function as protective against behavioral withdrawal and social anxiety. If a young person does not perceive themselves as overweight or obese, he or she may persist in interactions with others and continue to develop social competence, minimizing risk for social anxiety. One limitation of this study is that the participant's estimation of their size was not available to use as a covariate, and future research should investigate this as an importance aspect of how and why BMI might be associated with anxiety.

Overall, BMI was not found to be associated with social anxiety at age 17, nor was there an indirect effect of withdrawal explaining a relation between BMI and social anxiety. Social stress, hypothesized to moderate this indirect effect, was not found to be significantly related. While BMI predicted withdrawal in boys, it was not significant for girls. While withdrawal predicted social anxiety for girls, it was not significant for boys. Future research should further examine the gender differences that may exist in the etiology of social anxiety. Additionally, assessment of weight-based stigmatization in the child's environment as well as the child or adolescent's opinion of their weight status may be helpful in elucidating the relation between weight and social anxiety.

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APPENDIX A

TABLES AND FIGURES

Table 1. Descriptive Information for Study Variables.

Measure	**N**	**Mean**	**Min**	**Max**	**S.D.**	**Kurtosis**	**Skew**
BMI age 10	268	20.56	13	40	4.69	1.19	1.08
MASC Social Anxiety age 17	298	9.24	0	27	6.67	-.63	.57
CBCL Withdrawn/Depressed	300	2.03	0	16	2.57	3.90	1.78
BASC Social Stress	288	4.20	0	23	4.24	3.06	1.55
MASC Social Anxiety age 10	285	8.35	0	27	5.70	.06	.67

Table 2. Correlations Among Study Variables.

Variable	1	2	3	4	5
1. Age 10 BMI	--	.208**	.089	-.002	-.005
2. Age 15 Withdrawn		--	.164*	.044	.042
3. Age 17 Social Anxiety			--	.207**	.270***
4. Age 10 Social Stress				--	.562***
5. Age 10 Social Anxiety					--

* p < .05, ** p < .01, *** p<.001

Table 3. Correlations Among Study Variables at Each Age for Entire Sample.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Age 10 BMI	--	.745**	.731**	.146*	.161*	.131	.001	-.065	.043	.005	.050	.209**
2. Age 15 BMI		--	.904**	.142*	.151*	.113	.081	-.033	-.037	.097	.051	.095
3. Age 17 BMI			--	.101	.168*	.198*	.135	-.019	-.049	.209**	.096	.153*
4. Age 10 Withdrawal				--	.576**	.458**	.055	.138*	.211**	.086	.110	.156*
5. Age 15 Withdrawal					--	.755**	.046	.155**	.156*	.060	.183**	.169**
6. Age 17 Withdrawal						--	.163*	.306**	.246**	.118	.260**	.318**
7. Age 10 Social Anx							--	.380**	.246**	.565**	.285**	.253**
8. Age 15 Social Anx								--	.609**	.265**	.399**	.371**
9. Age 17 Social Anx									--	.175**	.298**	.525**
10. Age 10 Social Stress										--	.343**	.331**
11. Age 15 Social Stress											--	.617**
12. Age 17 Social Stress												--

* p < .05, ** p < .01, *** p<.001

Note. Correlations conducted in SPSS with manifest variables. No sig differences between MPlus and SPSS correlations.

Table 4. Correlations Among Study Variables at Each Age: Boys.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Age 10 BMI	--	.814**	.819**	.121	.307**	.236*	.002	-.139	.084	-.036	.055	.303**
2. Age 15 BMI		--	.905**	.056	.140	.171	.011	-.053	-.062	.054	.009	.182
3. Age 17 BMI			--	.048	.194	.280**	.050	-.054	-.080	.111	.033	.225*
4. Age 10 Withdrawal				--	.646**	.452**	.149	.131	.230*	-.003	.110	.225*
5. Age 15 Withdrawal					--	.793**	.010	.102	.031	-.133	.170	.187
6. Age 17 Withdrawal						--	.121	.437**	.206*	-.201*	.331*	.360**
7. Age 10 Social Anx							--	.304**	.254*	.417**	.348**	.143
8. Age 15 Social Anx								--	.456**	-.057	.421**	.320**
9. Age 17 Social Anx									--	.034	.195*	.491**
10. Age 10 Social Stress										--	.247*	.179
11. Age 15 Social Stress											--	.567**
12. Age 17 Social Stress												--

* p < .05, ** p < .01, *** p<.001

Note. Correlations conducted in SPSS with manifest variables. No sig differences between MPlus and SPSS correlations.

Table 5. Correlations Among Study Variables at Each Age: Girls.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Age 10 BMI	--	.699**	.652**	.151	.033	.047	-.010	-.031	.011	.030	.046	.149
2. Age 15 BMI		--	.904**	.184*	.163	.078	.128	-.018	-.027	.127	.089	.040
3. Age 17 BMI			--	.133	.140	.133	.207*	-.001	-.029	.278**	.157	.095
4. Age 10 Withdrawal				--	.526**	.465**	-.025	.123	.173*	.125	.119	.110
5. Age 15 Withdrawal					--	.722**	.066	.200*	.567**	.206*	.199*	.153
6. Age 17 Withdrawal						--	.175*	.234*	.275**	.297**	.200*	.286**
7. Age 10 Social Anx							--	.372**	.252**	.645**	.259**	.325**
8. Age 15 Social Anx								--	.655**	.413**	.427**	.414**
9. Age 17 Social Anx									--	.227**	.377**	.563**
10. Age 10 Social Stress										--	.417**	.414**
11. Age 15 Social Stress											--	.660**
12. Age 17 Social Stress												--

* p < .05, ** p < .01, *** p<.001

Note. Correlations conducted in SPSS with manifest variables. No sig differences between MPlus and SPSS correlations.

Table 6. Unstandardized Model Estimates and 95% Bootstrap Confidence Intervals for Direct and Indirect Effects Model.

	Estimate	S.E.	Confidence Intervals	
			Lower	Upper
Direct Paths				
BMI 10→ Social Anxiety 17	.131	.130	-.114	.395
BMI 10→Withdrawn/Depressed 15	.146	.074	.016	.305
Withdrawn/Depressed 15→Social Anxiety 17	.373	.256	-.013	.962
Covariates				
Sex→ Social Anxiety 17	.247	.100	.060	.453
Race→ Social Anxiety 17	-.389	.105	-.594	-.179
Social Anxiety 10→ Social Anxiety 17	.373	.096	.176	.556
Indirect Paths				
BMI→Withdrawal→Social Anxiety	.054	1.010	.002	.183

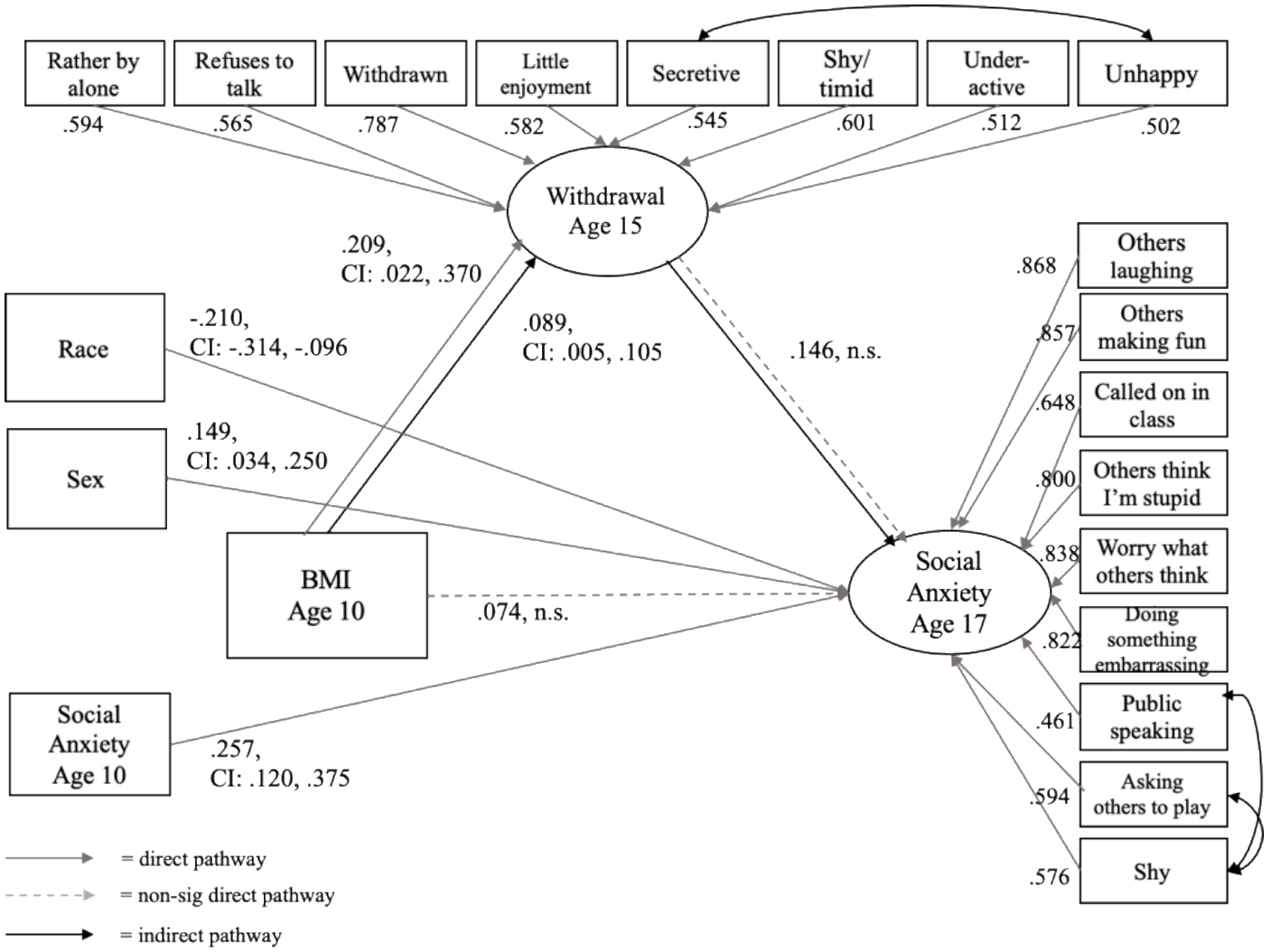

Figure 1. Indirect and Direct Effects Model: Standardized Estimates and 95% Confidence Intervals.

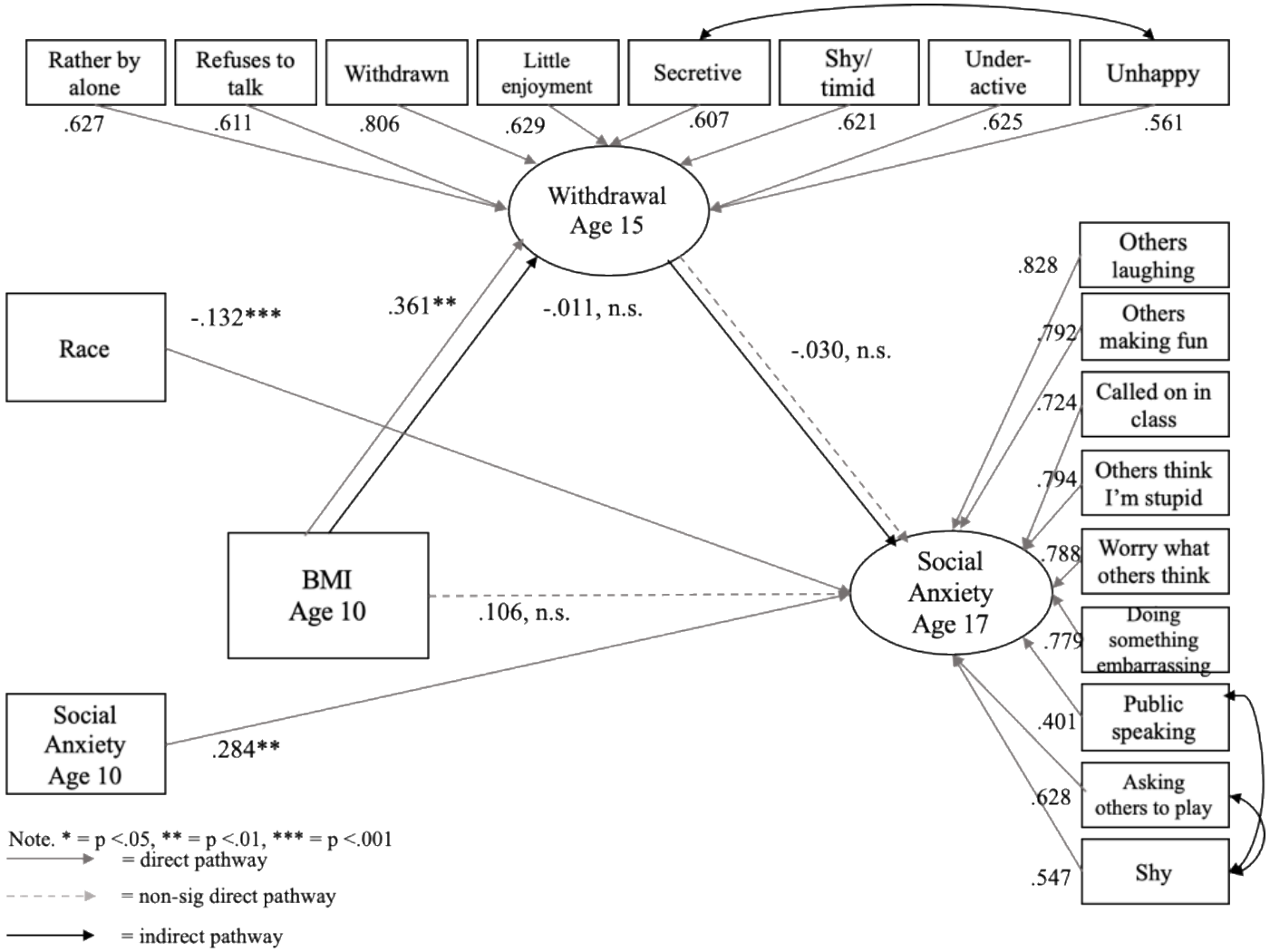

Figure 2. Direct and Indirect Effects Model for Boys: Standardized Estimates and *p* Values.

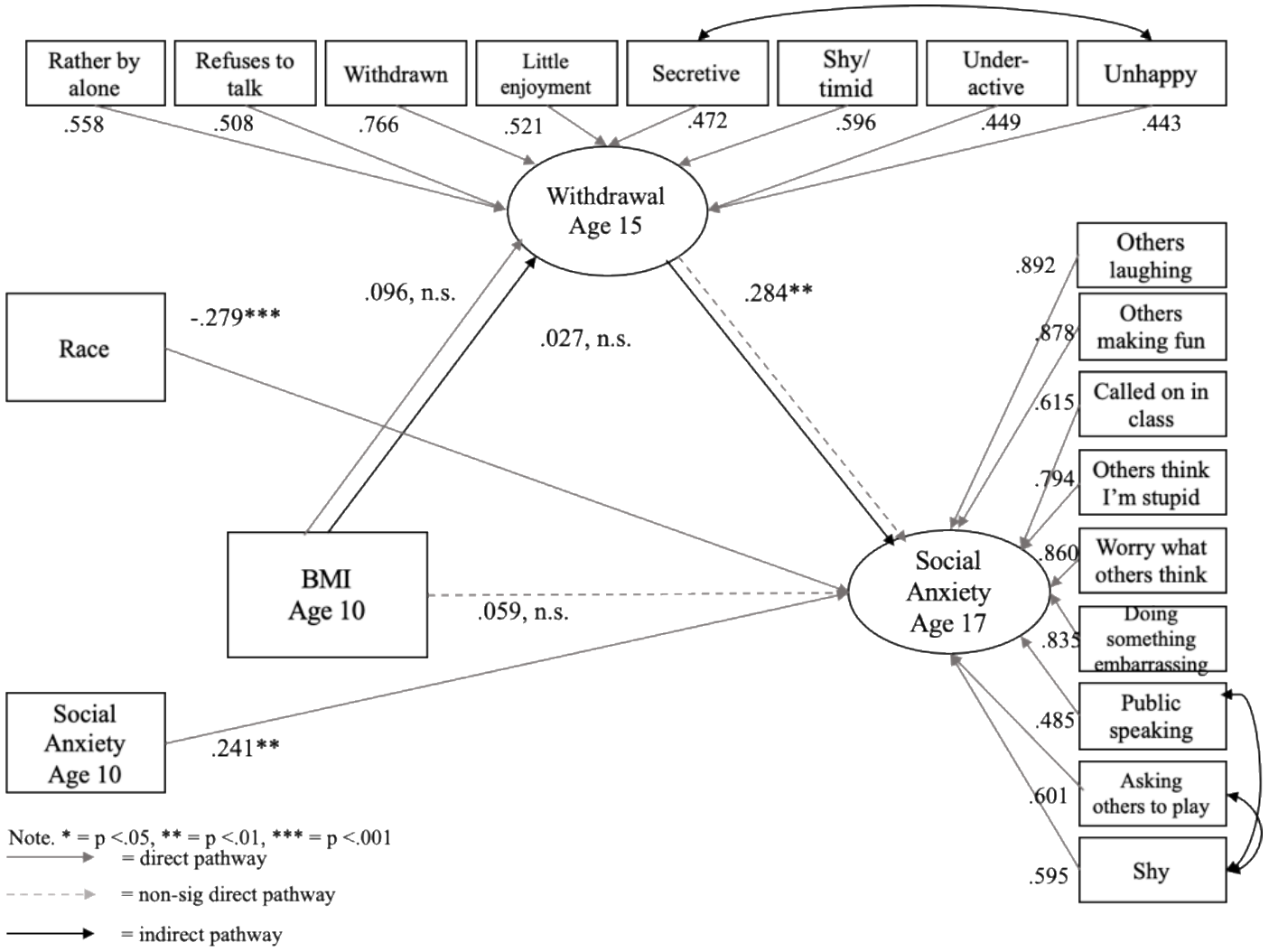

Figure 3. Direct and Indirect Effects Model for Girls: Standardized Estimates and *p* Values.

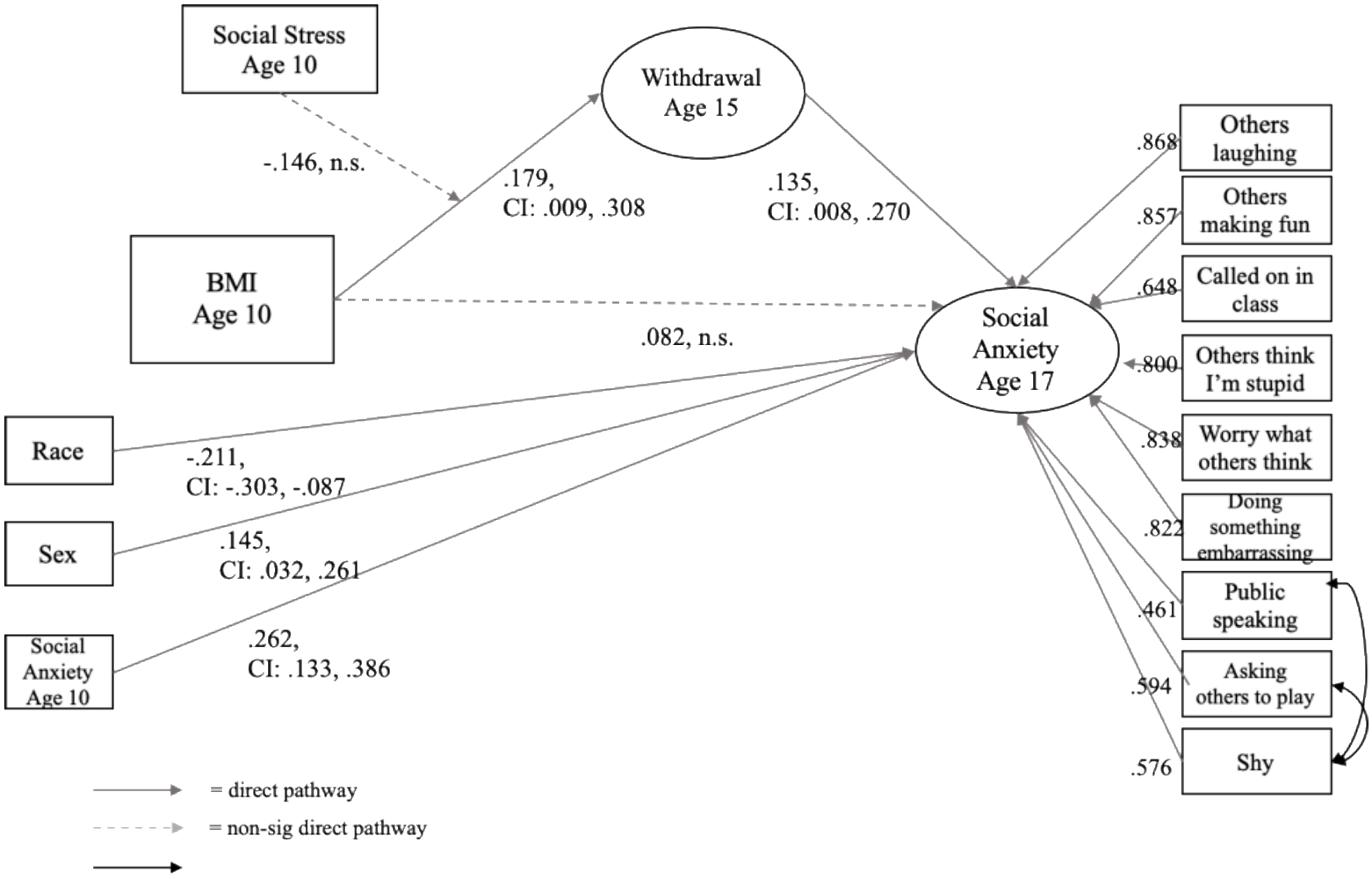

Figure 4. Conditional Indirect Effects Model: Standardized Estimates and 95% Confidence Intervals.

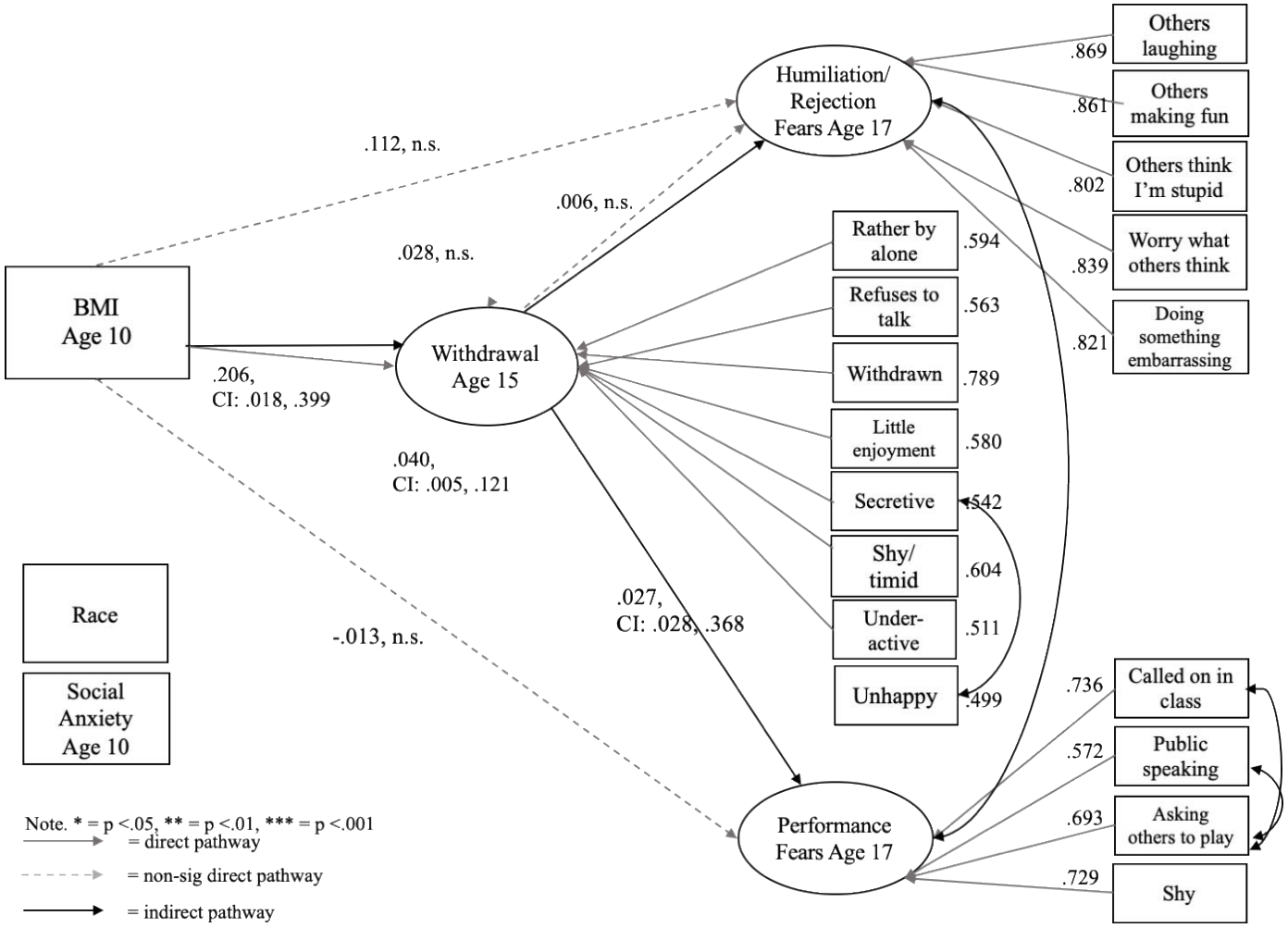

Figure 5. Indirect and Direct Effects Model Using Two Social Anxiety Outcomes: Stand. Estimates and 95% Confidence Intervals.

APPENDIX B

BEHAVIOR ASSESSMENT SYSTEM FOR CHILDREN-2, SELF REPORT FORM, CHILD (BASC-2-SRP-C)
SOCIAL STRESS SUBSCALE

My friends have more fun than I do.	N S O A
I am bothered by teasing from others.	N S O A
I am left out of things.	N S O A
I am lonely.	N S O A
I feel out of place around people.	N S O A
Other people find things wrong with me.	N S O A
People act as if they don't hear me.	N S O A
People say bad things to me.	N S O A

APPENDIX C

CHILD BEHAVIOR CHECKLIST FOR AGES 6-18, PARENT REPORT FORM, WITHDRAWN/DEPRESSED SUBSCALE

There is very little he/she enjoys.	0 1 2
Secretive, keeps things to self.	0 1 2
Too shy or timid.	0 1 2
Would rather be alone than with others.	0 1 2
Refuses to talk.	0 1 2
Underactive, slow moving, or lacks energy.	0 1 2
Unhappy, sad, or depressed.	0 1 2
Withdrawn, doesn't get involved with others.	0 1 2

APPENDIX D

MULTIDIMENSIONAL ANXIETY SCALE FOR CHILDREN (MASC)
SOCIAL ANXIETY SCALE

HUMILIATION FEARS SUBSCALE

I'm afraid other people will think I'm stupid.	0	1	2	3
I worry about what other people think of me.	0	1	2	3
I worry about doing something stupid or embarrassing.	0	1	2	3
I worry about other people laughing at me.	0	1	2	3
I'm afraid that other kids will make fun of me.	0	1	2	3

PERFORMANCE FEARS SUBSCALE

I get nervous if I have to perform in public.	0	1	2	3
I have trouble asking other kids to play with me.	0	1	2	3
I feel shy.	0	1	2	3
I worry about getting called on in class.	0	1	2	3