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Historically, aggression has received much attention in the field of psychology, because of the immediate consequences and long-lasting implications of aggressive behavior for both the victim (e.g. Card, 2003) and the perpetrator (e.g. Coie & Dodge, 1988). However, research that has examined the predictors of aggression often has focused on a single form of aggression: either physical or relational aggression (e.g. Spieker et al., 2012). The present study examined a model of both physical and relational aggression in order to determine whether similar processes in middle childhood predict both forms of aggression in preadolescence. Since several theories highlight the role of children's individual abilities in preadolescent aggression, we considered whether socio-cognitive (Dodge, 1986), physiological (Calkins & Keane, 2004), and behavioral (Zelazo & Cunningham, 2007) factors in middle childhood were predictors of physical and relational aggression in preadolescence.

Using behavioral, self-reported, and sociometric nomination indicators the relations among hostile attribution bias, physiological regulation, executive functioning, and physical and relational aggression were examined in a longitudinal community-based sample of children aged 7 and 10. Specifically, the study used multivariate multiple regressions to examine the role of children's hostile attribution bias, respiratory sinus arrhythmia withdrawal, and executive functioning abilities as predictors of peer nominated physical and relational aggression in preadolescence. First, predictors of

physical aggression were examined. Results demonstrated that children who had poorer executive functioning scores at age 7, received significantly more peer nominations of physical aggression at age 10. However, children's hostile attribution bias, RSA withdrawal, and the two-way and three-way interactions of these focal variables at age 7 did not predict children's use of peer nominated physical aggression at age 10.

In contrast to the findings on physical aggression, the interaction of children's hostile attribution bias and their executive functioning abilities predicted their peer nominated use of relational aggression. Children who had better executive functioning scores at age 7 received significantly more relational aggression nominations at age 10 when their hostile attribution bias was increased. Perhaps, children who have better emotional problem solving skills are able to reassess and reframe their negative emotions and successfully plan more deliberate and covert relational aggression as a response to perceived threats. However, children's physiological regulation at age 7 did not predict their use of relational aggression at age 10. Children who may have developed more advanced regulatory skills used more peer nominated relational aggression because they did not need to rely on their basic emotional control abilities in order to cope with their emotional challenges. The current study adds to our understanding of the individual processes that contribute to the use of both physical and relational aggression in preadolescence.

SOCIO-COGNITIVE, PHYSIOLOGICAL, AND BEHAVIORAL PREDICTORS OF PREADOLESCENT PHYSICAL AND RELATIONAL AGGRESSION

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Childhood and preadolescent patterns of aggression predict concurrent and subsequent maladjustment that extends to adult functioning (Crick, 1996; Cleverley, Szatmari, Vaillancourt, & Boyle, 2012). Therefore, it is important to identify the early factors that might contribute to children's use of aggression. However, aggression research has historically focused on the developmental course and correlates of the physical form of aggression. Although this focus derives from the high costs of physical aggression to society (Foster & Jones, 2005), families (Monographs of Research, 2004), and individuals (Tremblay, Masse, Pagani, & Vitaro, 1996), this work fails to address the relational form of aggression. Like children who engage in physical aggression, children who engage in relational aggression also have an increased risk of socioemotional, health, and behavioral consequences (e.g. Crick, Ostrov, & Werner, 2006; Ostrov & Godleski, 2013; Williams, Fredland, Han, Campbell, & Kub, 2009; Herrenkohl, Catalano, Hemphill, & Toumbourou, 2009).

It is important to understand what might predict children's use of both physical and relational aggression in a single model, because the study of only one form of aggression is not likely to capture children's unique manifestations of aggression over time. Although some children may use both physical and relational aggression, they may vary when they use each form of aggression. There is evidence that children who use

physical aggression in early childhood are more likely to use relational aggression in later childhood (Côté, Vaillancourt, Barker, Nagin, & Tremblay, 2007). This could be interpreted that children have a single underlying trait of aggression, which they manifest in different ways over time.

Children's distinct behavioral manifestations of aggression (i.e. hitting versus gossiping) as captured by the separate aggressive forms (physical versus relational) might reflect children's developing cognitive, emotional, and social abilities. Children often use physical aggression in early childhood simply as a hasty, instantaneous, and overt behavioral response (Bandura, 1978). In contrast, children often use relational aggression in preadolescence as a deliberate, delayed, and covert behavioral response (Xie et al., 2005). Children's increased abilities to engage in more complex behaviors might be one explanation for the unique manifestations of children's aggression. As children develop more advanced social, emotional, and behavioral skills, they may use less overt physical aggression and more covert relational aggression. Since there is individual variation in the development of these skills (e.g. Calkins & Howse, 2004), those children who have more immature social, emotional, and behavioral skills might continue to use physical aggression.

The heterotypic continuity of aggression hypothesis (Björkqvist, Lagerspetz, & Kaukiainen, 1992; Björkqvist, Osterman, & Kaukiainen, 1992; Lagerspetz, Björkqvist, & Peltonen, 1988) postulates that the development of children's social, cognitive, biological, emotional, and behavioral skills will result in the use of a more sophisticated form of aggression over time by children who are predisposed to display aggression. For

example, younger children express aggression by kicking or hitting, because they have not yet developed other ways (i.e. verbal skills) to express themselves. Subsequently, older children should have developed more advanced abilities, such as inhibitory control, which allow them to regulate their physically aggressive behaviors and express their aggression verbally or relationally. Thus, among those children predisposed to behave aggressively, the development of advanced social, cognitive, biological, emotional, and behavioral skills might contribute to children's increased use of relational aggression in preadolescence. Among those children predisposed to behave aggressively, those children who do not develop these advanced social, cognitive, biological, emotional, and behavioral skills might be at an increased risk for continuing to use more physically explicit forms of aggression. This suggests that for those children who are predisposed to display aggression, factors that decrease their use of physical aggression might increase their use of relational aggression and vice versa.

The social learning model of aggression might also explain why children might use different forms of aggression over time. Bandura's model of aggression (1978) suggests that children who are predisposed to behave aggressively can learn to use specific forms of aggression from parents and peers, both directly and indirectly. Over time, parents and peers might discourage children from using direct overt physical aggression and encourage children to use more indirect covert relational aggression. Children also learn to use particular aggressive techniques because of the patterns of reinforcement available in their environments. Children who use one form of aggression might be reinforced by the reduction of negative emotions or the achievement of a goal;

however, these patterns of reinforcement might change over time, and children's use of one form of aggression may no longer have the same result. For example, a younger child might hit a peer in order to get a toy, and if the child gets the toy this might encourage him or her to continue to hit others. However, an older child who punches a peer might be punished by a teacher and lose friends. Children might learn to adapt their behaviors and become more covert in the expression of their aggression in order to continue to gain positive reinforcement and avoid punishment. For example, if a child covertly excludes a peer, he or she might gain more social power, reduce his or her negative emotions, and avoid punishment. Therefore, children who are taught to be aggressive might learn to use less physical aggression over time, because it earns less positive reinforcement and more punishment. In contrast, children might learn to use more relational aggression over time, because it earns more positive reinforcement and less punishment.

Both the heterotypic continuity model of aggression and the social learning model of aggression have been supported by some previous research. Longitudinal person-centered research has demonstrated that children who display physical aggression in early childhood also display more relational aggression in early adolescence (Côté et al., 2007; Miller, Vaillancourt, & Boyle, 2009); and concurrent research demonstrates that children with more advanced social skills are more likely to use more relational aggression (Björkqvist et al., 1992). Other research has demonstrated an impact of learning: children who are victimized by their peers learn to fight back in kindergarten (Kochenderfer & Ladd, 1997). However, the current literature has not yet identified how children's individual abilities differentially relate to their use of both forms of aggression over time.

A model that includes both relational and physical aggression might permit a more comprehensive examination of children's use of aggression.

A model that predicts children's use of both physical and relational aggression should be focused on the preadolescent period of development. Although young children and adults use aggression (Moffitt, 1993), the study of preadolescent aggression might be particularly significant, because it has been reported that some preadolescents exhibit significantly more aggression than children (Côté et al., 2007). Middle childhood into preadolescence is a critical period of aggression use, because this is when some children shift from the predominant use of physical aggression to the greater use of relational aggression (Ojanen & Kiefer, 2013). It is also important to study preadolescent aggression because during this period peer relationships also become increasingly significant to children (Laird, Jordan, Dodge, Pettit, & Bates, 2001; Wray-Lake, Crouter, & McHale, 2010). Peer relationships are affected by children's use of aggression (e.g. Cillessen & Mayeux, 2004). Because of children's divergent use of the forms of aggression and the importance of peer relationships during this period of development, it is important to identify those factors in middle childhood that might predict preadolescent aggression.

Early aggression theories and research have primarily focused on how external influences, such as low socioeconomic status and coercive parenting, affect children's use of aggression (Tremblay et al., 2004). This focus on external factors was based on the assumption that early in development children are a "tabula rasa" or blank slate. Most early aggression models were led by the assumption that children's behaviors are shaped

by others around them; thus, parents and peers were thought to directly and indirectly teach children to be aggressive. Although research has shown that parents and peers can influence children's behavior (e.g. Tremblay et al., 2004; Low, Polanin, & Espelage, 2013), over the course of childhood other processes also might affect preadolescents' use of aggression.

In contrast to the notion that extrinsic factors affect children's early use of aggression, in preadolescence children's individual abilities also might affect their use of aggression. In preadolescence, children become more independent from parents (Steinberg & Silverberg, 1986) and develop increased self-control (Calkins & Howse, 2004). Children's ability to self-regulate allows them to modulate their own attention, physiology, emotions, cognitions, and behaviors (Calkins & Howse, 2004). However, individual differences in children's regulatory abilities might affect their use of aggression and this variability might be explained by children's normative brain growth in middle childhood. Specifically, research has shown that children with variations in their brain structure, such as cortical thickness, exhibit variations in their individual abilities, such as in intelligence (e.g. Shaw et al., 2006; Banfield et al., 2004). Thus, children who exhibit a refinement of the local connections in the prefrontal cortex, as well as distal connections between the prefrontal cortex, sensory, and motor regions of the brain are more likely to have more advanced social cognitive abilities (e.g. Khundrakpam et al., 2013; Eisenberg & Harris, 1984) in middle childhood.

Previous models of aggression have focused on cognitive (Dodge, 1980), biological (Calkins & Keane, 2004) and behavioral factors (Sèguin & Zelazo, 2005) that

may influence children's aggressive behaviors. These models suggest that a child's tendency to be aggressive might be influenced by individual differences in their hostile attribution bias, ability to regulate their physiological arousal, and executive functioning abilities. The proposed study tested the hypothesis that these three factors in middle childhood predict physical and relational aggression during preadolescence.

CHAPTER II

LITERATURE REVIEW

Physical Aggression.

Aggression is broadly defined as behaviors that harm others (Buss, 1961). However, historically children's aggression has been measured more narrowly by the assessment of the frequency of physical behaviors only, with little or no attention to additional behaviors that may harm others. Thus, the majority of aggression literature has focused on the examination of physical aggression, which is defined as the use of physical force that results in the harm of other individuals (Tremblay & Nagin, 2005) and includes behaviors such as kicking, punching, and hitting (Buss & Perry, 1992). Children might use these overt, direct, and immediate behaviors as a strategy for coping with emotional and social problems (Bandura, 1978).

Children's use of physical aggression is related to their engagement in other disruptive behaviors, such as externalizing and antisocial behaviors; however, physical aggression is a distinct construct (Tremblay, 2000). Children's antisocial behavior and use of physical aggression are both generally disruptive and negatively viewed by society, but antisocial behavior also includes other acts of defiance and risk, such as lying and theft (Tremblay, 2000). And unlike physical aggression, children who engage in antisocial behaviors also engage in illegal activities. Although children's use of physical aggression may or may not be appropriate given the social context, these behaviors are

not necessarily illegal. Externalizing behavior is a much broader construct than physical aggression and is generally defined as negative behaviors directed outward and can include physically aggressive behaviors. However, externalizing behavior also includes other destructive and oppositional behaviors, such as cursing (Achenbach, Edelbrock, & Howel, 1987). Physical aggression is a more focused construct than antisocial behavior and externalizing behavior; thus, the current study will concentrate on children's use of physical aggression and its predictors and correlates.

Many studies of physical aggression have been published over the past 75 years (*Monographs of the Society for Research in Child Development*, 2004). This focus on physical aggression is likely due to the overt nature of physical aggression and obvious harm it can cause to the victim, but also because physical aggression can have serious consequences for the aggressor (Tremblay, Mâsse, Pagani, & Vitaro, 1996). Children who use physical aggression are more likely to experience peer rejection (Dodge, Coie, & Brakke, 1982), engage in substance use (Piko, Keresztes, & Pluhar, 2006), and have poor study habits (Campbell, Spieker, Vandergrift, Belsky, & Burchinal, 2010). These negative consequences make it important to identify the general pattern of children's use of physical aggression over childhood and preadolescence and the factors that might contribute to individual variability in this pattern.

Children generally use the most physical aggression in preschool and then use less physical aggression across childhood (Tremblay et al., 1996; Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006). Children might exhibit this early peak in physical aggression, because as toddlers they have limited self-control, and they cannot express

their frustration in more appropriate ways (Calkins & Howse, 2004). Children's physical aggression can be described as an instant, uninhibited, overt behavioral response to uncontrolled negative emotions (Bandura, 1978). Over time, children develop greater emotional and behavioral control (Kopp, 1982) and other verbal and behavioral strategies (Eisenberg & Harris, 1984), which allow them to better express their frustration and solve their social-emotional problems. The growth of children's individual abilities might contribute to their decreased use of physical aggression.

Children's decreased use of physical aggression over childhood may also be explained by the increased external pressure for them to refrain from the use of physical aggression (Bandura, 1978). Adults and peers socialize children to be less aggressive over time, because physical aggression is an aversive behavior that is increasingly linked to poor outcomes for children. Toddlers who hit, punch, and kick do very little harm to others, because of their small size and limited strength. As a result, toddlers are not likely to be punished for their use of physical aggression. Yet as children grow older and become larger, their use of physical aggression does more damage and children who use physical aggression are more likely to be punished (Bandura, 1978). Subsequently older children learn that physical aggression is socially inappropriate and will result in punishment. Older children will internalize these social norms and use less physical aggression during childhood (Nagin & Tremblay, 2005). In spite of this typical progression, a small subset of children continues to use physical aggression over time (Côté et al., 2006; Tremblay et al., 1996). For that reason, it is important to identify the factors associated with children's continued use of physical aggression.

Theories of Physical Aggression. Several theories of physical aggression have been proposed, which offer insight into the possible factors that might predispose children to use physical aggression in preadolescence. Because of the development of children's abilities to modulate their own cognitions, physiology, emotions, and behaviors in middle childhood (Calkins & Howse, 2004), theories of social cognitive, physiological regulation, and executive functioning will be explored.

Social Cognition and Social Information Processing Model of Physical Aggression. Theories of social cognition posit that children who have deviant social information processing might use more physical aggression (Dodge, 1986). All children are born with the ability to generally respond to social situations. However, over the course of early childhood, children's social experiences will begin to shape their responses to their social world. Based on their unique social experiences, children will derive distinct information from the world. And consequently, children will form unique expectations of their social context. These expectations will influence how children will perceive, interpret, and store future social stimuli in their environment. Dodge (1986) proposed that this cognitive process would influence children's behavioral responses to subsequent social experiences; and more specifically he hypothesized that those children who have deviations in this process might have more negative behavioral responses. For example, if a child is shoved on the playground, the child may focus on and store cues about the hostile intent of the perpetrator, such as the enraged look on the other child's face or the lack of apology. The child might then interpret similar future events as hostile and choose to respond in aggressive ways, even if these events are more ambiguous in

their content. These processes are affected by socialization, influenced by peers and parents, and are thought to shape social cognitions over time (Dodge & Pettit, 2003). Thus, children's information processing of social experiences might influence their use of physical aggression.

More specifically, Dodge's (1986) social information processing model describes six steps that might contribute to children's display of physical aggression. First, children must attend to and encode information in their social environment. Second, they must interpret this information based on prior experiences and cognitive schemas. Third, children must select social goals they want to accomplish. Fourth, they must generate possible solutions. Fifth, they must anticipate outcomes to their possible solutions. And sixth, children must select how to respond. Dodge (1986) hypothesized that children work through each of these steps sequentially in order to reach a final behavioral outcome. In spite of this hypothetical lengthy cognitive process, children might still respond quickly, because they fail to evaluate all possible information or outcomes expectancies, or have a limited set of behavioral responses from which to select or have established response biases based on previous cognitive processing

Children who experience deviations at any of these six steps might result their use of aggression. For example, if a child deviates in the first step and only pays attention to other children hitting, the child might also hit. Or if a child deviates in the second step and he or she interprets being pushed by a peer as hostile, the child might also push his or her peer. Or if a child deviates in the third step and selects social goals that include dominating his or her peers, the child might be more likely to use physical aggression. If

a child deviates in the fourth step and generates solutions to problems that only include kicking, punching, or hitting, the child will kick, punch, or hit. If a child deviates in the fifth step and anticipates being first in line by pushing his or her peers, the child might be more likely to push his or her peers out of the way to get there. And if a child deviates in the sixth step and pushes a classmate out of the way and becomes first in line, this positive outcome might encourage the child to continue to behave more aggressively.

The social information processing model provides an explanation of why children might use more physical aggression; however, some of the basic premises of the model have not been empirically investigated. Dodge (1986) assumed that children learn these deviations earlier in development, which affects their subsequent maladaptive social information processing. And this learning process might be influenced by both the severity and primacy of these experiences. For example, parents might tell their child that when another peer hits him or her, it is intentional and mean. This explanation by parents might increase the likelihood that the child will later interpret similar ambiguous cues as hostile. This suggests that children may have indirectly and directly learned how to identify hostile cues from their parents and peers. Yet the origination of children's deviant information processing has not been tested in the social information processing literature. In spite of the failure to examine basic assumptions of the model, it still provides premises about the linkages between children's maladaptive social information processing and their use of aggression that can be tested.

These testable premises derived from the social information processing model have also evolved over time as different pathways to negative behaviors were

incorporated into Dodge's (1986) original model. Revisions to this model suggest that children do not have to go through the six social processing steps sequentially. Moreover, children who deviate at only one of these steps might not use physical aggression; rather more successful cognitive processing might protect a child with one deviation from using aggression (Crick & Dodge, 1994). For example, a child might generate only aggressive solutions to cope with a hostile peer, but because he or she anticipates that the teacher will punish physically aggressive behavior, the child will not behave aggressively. As such, children who vary in their degree of deviant social information processing might affect their likelihood of using physical aggression.

The revised model also posited that children's social information processing is influenced by their development (Crick & Dodge, 1994). As children develop greater processing speed, attentional capacities, and integrate new information into their cognitive schemas, their social information processing will also change. These developmental changes in children's social information processing might affect their use of aggression over time. This is similar to Bandura's social learning model of aggression (1978), however the social cognitive model posits that social learning effects children's use of aggression because of the effect it has on children's cognitive processing. For example, over the course of a year a child might be exposed to more aggressive classmates. Subsequently, he or she might interpret more hostility in his or her social context and increasingly perceive aggression as an acceptable response. A child might also anticipate more positive outcomes of physical aggression due to this increased

exposure. Children who have increased anticipation of positive outcomes and increased normality of physical aggression might be more likely to use physical aggression over time.

Children's emotional and physiological processes were also incorporated into the modified social information processing model, and these processes might also affect children's aggressive behaviors (Crick & Dodge, 1994; Lemerise & Arsenio, 2000). Children often have an emotional and physiological response to social information, which then might become connected to the processing of future social information. Children's emotional and physiological reactions might affect their use of physical aggression. For example, if a child is angry with a peer, then the child might only attend to negative social cues of the peer, such as the peer making faces at him or her, and the child might use more physical aggression. Or if a child has greater physiological arousal to a peer spilling milk over his or her desk, the child might be more likely to interpret the situation as threatening and respond with more retaliatory aggression. Children might use aggression in order to cope with their negative emotions and reduce their physiological arousal. This reformulation of the original model suggests that a more complicated social cognitive process predicts children's use of aggression and additional factors should be incorporated.

In spite of these complicated pathways that predict children's use of aggression as postulated by the revised social information processing model, empirical literature has predominantly examined the link between children's deviations in step two of the model, their interpretation of social information, and their use of physical aggression. Children

who interpret ambiguous social information as negative are labeled as having hostile attribution bias (Dodge, 1982). Children who have a hostile attribution bias are more likely to interpret ambiguous social cues as threatening, mean, and intentional (Dodge, 1980). Hypothetically, when children perceive ambiguous stimuli as threatening, they will be more likely to retaliate in an aggressive manner. For example, if a peer knocks a stack of papers out of a child's hands, the child could interpret the behavior as intentional, mean, and hostile, or as accidental and benign. If the child interprets more hostility in his or her social context, he or she might want to respond to this perceived threat by fighting back [defensive aggression]. In addition, children who interpret more hostility in their social environment subsequently might learn that mean and hostile behaviors are a socially normative behavioral response [offensive aggression]. Children who have hostile attribution bias might feel justified to behave aggressively, and consequently they might use more physical aggression.

Empirical research has generally supported this theoretical association: children who have increased hostile attribution bias use more physical aggression, both concurrently and over time (e.g. Dodge & Frame, 1982; Dodge, Pettit, Bates & Valente, 1995). Dodge and Frame (1982) studied 81 male participants in kindergarten through the fifth grade. Teachers rated half of the participants as high on aggressiveness and the other half of the participants as low on aggressiveness. Participants were asked to respond to negative and ambiguous outcome stories. Participants gave free responses to how they thought the outcome occurred (the intent) and how they would respond. For example, if a child places his lunch bag on the table, leaves, and comes back and another child is

holding the lunch bag (ambiguous) what is the intent of the child and how would the participant respond to that child. Participants who were rated as high in aggression were more likely to say that the outcome occurred because the other child was mean; consequently, these participants were labeled as having a greater hostile attribution bias. In addition, participants who had greater hostile attribution bias thought that aggression was normal. Therefore, children who use more aggression might consider physical aggression to be an acceptable response to perceived hostility.

In spite of the evidence that supports the relation between children's use of aggression and hostile attribution bias, some empirical research has not shown that children who have increased hostile attribution bias are more physically aggressive. In a longitudinal study of teacher rated physical aggression, Dodge and colleagues (Dodge, Lochman, Harnish, Bates, & Pettit, 1997) found that third grade children who had greater hostile attribution bias to cartoon vignettes did not use more physical aggression from kindergarten to third grade. Instead children who anticipated positive outcomes as a result of physical aggression used significantly more physical aggression over time. For example, if a child thought that pushing his or her peer would result in more friends, the child was more likely to use physical aggression. However, children's membership in aggressive groups was created by cut-off scores, which indicated children's use of only high or low aggression. By not predicting children's use of aggression on a continuous scale, this might have reduced the ability of Dodge and colleagues to show that children who have greater hostile attribution bias use more physical aggression over time. There is also wide variability in the relation between children's hostile attribution bias and their

use of physical aggression. Orobio de Castro and colleagues' (2002) meta-analysis of existing research found wide variability in this relation, as indicated by the range of effect sizes (between -.29 to .65). These null findings and inconsistent results suggest that other factors might affect whether children will be physically aggressive.

Physiological Theories of Physical Aggression: The Role of Middle Childhood Physiological Regulation in Preadolescent Physical Aggression. Early theories of aggression have also suggested that children who are angry or frustrated might use more physical aggression as an emotional coping response (frustration-aggression hypothesis; Buss, 1961). However, not all children who are angry and frustrated use more physical aggression (Averill, 1983). Children who can control their negative emotions by engaging in distraction or cognitive reframing might not use more physical aggression (Roberton, Daffern, & Bucks, 2012).

Emotion regulation is another individual process that might predict children's use of physical aggression. Emotion regulation is defined as the ability to modulate the experience and expression of emotion through automatic or deliberate processes (Gross & Thompson, 2007). Children with good emotion regulation skills are more likely to have better peer relationships, because they can reframe negative emotions and appropriately express emotions, which allow them to engage with others more appropriately (Calkins & Keane, 2004). For example, children who cry uncontrollably and continuously express their emotions in an unrestrained manner might upset their peers. These poorly regulated children might not be able to discuss their emotional problems in rational ways or express their emotions appropriately, consequently they

might fail to connect with their peers. Emotion regulation is a multi-level process, which is embedded within a network of interrelated systems, and children can use a variety of physiological, behavioral, and cognitive strategies in order to modulate their emotions (Thompson, Lewis, & Calkins, 2008). Children's physiological strategies of emotion regulation might be particularly important to their use of physical aggression, because children's use of aggression can be linked to their automatic visceral response to external threatening stimuli (Cannon, 1928).

Children's physiological regulation has two dominant components that might affect their use of aggression. One component of physiological regulation is the ability to regulate autonomic arousal, and is represented in the inhibitory effects of the parasympathetic nervous system. This component is particularly vital to children's regulation, because in comparison to the enervating effects of the sympathetic nervous system, i.e. pupil dilation and accelerated heart rate, the parasympathetic nervous system inhibits the body, i.e. pupil constriction and decelerated heart rate, and helps the body maintain homeostasis (Porges, 1995). The parasympathetic nervous system allows children to successfully buffer sympathetic responses and cope with stress and emotional challenges. According to Porges' polyvagal theory (1995, 2001), during an emotional challenge parasympathetic nervous system input decreases. This physiological decrease allows a child to shift attention from internal to external demands and deal with the emotional challenge. After the challenge is removed, parasympathetic nervous system input increases to return the body to a state of rest.

Physiological regulation of the parasympathetic nervous system responds via or through activation the myelinated vagus nerve, which allows an organism to rapidly engage and disengage with the environment (Porges, 1995, 2001). The myelinated vagus nerve is the tenth cranial nerve and is the part of the parasympathetic nervous system, which regulates cardiac output via the sino-atrial node. The myelinated vagus nerve also connects to facial muscles, which reflects a direct connection between the parasympathetic nervous system and social engagement through control of the face muscles and emotional expressions. Thus, parasympathetic nervous system activity is a coordinated response of the autonomic nervous system to emotional challenges and is posited to have a significant effect on children's emotion regulation and social behaviors (Porges, 1995, 2001).

Parasympathetic nervous system regulation of the heart has been referred to as vagal tone, which can be non-invasively indexed by measuring respiratory sinus arrhythmia (RSA; Porges, 1995, 2001, 2007). RSA is a continuous measure of the functional influence of the myelinated vagus on the heart and is reflected in the naturally occurring rhythm of heart rate approximately at the frequency of spontaneous breathing (Porges, 1995). RSA acts as the "brake" on the heart. When vagal tone is high, the "brake" is on, and heart rate is low. When vagal tone is low, the vagal "brake" is released, and heart rate can be higher.

Children's RSA can be measured at rest (baseline RSA) or as a response to challenge (RSA withdrawal). Children who have lower baseline RSA are thought to have increased temperamental reactivity and general trait emotionality (Stifter & Fox, 1990).

And children who have higher baseline RSA might have an increased ability to appropriately engage with others in their social environment and as a result display more socially competent behaviors (Beauchaine, 2001). In contrast, children's RSA withdrawal in response to a cognitive, emotional, and behavioral challenge might reflect better attention, emotion regulation, and state reactivity (Beauchaine, 2001). During a challenge, the vagal "brake" is disengaged, indexed by greater RSA withdrawal, and the child is able to attend to the challenge. When the challenge has ended, the child then reapplies the vagal "brake" and returns to baseline physiological functioning. The pattern of children's RSA withdrawal to an emotional challenge may have a more of an effect on their use of physical aggression than baseline RSA, because children with higher RSA withdrawal are better able to control their negative emotions and use more effective social strategies to cope with their emotional challenges.

Children with poor vagal control, or lower RSA withdrawal during an emotional challenge, may not be able to shift their focus from internal demands to external stimuli. Subsequently children's inability to shift their physiological resources will contribute to their increased emotional liability, less successful engagement with their social environment, and behavioral dysfunction (Porges, 1995, 2007; Beauchaine, 2001). In addition, children with poor vagal control might not have the opportunity to develop more appropriate social skills over time, because they are unable to appropriately interact with their peers (Calkins & Keane, 2004). Thus children with poor physiological regulation might engage in more physical aggression, because they fail to attend to and internalize social rules that would typically inhibit these negative behaviors.

Empirical work has supported the polyvagal theory of aggression and revealed that physically aggressive children with poor physiological regulation also have poor emotion regulation and behavioral control (Calkins & Dedmon, 2000). And this poor emotional and behavioral regulation might explain the link between children's poor physiological regulation and their use of physical aggression. Two- and three-year old children who were categorized as exhibiting more physical aggression also displayed more behavioral dysregulation and poor emotional control throughout several laboratory challenge tasks (Calkins & Dedmon, 2000). These children also had lower RSA withdrawal to a challenge task. Calkins and Dedmon (2000) concluded that those children who cannot regulate their negative emotions and behaviors are more aggressive, because they have difficulty with physiological regulation. These children might engage in more aggression because they cannot control their physiological response well enough in order to shift their attention externally and inhibit these negative behaviors and thus fail to generate a response to cope with emotional challenges. This research suggests that children's physiological regulation is an indicator of their emotion regulation, which explains the link between physiological regulation and children's aggressive behaviors.

Although some research has demonstrated that children who have poor physiological regulation are more physically aggressive (e.g. Calkins, Graziano, & Keane, 2007), other research has not supported this finding (e.g. Gordis, Feres, Olezeski, Rabkin, & Trickett, 2010). In a group of nine to 16-year-old maltreated and non-maltreated children, participants who had lower RSA withdrawal while watching conflict video clips did not display more parent-rated physical aggression (Gordis et al., 2010).

However, this study had several limitations that might explain the null findings, such as the use of passive responses to conflict video clips. The participants also represented a wide age range, which may reflect distinct developmental differences in abilities. Older adolescents might use less physical aggression, or use more covert aggression that may not be detected by parents. If that is the case, then the relation between physiological regulation and physical aggression that is observed among younger children may not be apparent in preadolescents. In addition, preadolescents may have developed additional skills that allow them to cope with these emotional challenges in the absence of better physiological regulation. These inconsistent findings suggest that there might be other processes that affect children's use of physical aggression.

The Association between Children's Executive Functioning and Preadolescent Physical Aggression. Characteristics of children's executive functioning also might affect preadolescents' use of physical aggression, in addition to the roles of children's social cognition and physiological regulation in the tendency of children to display aggression. Children who have better executive functioning abilities are able to control their higher-order cognitive processes (Zelazo, Müller, Frye, & Marcovitch, 2003), such as the conscious control of attention. Children who have better executive functioning abilities are able to engage in more complex behaviors and achieve goals in a given context (Pennington & Ozonoff, 1996), because they have increased behavioral control (Blair & Ursache, 2011) and better skills for solving emotional problems (Zelazo & Cunningham, 2007). In contrast, children who have poor executive functioning abilities are more likely

to have difficulty controlling their behaviors and resolving their emotional problems, and, as a result, they might use more physical aggression in preadolescence.

Although children's executive functioning abilities are related to their emotion regulation skills and can help them resolve their emotional problems, these abilities are considered to be distinct (Zelazo & Cunningham, 2007). Children can use their executive functioning abilities as a conscious strategy to modulate emotions (e.g. cognitive reframing) in order to solve their emotional problems. In contrast, children use their emotion regulation skills in the conscious and unconscious modulation of their emotions. Moreover, children do not always use their emotion regulation skills to solve their emotional problems. Children's executive functioning abilities might affect their use of physical aggression in preadolescence more than their emotion regulation skills, because children's executive functioning abilities contribute to their deliberate emotion regulation strategies and emotional problem solving (Zelazo & Cunningham, 2007). For example, children who are excluded by a peer might become angry and require their emotional problem solving skills in order to cope with this anger. They might consciously try to cognitively reframe their negative experience to deliberately reduce their anger, in order to control their behaviors and not use physical aggression.

The distinction between children's executive functioning abilities and emotion regulation skills is not the only ambiguity in the definition and measurement of children's executive functioning abilities. Children can display multiple types of cognitive control and their executive functioning abilities are related to a variety of complex behavioral outcomes (Zelazo, Carter, Reznick & Frye, 1997). As a result, children's executive

functioning abilities encompass several abilities, including planning ability (setting up a process to achieve a given outcome), working memory (the short-term maintenance and storage of information), and inhibitory control (ignoring extraneous stimuli) (Pennington & Ozonoff, 1996). There are other skills that are included in children's executive functioning abilities, however just these three abilities will be the focus of the current study. Thus, children's executive functioning ability may be considered as a global construct that encompasses several different indicators, or it can be divided into separate components. The development of children's advanced conscious control might affect their use of physical aggression, because they can inhibit dominant automatic behavioral responses, remember and focus on their future goals, plan out and select more skillful behaviors to respond to their emotional problems.

The development of children's executive functioning is relatively protracted; it begins in early childhood and continues into adolescence (Davidson, Amso, Anderson, & Diamond, 2006). This growth and refinement of children's executive functioning abilities throughout childhood and adolescence is influenced by a critical period of neurological change (Tsujimoto, 2008). The developmental changes of the prefrontal cortex are related to children and adolescent's greater behavioral and cognitive control (Banfield, Wyland, Macrae, Münte, & Heatherton, 2004; Tsujimoto, 2008). And thus, over time children who experience this growth in the prefrontal cortex are able to better remember their social goals and have greater inhibition of dominant behaviors as a response to negative emotions, and might use less physical aggression as a result.

Children and adolescents who develop more refined executive functioning abilities are more likely to have positive academic (e.g. Martel et al., 2007), socioemotional (e.g. McQuade, Murray-Close, Shoulberg, & Hoza, 2013), and behavioral outcomes (e.g. Riggs, Blair, & Greenberg, 2003), because they are able to control their behaviors, attention, and emotions (Zelazo & Cunningham, 2007). Children who have advanced executive control might be able to appropriately engage with their peers and deal with their emotional problems, because they can inhibit more automatic and dominant responses to their negative emotions. Children with better executive functioning abilities might also be able to cognitively reframe their negative emotions, think of alternative behavioral responses, and plan a more acceptable course of action, which would result in better solutions to their emotional problems and have more successful social interactions with their peers. Children who have more advanced executive functioning abilities also have better working memory and response inhibition (Vuontela et al., 2013); thus, they might remember their future goals, inhibit inappropriate behaviors, and plan more skillful behaviors. As children develop their executive functioning abilities, they might have an increased capacity to use sophisticated peer behaviors, and subsequently they might use less physical aggression.

Children generally exhibit a normative developmental progression in their acquisition of executive functioning skills; however, there are individual differences in this progression. And, the consequences of these individual differences in the development of executive functioning skills are reflected in their social as well as cognitive behaviors. For example, children who are not able to cognitively reframe their

negative emotions might be more likely to use inappropriate behaviors, such as hitting a peer, in order to reduce these negative emotions. So, children with poor executive functioning skills might be more likely to use physical aggression in preadolescence, because they are not able to control their negative behavioral responses to emotional challenges.

The emotional problem-solving framework (Sèguin & Zelazo, 2005) is used to explain how children with this atypical developmental progression of executive functioning skills might be more likely to engage in poor social behaviors. This framework suggests that if children with poor executive functioning abilities are faced with an emotional challenge, they will fail to cognitively reappraise the situation. They also will be unable to generate alternative behavioral responses (Zelazo & Cunningham, 2007), and they will be unlikely to inhibit their dominant responses to the emotional challenge. Because children often use physical aggression as an immediate and dominant response to their emotional problems and challenges, theoretically children with poor executive functioning abilities might be more likely to use physical aggression in response to their emotional problems in preadolescence.

The postulates of the emotional problem solving theory of aggression have been supported by some cross-sectional research: children with poor executive functioning abilities are more likely to use more physical aggression (e.g. Ellis, Weiss, & Lochman, 2009). In a sample of fourth and fifth grade male children, participants who performed poorly on tasks that measured planning ability and response inhibition exhibited greater teacher-rated aggression (Ellis et al., 2009). However, children's poor planning ability

only was related to greater use of reactive physical aggression and less proactive physical aggression when they had high hostile attribution bias. This finding suggests that specific components of children's executive functioning abilities are related to their use of aggression. However, this link is only present when children also have high hostile attribution bias and not low hostile attribution bias. This might suggest that children who engage in aggression as a consequence of poor executive functioning must first have an emotional problem that requires better executive functioning and emotional problem solving skills. This study did not include female participants or measure other aspects of children's executive functioning abilities, such as working memory. Children who have poor working memory might be more likely to use aggression, because they might have difficulty remembering social norms, understanding cause and effect, and remembering future goals (Barkley, 1997). Children who have poor working memory might have a difficult time solving their emotional problems with socially appropriate behaviors and consequently also use more physical aggression.

Although the work of Ellis and colleagues (2009) provides some empirical evidence that children who have poor executive functioning abilities are more likely to use physical aggression concurrently, additional work is needed to support these relations across time. Few studies have addressed whether poor executive functioning skills in childhood have any influence on later engagement in aggressive behavior. A related study by Bohlin, Eninger, Brocki, and Thorell (2012) demonstrated in a small group of five-year-old children that those children who had poor executive functioning, as indexed by several measures of inhibitory control, were more likely to engage in externalizing

behaviors at age seven. They concluded that younger children who cannot inhibit a dominant response do not develop other appropriate behavioral responses and do not learn alternative ways to control their behaviors. Subsequently, these children who have poor executive functioning skills in early childhood will continue to use more uninhibited problem behaviors in middle childhood, such as physical aggression.

The longitudinal research on the effect of children's executive functioning abilities on their use of physical aggression has some limitations. Bohlin and colleagues (2012) only measured children's inhibitory control. They did not include measures of the other components of children's executive functioning. Children develop inhibitory control earlier than other components of executive functioning, which might explain why children who have greater inhibitory control in early childhood use less physical aggression in middle childhood. As children enter middle childhood, their executive functioning skills are broadening and begin to encompass other aspects of cognitive control (Garcia-Barrera et al., 2013). More advanced aspects of children's executive functioning abilities, such as working memory and planning ability, might affect children's emotional problem solving and aggressive behavior in preadolescence. It is important to identify other aspects of children's executive functioning in middle childhood that might affect preadolescents' use of aggression. Another limitation of this research is that most of this research has predominantly assessed the link between executive functioning and physical aggression for males only (e.g. Ellis et al., 2009). Females can develop advanced social and language abilities at an earlier age than males (Zimmer-Gembeck, Geiger, & Crick, 2005; Van de gaer, Pustjens, Van Damme, & De

Munter, 2009), which might differentially affect their use of aggression in preadolescence. It is important to consider the role of gender in preadolescents' use of physical aggression.

The Role of Gender in the Development of Physical Aggression. The research on physical aggression has primarily focused on males' use of physical aggression (e.g. Ellis et al., 1996). This focus on males is likely because males have a greater tendency to use physical aggression than females (e.g. Cairns, 1986). There are several theories that seek to explain why males are the more physically aggressive sex. The evolution theory of aggression (Archer, 1996) suggests that over time males have evolved to be more physically competitive than females in order to obtain limited resources and have greater reproductive success (Archer, 1996). Males have evolved to be bigger and stronger than females, which occurs by sexual selection. Their larger size increases their ability to compete for limited resources. Additionally, males have more testosterone, a sex hormone that is also linked to greater physical aggression (Archer, 1996). This evolved difference in competitive nature, size, strength, and testosterone might explain why males might use more physical aggression than females. However, size differences are not as great as we might expect based on what should be generated by sexual selection. These evolved sex differences might only weakly affect sex differences in preadolescents' use of physical aggression.

Accordingly, socialization theories have also been used to explain gender differences in preadolescents' use of physical aggression. Cairns (1986) hypothesized that boys and girls are socialized to exhibit different gender-typed behaviors in their peer

relationships, which might affect differences in their use of physical aggression. Parents and peers encourage boys to engage in more rough and tumble play, whereas parents and peers encourage girls to engage in more “civilized” and discussion based play. Boys are given swords with which to play, while girls are given tea sets. Adults directly teach children gendered aggressive behaviors, as well as modeling these gendered behaviors for them. Thus, males are socialized to be more physically aggressive than females (Cairns, 1986). This theory might suggest that if males were socialized in similar ways as females, which is increasingly the case in modern society, males might also use less physical aggression. And vice versa, females who were socialized in similar ways as males might use more physical aggression. However, the effect of differential non-gender-matched socialization on children’s use of aggression has not been empirically tested.

A gender difference in physical aggression could also be attributed to the socialized expectations of gender differences. Parents and teachers often report that boys use more physical aggression then girls. However, parents and teachers are also socialized to think that boys should engage in more physical aggression. Even though females’ use of physical aggression might be unusual and attract more attention, teachers and parents might categorize this behavior as accidental and not aggressive. As such, the expectation of gender differences in aggression might result in the over-report of male physical aggression and the under-report of female physical aggression.

Empirical evidence supports a gendered theory of aggression: boys are reported to use more physical aggression than girls (e.g. Cairns, 1986). In addition, boys have an increased likelihood of displaying more physical aggression over time than girls (e.g.

Cairns, 1986). Cairns (1986) demonstrated that out of 475 seventh grade children, 59% of boys were identified as using more physical aggression compared to 17% of girls. Over time, the rates of physical aggression decreased in girls, while the rates in boys increased. Cairns concluded that generally boys were more aggressive than girls.

By operationalizing aggression as the frequency of physical behaviors only, early aggression research demonstrated that boys were the more aggressive sex. However, later aggression research noted that girls were engaging in many other non-physical behaviors that also caused harm to their peers (Crick & Grotpeter, 1995). Consequently, early aggression research was limited by defining and measuring aggression as the frequency of physical behaviors and was not accurately describing aggression use in all children. In order to capture all manifestations of aggression for boys and girls, the definition and measurement of aggression was broadened. The concept of relational aggression captured these alternative aggressive behaviors (Crick & Grotpeter, 1995), which created a more differentiated conceptualization of aggression for all children.

Relational Aggression.

To understand and predict the use of aggression for both girls and boys, one must consider that children can manifest aggression unique ways. Early aggression research demonstrated that boys were more aggressive than girls. However, these studies measured only direct, overt, and physically aggressive behaviors, and neglected to measure indirect, covert, and relationally aggressive behaviors. When Crick and Grotpeter (1995) measured indirect, covert, and relationally aggressive behaviors, they found that girls were equally as aggressive as boys. They coined the term relational

aggression in order to capture these distinct aggressive behaviors. Relational aggression is defined as behaviors that harm others through the manipulation of social relationships, which includes behaviors such as gossiping and peer exclusion (Crick & Grotpeter, 1995).

In addition to children's relationally aggressive behaviors, other aggression research has identified other constructs that measure children's non-physical aggressive behaviors, which have been labeled indirect aggression (Lagerspetz, Björkqvist, & Peltonen, 1988) and social aggression (Cairns, Cairns, Neckerman, Ferguson, & Gariepy, 1989; Galen & Underwood, 1997). These constructs capture children's aggressive behaviors that are similar to relational aggression. Relational aggression encompasses both indirect and direct behaviors. For example, children can directly exclude others by telling their peers not to sit with them, or they can indirectly exclude their peers by telling classmates not to play with a peer. Children's indirect aggression can also include non-relational behaviors, such as property damage. Children use social aggression within larger social groups, whereas children use relational aggression in a smaller social dyad. However, children's larger peer groups are composed of these relational dyads, therefore children's relational aggression can also affect the larger peer group. Although there are some minor differences among these constructs that capture children's non-physical aggressive behaviors (see Archer, 2001 for a comprehensive review), children's relational aggression tends to capture their use of these other forms of non-physical aggression. Relational aggression will be used to refer to the theories and research that examines children's manipulation of social relationships.

When describing children's use of relational aggression, comparisons are also made to children's use of physical aggression. Children who use physical aggression are also more likely to use relational aggression (e.g. Crick & Grotpeter, 1995). Children can use both relational aggression and physical aggression to harm others (Cairns, 1986; Crick & Grotpeter, 1995). Although there are similarities between children's use of relational and physical aggression, these aggressive behaviors are also distinct. Children use relational aggression in order to manipulate social relationships, and accordingly they must use these behaviors in a social context (Crick & Grotpeter, 1995). Although children can use physical aggression to affect other people, and their use of physical aggression might damage their relationship with a peer, they do not need a social relationship in order to use this aggressive behavior. Children can punch or kick someone they have never met before. Therefore, children who use relational aggression must be able to have social relationships, which suggest that the processes that predict preadolescents' relational aggression might be different than the processes that predict preadolescents' physical aggression.

Since children's use of relational aggression is conducted within social relationships, it might require more sophisticated social abilities, such as perspective taking and theory of mind. And since children's social abilities develop over time (Berry & O'Connor, 2010; Kurdek, 1977), children's use of covert, delayed, and deliberate relational aggression might increase, whereas children's use of overt, immediate, and hasty physical aggression might decrease (Björkqvist et al., 1992). Thus, although some children have a tendency to behave aggressively generally, there might be unique

correlates and predictors of relational aggression. This makes it important to specifically identify those children who are at risk of using relational aggression.

The early identification of children who use relational aggression is critical, because children can use relational aggression to harm their peers. Children who are relationally victimized are more likely to be lonely, experience depressive symptoms, and have low self-esteem (Prinstein, Boergers, & Vernberg, 2001). But just as importantly, relational aggressors also experience serious consequences as well. Children who are relational aggressors are more likely to be anxious, withdrawn, depressed, and delinquent over time (Crick, Werner, & Ostrov, 2006). These negative consequences for both the relational victims and relational aggressors make it vital for the early identification of children who might use more relational aggression.

Unfortunately, children and adolescents who use relational aggression not only experience negative consequences, but they also can experience positive effects of relational aggression. These positive effects of relational aggression might serve to encourage children to continue to use more relational aggression over time. Peers often perceive children and adolescents who use more relational aggression as more popular (e.g. Rose, Swenson, & Waller, 2004). Thus, children and adolescents might use relational aggression as a strategic behavior to attain or maintain higher social status and meet their social goals (Pellegrini, Roseth, Van Ryzin, & Solberg, 2011). Relationally aggressive children might have developed more advanced social skills, which mitigates the negative effects of relational aggression and/or allow them to be more effective in manipulating others (Hawley, 2003; Gangel, Keane, Calkins, Shanahan, & O'Brien,

2016). For example, a preadolescent might have more sophisticated language skills that allow him or her to be more persuasive in convincing their classmates to exclude a peer, which could increase the preadolescents' popularity. Relationally aggressive children who are more popular among their peers might be encouraged to use more relational aggression over time. These positive outcomes might reinforce these negative behaviors in children and explain why the majority of children use more relational, rather than physical aggression over childhood and into preadolescence (Côté et al., 2007; Kawabata, Tseng, Murray-Close, & Crick, 2012).

Children's tendency to use more relationally aggressive behaviors as a substitute for physically aggressive behaviors over the course of childhood might also be explained by children's growth of social, emotional, and cognitive skills (Björkqvist et al., 1992; Davidson et al., 2006; Calkins & Howse, 2004; Kopp, 1982; Chan, Ramey, Ramey, & Schmitt, 2000). For example, children who can control their emotions may not push a peer when they are angry. Instead, they might inhibit this behavior and use increased communication skills to gossip about the peer to their classmates. However, there is limited research that has identified the individual processes in childhood that predict preadolescents' use of relational aggression and a more thorough examination is required.

Theories of Relational Aggression. Several theories of relational aggression have identified processes that might predict children's use of relational aggression in preadolescence. Some of these theories have considered the important role of peers and parents in the development of relational aggression (Werner & Crick, 2004). However, research has paid less attention to theories that consider how children's individual

abilities might affect their tendency to use relational aggression in preadolescence. And in middle childhood, children begin to control their own behaviors, emotions, physiology, cognitions, and attention (Calkins & Howse, 2004). Thus, social cognitive, physiological, and cognitive behavioral theories of relational aggression will be explored.

Social Cognition and Social Information Processing Model of Relational Aggression. The social information processing model was originally formulated to explain children's use of physical aggression (Dodge, 1986), but this model has also been applied to children's use of relational aggression (Crick, 1995). Given that relational aggression must be conducted within the context of social relationships and significantly impacts social situations (Crick & Grotpeter, 1995; Cillessen & Mayeux, 2004), deviations in children's social cognition might also contribute to preadolescents' use of relational aggression.

Similar to the description of how the six steps of the social information processing model affect children's use of physical aggression, deviations in children's social information processing might also affect children's use of relational aggression (Crick, 1995). Children may incorporate aggressive social cues into their cognitive schemas, which might increase their use of relational aggression, such as children observing their parents gossiping. Children may attend to, encode, and interpret hostile information that affects their use of relational aggression, such as the perception of others excluding them as intentional and mean. Children may also select social goals that require them to manipulate others, generate more relationally aggressive responses, and evaluate these relationally aggressive responses as optimal. Children may also want to respond in ways

that specifically support their increased use of relational aggression, such as wanting to inflict harm without detection and the desire to increase social status. Children who have deviations at any of these six steps of social information processing may use more relational aggression.

Although all of these six steps of the social information processing model might contribute to children's use of relational aggression, children's deviant interpretation of social information, or hostile attribution bias, might importantly contribute to their use of relational aggression. Children who perceive ambiguous events as hostile might perceive relational aggression as a normative behavior, which might subsequently increase their use of relational aggression. Children who have greater hostile attribution bias might feel justified in their use of relational aggression, because they falsely perceive that others have been intentionally mean to them. These children subsequently might feel threatened and distressed, and they might want to retaliate in order to respond to this perceived hostility and cope with their negative emotional response. For example, if a classmate does not pick a child to be on a sports team and the child interprets this behavior as intentional and mean, the child may retaliate and not let the classmate sit at his or her lunch table. Thus, the child may be more likely to use relational aggression in order to cope with this perceived threat. This theory of relational aggression is based on the assumption that those children who have increased hostile attribution bias have learned earlier in life that certain social cues are hostile and threatening, directly and indirectly from others around them; however, this assumption has not been tested empirically.

The limited body of empirical literature has supported this link and shown that children who have increased hostile attribution bias use more relational aggression concurrently. In a large study of third and sixth grade children, those children who had increased hostile attribution bias to relational provocations were more likely to use relational aggression (Crick, Grotpeter, & Bigbee, 2002). This link between increased hostile attribution bias and more relational aggression use was the same for male and female children, and older and younger children. This study also measured children's distress to these relational hostile situations and found that relationally aggressive children had more negative feelings as a consequence of perceived relational hostility. Crick and colleagues concluded that children who perceive their peers' behavior as mean are more likely to use relational aggression, because they are coping with the negative emotions that are a result of these hostile attributions.

In addition to the concurrent link between hostile attribution bias and children's use of relational aggression, longitudinal evidence also demonstrates that children who have elevated hostile attribution bias in childhood are also more likely to use relational aggression over time. Using both a categorical and dimensional approach, Godleski and Ostrov (2010) demonstrated that children who had high hostile attribution bias to both relational and physical provocations across third to fifth grades exhibited significantly more relational aggression in sixth grade. In addition, they showed that female participants were more likely to rate relational provocations as having more hostile intent than male participants. This might suggest that females find these relational events more distressing than males. Thus, females might be even more likely to use relational

aggression as retaliatory behavior in order to cope with their increased distress. Although this study is one of the first to demonstrate the important role of hostile attribution bias in the prediction of children's use of relational aggression over time, this study is not without limitations. Godleski and Ostrov (2010) used a mean score of children's ratings of hostile attribution bias across three grades. They also measured children's hostile attribution to two vignettes of relational provocations instead of the previously used five vignettes. This reduction of vignettes might limit the information derived from children and reduce the reliability of children's hostile attribution assessment. Furthermore, they measured children's relational aggression with teacher reports of these behaviors. Teachers may not be aware of the children's use of more covert acts of relational aggression. Though these limitations might have affected the findings, this study demonstrates that it is important to consider children's hostile attribution bias to both relational and physical provocations in their use of relational aggression in preadolescence.

In contrast to those studies that reveal hostile aggression bias is an explanation of children's use of relational aggression, other studies have not observed that children with elevated hostile attribution bias use more relational aggression. Fourth grade children with increased hostile attribution bias in response to relational provocations did not use more relational aggression concurrently (Nelson, Mitchell, & Yang, 2008). Nelson and colleagues measured children's use of relational aggression with peer nominations of these behaviors, which may more accurately measure children's more covert behaviors. Children's intent attributions were assessed by the use of five hypothetical situations of

relational provocations, which have been used in previous research. However, this study added two vignettes to assess children's intent attributions, and these vignettes were created without empirical validation, which might have produced these null findings. Of course, the null findings might also indicate that there are other factors that might affect preadolescents' use of relational aggression.

Emotional and Physiological Theories of Relational Aggression: The Association Between Children's Physiological Regulation and Preadolescent Relational Aggression. Another process that might affect children's use of relational aggression is the ability to regulate emotions. Similar to theories that posit that children use physical aggression to respond to anger (Buss, 1961), children might use relational aggression to cope with and reduce their negative emotions. However, not all children who are angry use more relational aggression. Emotion regulation theories of aggression posit that if children can control their negative emotions with more appropriate regulatory strategies, they might not use more aggression.

Although the application of emotion regulation theories of aggression postulate that children use more physical aggression as a response to poorly controlled negative emotions, children's emotional control might relate differently to their use of relational aggression. Children must use relational aggression in a social context, which might require them to have more emotional control. For example, in order for a child to gossip about a peer to a classmate, the child must have a relationship with the classmate. In order to develop these relationships and create a relational context to use these types of aggressive behaviors, children might need better emotional control.

Physiological control of the parasympathetic nervous system is one strategy that children can use to regulate their emotions, and children who have better emotional control also have better physiological regulation (Porges, Doussard-Roosevelt, & Maita, 1994; Calkins & Keane, 2004). Hence, children who have better physiological regulation might use more relational aggression in preadolescence. Physiological regulation of the parasympathetic nervous system (vagal regulation) might be particularly important to children's use of relational aggression, because children who have better vagal regulation are able to successfully engage and disengage with their social environment (Porges, 1995, 2001). Children who use relational aggression must be able to successfully engage with their social environment, because they use relational aggression in the context of their social relationships (Crick & Grotpeter, 1995). Also, children often use relational aggression as a social strategy, in order to gain more perceived popularity (Cillessen & Mayeux, 2004). For example, in order to exclude another peer from a group of classmates, the child must first be part of this social group. Since children who have better physiological regulation are more likely to be more socially engaged and have improved social skills (Beauchaine, 2001), children who have better physiological regulation of the parasympathetic nervous system might use more relational aggression in preadolescence.

Very few empirical studies have examined the relation between children's physiological regulation of the parasympathetic nervous system and their use of relational aggression. Only one study by Sijtsema, Shoulberg, and Murray-Close (2011) analyzed the concurrent relation between female adolescents' use of relational aggression and

physiological regulation, indexed by RSA withdrawal. In contrast to the hypothesis linking better physiological regulation to more relational aggression use, adult reporters rated female adolescents who had poorer physiological regulation as more relationally aggressive. In addition, females who had poor physiological regulation, who were also rejected by their peers, and who had greater sensitivity to being rejected used the most relational aggression. When viewed in light of Porges' (1995, 2001) polyvagal theory, these results suggest that those females who experience more peer rejection and are sensitive to this rejection might have more negative emotions. And consequently, if those females also have poor vagal regulation they might have difficulty controlling their negative emotions. Therefore, females with poor physiological regulation might use more relational aggression in order to cope with these uncontrolled negative emotions.

The limited research on physiological regulation and relational aggression in adolescence suggests that females who have poor physiological regulation use more relational aggression. In addition, those females who have poor physiological regulation use the most relational aggression in the context of social and cognitive risk factors (Sijtsema et al., 2011). Therefore, it is important to identify other middle childhood factors that might affect preadolescents' use of relational aggression.

The Differential Association Between Children's Executive Functioning and Preadolescent Relational Aggression. In addition to hostile attribution bias and physiological regulation, children's executive functioning abilities might also affect their use of relational aggression in preadolescence. Children who have better executive functioning abilities are able to engage in more complex behaviors and achieve goals in a

given context (Pennington & Ozonoff, 1996), because they have increased behavioral control (Blair & Ursache, 2011) and more advanced emotional problem solving skills (Zelazo & Cunningham, 2007). In preadolescence youth might use relational aggression as a more deliberate and covert response to their emotional problems (Xie et al., 2005), which might require increased behavioral control and emotional problem solving skills. Thus, children who have better executive functioning abilities might use more relational aggression in preadolescence.

Children who are predisposed to behave aggressively and have advanced executive functioning abilities may use relational aggression as a socially acceptable way to solve their emotional problems. Children who use covert relational aggression are less likely to be punished for these behaviors, because their aggression use can be subtler, disguised as "girl talk" (Maccoby, 1995), and the source of the aggression can even be unknown (Xie et al., 2005). For example, a preadolescent who is upset by a peer might decide to not act immediately, but instead spread rumors later about the peer that cannot be traced back to him or her. The preadolescents' covert aggressive behavior may hurt the peer, but is more likely to go undetected. Preadolescents' relationally aggressive behaviors allow them to retaliate and cope with their emotional challenges, but allow them to remain in control of their behaviors and avoid punishment.

Children's advanced executive functioning abilities might allow them to be more successful in the covert and often delayed manipulation of others. Children who have better executive functioning abilities can cognitively reappraise situations and generate alternative behavioral responses to their emotional challenges (Zelazo & Cunningham,

2007); thus, they might use more relational aggression as a retaliatory response than physical aggression. For example, if a child is not invited to a peer's house, the child might cognitively reframe this as an opportunity to become friends with other classmates. He or she might also exclude the peer from being friends with these other classmates. In addition, children who have better executive functioning abilities, such as improved working memory, might remember their social goals, have a finer understanding of the cause and effect of their behavior, and search their available memory for more appropriate behavioral responses (Barkley, 1997). For example, the child might remember that he or she wants to be more popular, and he or she might covertly gossip about a peer in order to gain more social power (e.g. Cillessen & Mayeux, 2004). Children with more advanced executive functioning abilities might understand that relational aggression will affect their relationships in more discrete ways that will not result in negative outcomes. Therefore, children with more advanced executive functioning abilities may use more relational aggression in response to their emotional challenges in preadolescence.

In spite of the theoretical link between executive functioning abilities and children's use of relational aggression, there is limited empirical support for the hypothesis that children who have more advanced executive functioning abilities will use more relational aggression (Granvald & Marciszko, 2015; McQuade et al., 2013). In one study, investigators (McQuade et al., 2013) examined fourth and fifth grade children's scores on working memory tests and teachers' reports of relational aggression. They found that those children who had poorer working memory used more relational

aggression. McQuade and colleagues concluded that children who have poorer working memory failed to plan out more socially appropriate behaviors and might exhibit relational aggression in order to deal with their emotional challenges. However, children's working memory is just one component of their executive functioning abilities, and other abilities might relate differently to their use of relational aggression.

Extending this research on children's executive functioning abilities and their use of relational aggression, Granvald and Marciszko (2015) studied the relation between three specific components of children's executive functioning and teacher-rated aggression. They found that teachers rated nine-year old children who had poorer working memory and poorer inhibitory control as more relational aggression. However, children's mental set-shifting was not related to the teacher ratings of relational aggression. These results suggest that individual executive functioning components may relate differently to children's use of relational aggression. For example, children with poor working memory might use more relational aggression, because they have attention difficulties that contribute to their misinterpretation of social cues. Granvald and Marciszko proposed that children who have poor inhibitory control might use more relational aggression, because they cannot control their impulses to engage in negative behaviors, similar to the link between children's poor impulse control and use of physical aggression. However, both of these studies were limited by using teacher reports to measure children's aggressive behaviors. Teachers might only assess overt and obvious relational aggressive behavior, because of their limited perspective of children's more covert behaviors. Teacher reports of children's relational aggression might explain the

relation to children's poorer executive functioning abilities. Children who have better executive functioning might be able to hide their more deliberate and controlled relationally aggressive behaviors from their teachers.

This limited research suggests that children's executive functioning abilities might influence the degree to which they use relational aggression. However, there is no longitudinal research that investigates whether children's executive functioning abilities in middle childhood predict their use of relational aggression later in preadolescence.

The Role of Gender in the Development of Relational Aggression. In addition to the theories of children's individual processes predicting children's use of relational aggression, several theories have also explored the role of gender in relation to children's relationally aggressive behaviors. Historically, research demonstrated that females did not use physical aggression, but females were harming one another by manipulating peer relationships (Crick & Grotpeter, 1995). Consequently, relational aggression was intended to characterize female aggressive behaviors. Several gender-based theories are used to explain why females might use more relational aggression than males.

Gender socialization theories postulate that females use more relational aggression than males, because parents and other adults directly and indirectly teach female and male children to behave in gender appropriate ways (Zahn-Waxler & Polanichka, 2004). For example, some parents encourage boys to exert their dominance by play fighting, and some parents encourage girls to engage in more stereotypically feminine activities (Maccoby, 2004). Adults and peers also model gender roles by acting in gender normative ways (Chaplin, Cole, Zahn-Waxler, 2005). Subsequently, girls and

boys are socialized to behave in different ways. These socialization processes encourage girls to mask their aggression and use more covert relational aggression than boys. And the socialization of boys encourages them to express their aggression in more physical ways. However, there is no empirical evidence that has tested whether boys socialized to behave in female-gender appropriate ways would also use more relational aggression. It is possible that this type of feminine socialization might also affect boys similarly.

Differences in female and male friendship structures might also explain why females might use more relational aggression than males. Females interact in close dyads and triads, whereas males interact in less close collective groups (Maccoby, 1986, 2004). This structure of friendships gives females the opportunity to use more relational aggression than males, because they have more intimate knowledge of their peers to use as a relationally aggressive weapon. In addition, females value these close friendships more than males. Thus, threats of exclusion from these friendships are effective weapons to harm other females. In addition, the covert skillful nature of relational aggression allows females to maintain this close social structure. And in these close dyads, females also have increased intimate exchanges, which provide females with more relational information that can be used to inflict harm (Murray-Close, Ostrov, & Crick, 2007). Consequently, the nature and structure of females' social relationships might explain why females use more relational aggression than males. However, it is possible that if males were to have this same type of friendship structure, they might also use more relational aggression.

Gender differences in social competence might also affect females' and males' use of relational aggression. Females tend to be more socially competent than males in childhood (e.g. Hastings, Utendale, & Sullivan, 2007). In order for children to use relational aggression more effectively, they might need to have improved social skills (Cillessen & Mayeux, 2004). By using social skills to mitigate their relationally aggressive behaviors, these children might have more positive outcomes (Hawley, 2003). For example, females who are leaders can communicate clearly with their peers, which might cause their peers to accept their gossip. Thus, females may use more relational aggression in conjunction with these social skills, because they are less likely to face negative consequences and may have more social rewards (e.g. Gangel et al., 2016). This facilitation of positive outcomes due to their advanced social skills might encourage females to use more relational aggression than males.

In spite of these gendered theories of relational aggression, in general the empirical literature does not consistently demonstrate that females use more relational aggression than males. Although some empirical research has shown that females are more relationally aggressive than males (Crick, Ostrov, Burr, Cullerton-Sen, Jansen-Yeh, & Ralston, 2006; Crick & Grotpeter, 1995; Crick, 1996; Crick, Bigbee, & Howes, 1996; Crick, Grotpeter, & Bigbee, 2002; Crick & Werner, 1998; French, Jansen, & Pidada, 2002), some research has demonstrated females and males equally use relational aggression (Zahn-Waxler et al., 2005; Tiet, Wasserman, Loeber, McReynolds, & Miller, 2001; Rys & Bear, 1997; Park, Essex, Zahn-Waxler, Armstrong, Klein, & Goldsmith, 2005; Goldstein & Tisak, 2004; Delveaux & Daniels, 2000). And even more surprisingly,

some research has demonstrated that males use more relational aggression than females (Tomada & Schneider, 1997; David & Kistner, 2000; Little, Jones, Henrich, & Hawley, 2003). These studies differed in sample characteristics and methods of assessment. The inconsistent gender differences in relational aggression might be explained by the use of different reporters. Parents and teachers are socialized to expect females to use more relational aggression than males, which might result in the over-reporting of female relational aggression and under-reporting of male relational aggression. Peers might accurately report females' and males' use of relational aggression, because they are not yet socialized to expect these gender differences (McEvoy, Estrem, Rodriguez, & Olson, 2003).

The inconsistency in the differences between male and female children's use of relational aggression might also be explained by the comparison of children's use of relational aggression at different developmental stages. Gender differences in the use of relational aggression might emerge at different points in children's development as children begin to learn and conform to gender roles. In early childhood, females and males might use equal amounts of relational aggression, because they have not yet been socialized to behave in gender appropriate ways. As children become increasingly socialized over childhood, females may use more relational aggression than males in later childhood and preadolescence. In a longitudinal study, mothers and teachers reported children's use of relational aggression from ages eight through 15 (Spieker et al., 2012). At age eight girls used more relational aggression than boys, and girls continued to use more relational aggression over time. In contrast, boys used less relational aggression

over time, which resulted in even more gender differences in the use of relational aggression in adolescence. The role of gender on children's use of relational aggression should continue to be examined, because of the differences in males' and females' use of relational aggression in preadolescence.

Gaps in the Study of the Development of Physical and Relational Aggression. To summarize, in order to accurately characterize children's use of aggression, a conceptual model must incorporate children's physical and relational manifestations of aggression. Although children often use both forms of aggression to hurt their peers, over time, most children begin to use less physical aggression and more relational aggression (Côté et al., 2007). Children's divergent use of physical and relational aggression over development might be best explained by the growth of their social, emotional, and cognitive skills (Björkqvist, 1992). In early childhood, children might not have the advanced emotional, social, and cognitive skills that are required to respond to social challenges and solve their emotional problems without the use of physical aggression. As children develop more sophisticated behavioral and emotional regulation abilities, they should be able to use these advanced abilities to increase their skillful interactions with their peers. Children who do not develop these abilities might continue to use unskillful overt physical aggression as a way to interact with their peers and cope with their emotional challenges. Alternatively, children who develop more sophisticated behavioral and emotional regulation abilities, but are predisposed to behave aggressively and continue to face emotional and social challenges, might use more covert and deliberate relational aggression. Thus, physical and relational aggression might share common predictors and

correlates, but these predictors and correlates might differ in the way they specifically affect children's use of each form aggression. Very few studies have focused on children's use of both physical and relational aggression, which makes it difficult to identify both the overlapping and independent factors that may predict the use of one or both of these types of aggression.

The notable exception to this limited aggression literature is the work of Ostrov and Godleski (2010), who proposed an integrative model that included both physical and relational behaviors to assess children's aggression. In order to better understand children's use of these distinct forms of aggression over development, they posited that children's social information processing predicts their use of aggression. And children's social information processing is influenced by their gender schemas. Thus, girls process information in categorically different ways than boys, because peers and parents socialize children to accept gender specific information. Thus, girls and boys integrate distinct social cues into their social information processing that specify gender-linked behaviors, and increase females' use of relational aggression and males' use of physical aggression. For example, girls are taught to value peer relationships more than boys (Maccoby, 2004), consequently girls interpret relational exclusion as more intentional and mean than boys. Thus, girls might perceive that relational aggression is normative and justified, and girls might learn to use more relational aggression in order to effectively harm others. In contrast, boys are taught to hit to solve their social problems (Cairns, 1986), consequently boys perceive physical aggression as normative and justified and use more physical aggression in order to harm others. In conclusion, children's use of both physical and

relational aggression should be included in a model of aggression, because boys and girls use different forms of aggression. Although Ostrov and Godleski's model of aggression (2010) included gendered assumptions of social information processing, this model did not incorporate other individual processes that might affect children's use of aggression in preadolescence.

A small number of empirical studies have tested some of these theoretical assumptions of a joint model of aggression and separately highlighted the role of children's hostile attribution bias, physiological regulation to emotional challenges, and the contribution of advanced executive functioning abilities in their use of aggression. Each of these studies has methodological weaknesses that raise questions about the interpretation of the findings. In one study, Godleski and Ostrov's (2010) assessed the relation between children's hostile attribution bias in middle childhood and their use of both physical and relational aggression in preadolescence. Children self-reported hostile attribution bias was derived from their responses to hypothetical vignettes in third, fourth, and fifth grades. Participants were only allowed to give responses that indicated that children were trying "to be mean" or "not to be mean." Younger children might not have understood the vignettes, but they were still forced to give a response. Composites were created in order to measure children's hostile attribution bias. The results of this study indicated that children who attributed more hostility to physical provocations used more physical and relational aggression in preadolescence. This study was limited by measuring relational and physical aggression by teacher and parent report, which might have introduced reporter's gender biases and the failure to measure more covert

relationally aggressive behaviors. Peers might provide a more accurate assessment of children's use of aggression in preadolescence. Future research should consider how children's hostile attribution bias is linked to peer reported physical and relational aggression in preadolescence.

In addition to the work examining hostile attribution bias in relation to both types of aggression, one study has assessed the effect of adolescent's physiological regulation on their concurrent use of both physical and relational aggression (Sijtsema et al., 2011). The results of this work revealed that female adolescents who had poor physiological regulation used more adult reported physical and relational aggression. However, this study did not assess the longitudinal effect of children's physiological regulation in middle childhood on their use of aggression in preadolescence. Earlier physiological regulation might allow children to establish important social bonds that lay the groundwork for them to engage in later relational aggression; thus, it is important to study these relations over time. In addition to the concurrent nature of the study, it also has some other limitations: it included female participants only, measured aggression using adult report, and measured physiological regulation to a specific relational exclusion task. These limitations restrict the generalizability of the findings.

Although there are a few studies examining the role of hostile attribution bias and physiological regulation on children's use of both forms of aggression, unfortunately, no research has identified the role of middle childhood executive functioning as a predictor of both preadolescent physical and relational aggression. One study has identified the concurrent association between preschooler's effortful control and their use of both

physical and relational aggression (Gower & Crick, 2011). Children who had poor effortful control used more physical and relational aggression at lower levels of baseline sympathetic nervous system activity. Although this research focused on an earlier developmental period, measured a behavior related to executive functioning skills, and included an interaction with children's sympathetic nervous system arousal, these results could indicate that poor executive functioning in middle childhood might increase children's use of physical and relational aggression in preadolescence.

In addition to the highlighted role of children's individual processes as separate predictors of their use of aggression, the reviewed theoretical and empirical work also suggests that children's use of physical and relational aggression result from complex interactive processes (e.g. Lemerise & Arsenio, 2000). However, very few studies have identified how multiple factors in middle childhood interact and predict preadolescents' use of relational and physical aggression. For example, children who have hostile attribution bias might only use physical aggression if they cannot control the negative emotions that result from this perceived of threat. Some existing research has examined how multiple individual factors exacerbate the risk of children's use of aggression concurrently (Gower & Crick, 2011; Sijtsema et al., 2011). But no study has evaluated how the interaction of multiple factors in middle childhood might predict the children's use of both forms of aggression in preadolescence. This reveals a large gap in the aggression literature. In order to examine males' and females' use of aggression in preadolescence, a model should include both preadolescent relational and physical

aggression and hypothesize specific interactive effects of children's hostile attribution bias, physiological regulation, and executive functioning in middle childhood.

Model of the Differential Prediction of Physical and Relational Aggression.

Based on the reviewed theoretical and empirical work, I developed a model of how middle childhood individual processes predict preadolescents' use of physical and relational aggression. I predicted that patterns of hostile attribution bias, physiological regulation, and executive functioning during middle childhood would significantly predict patterns of preadolescents' use of physical and relational aggression (see Figure 1). This model focuses on children's individual abilities and not external risk factors, such as parenting and peer influence, because in middle childhood children are becoming independent and have developed abilities that help guide their own behaviors, thoughts, physiology, and emotions. Although parents and peers might continue to influence these behaviors, it is important to identify whether children's own abilities predict their aggressive behaviors in preadolescence.

This model makes a number of specific predictions about how individual factors interact to predict children's use of physical and relational aggression. First, I predict that children who have increased hostile attribution bias will use more physical and relational aggression in preadolescence. For example, children who have high hostile attribution bias perceive more threats in their environment, and as a consequence they might think aggression is a normative behavior. Over time, children who have increased hostile attribution bias will learn to use more physical and relational aggression because this bias will justify their use of aggression against their peers (Dodge, 1986). In addition, children

who have high hostile attribution bias might have an increased physiological response to the perceived threats in their environment, and they might use aggression in order to decrease their physiological response (Cannon, 1928; Dodge, 1996). Children might also become angrier, because of these perceived threats (Lemerise & Arsenio, 2000). They might seek to reduce their negative emotional state by using more aggression. Hostile attribution bias thus creates an emotional and physiological challenge for some children, and children might use relational and physical aggression as a retaliatory response to this emotional challenge.

In spite of this, not all children who have increased hostile attribution bias will use more aggression (e.g. Nelson et al., 2009). A second prediction of the model suggests that children who have better RSA physiological regulation will not use more aggression as a response to their increased hostile attribution bias. Children who can control their physiological arousal during an emotional challenge, indexed by increased RSA withdrawal, might be able to successfully control their negative emotions. Consequently, they might not use more retaliatory aggression as a response to their increased hostile attribution bias. Alternatively, children who have poor physiological regulation to emotional challenges might not be able to control their negative emotions and physiological arousal. These poorly regulated children might be unable to successfully engage and disengage with their environment, subsequently they are more likely to be rejected by their peers and not have the opportunities to learn alternative social behaviors (Calkins & Keane, 2004). And children who have immature social abilities might use physical aggression as an instantaneous, overt coping behavior (Bandura, 1978).

Subsequently, poorly regulated children who have increased hostile attribution bias will use more physical aggression.

In contrast to the hypothesis that children who have poor physiological regulation will use more physical aggression, children who have better physiological regulation will use more relational aggression in response to increased hostile attribution bias. Preadolescents' relational aggression can be more covert, deliberate, and delayed (Xie et al., 2005). As such, children need to have better control of their emotional and physiological arousal in order to use relational aggression as a response to their increased hostile attribution bias. Children who have better physiological regulation will be able to successfully interact with their peers (Calkins & Keane, 2004). This will provide them with opportunities to learn more successful social skills. These interactions with their peers and social skills will give them more opportunities and abilities to manipulate their peer relationships. Thus, children who have better physiological regulation will use more relational aggression in preadolescence in order to cope with the negative emotions and physiological arousal that is a result of their increased hostile attribution bias.

In addition to the proposed role of physiological regulation, the model also suggests that children's executive functioning abilities will affect the relation between children's hostile attribution bias and their use of physical and relational aggression. Children who have increased hostile attribution bias have more emotional problems that they must solve. Children's executive functioning abilities will allow them to determine how and when they will respond to these perceived threats. Children who have poor executive functioning abilities will not be able to reframe these perceived negative events

and delay their responses to emotional challenges. Consequently, they will use more aggression to solve their emotional problems.

More specifically, the model proposes that children's executive functioning abilities also will relate differently to their use of physical and relational aggression. Children who have poor executive functioning abilities will not be able to inhibit their dominant behavioral responses, and they cannot plan a more appropriate response to perceived hostility. They will fail to remember the negative consequences that result from their aggressive behaviors and forget their social goals of being accepted by their peers. Hence, children with poor executive functioning abilities will use more uninhibited overt physical aggression in preadolescence. For example, if a child feels threatened when another peer bumps into him or her, and the child cannot inhibit their automatic dominant response to retaliate or plan an alternative behavioral response, they will choose to hit the peer immediately.

In contrast to the hypothesized link between children's poor executive functioning abilities and increased use of physical aggression, the model proposes that children who have better executive functioning abilities will use more relational aggression in response to their increased hostile attribution bias. Older children often use relational aggression as a covert, delayed, and deliberate response to their emotional problems (Xie et al., 2005). Thus, children who have better executive functioning abilities will use more relational aggression because it will be a more appropriate, inhibited, planful response to their perceived hostility. Children who have better working memory will use relational aggression, because it allows them to attain their remembered social goals. For example,

if a child is not invited to sit at a peer's table at lunch and becomes angry, and if he/she can inhibit their automatic response (hitting), the child will be more likely to exclude that peer from his or her lunch table in the future. This relationally aggressive behavior allows the child to avoid negative consequences (i.e. peer rejection for hitting others) and meet his or her social goals, while still responding to his or her emotional problems.

In addition to the separate effects of children's physiological regulation and executive functioning abilities, the model postulates that these processes together will affect how children respond to perceived hostility and increase preadolescents' use of physical and relational aggression. Children who cannot control their negative emotional and physiological responses to emotional challenges or use their executive functioning abilities to solve their emotional problems will be the most physically aggressive in preadolescence in response to their increased hostile attribution bias. In contrast, children who can control their negative emotional and physiological responses to emotional challenges and use their executive functioning abilities to solve their emotional problems will use the most relational aggression in preadolescence in response to their increased hostile attribution bias.

The proposed model posits that processes in middle childhood affect children's use of both forms of aggression in preadolescence. However, these processes in childhood will have a distinct effect on preadolescents' use of physical and relational aggression, because children must use relational aggression in a social context. Moreover, children tend to use relational aggression in more covert and delayed ways than physical aggression, which may require more advanced regulatory and problem solving abilities.

A model that predicts children's use of both physical and relational aggression will provide a more nuanced characterization of aggressive boys and girls over middle childhood and preadolescence.

CHAPTER III

AIMS AND HYPOTHESES

Several research questions have emerged from the proposed model of middle childhood individual processes and the prediction of preadolescent physical and relational aggression. 1) Do children's hostile attribution biases influence their use of physical and relational aggression in preadolescence? 2) Does children's physiological regulation as indexed by RSA withdrawal moderate the association between hostile attribution bias and their use of aggression in preadolescence and is this effect different for physical and relational aggression? 3) Does children's executive functioning abilities moderate the association between hostile attribution bias and their use of aggression in preadolescence and is this effect different for physical and relational aggression? 4) Does children's executive functioning interact with physiological regulation to moderate the association between hostile attribution bias and aggression?

Aim 1: To examine the effect of children's hostile attribution bias on preadolescent physical and relational aggression. The initial goal of this research was to identify whether children's hostile attribution bias to all forms of provocation was related to their preadolescent physical and relational aggression. It was hypothesized that children with a greater hostile attribution bias to all forms of provocation at age 7 would use more physical and relational aggression at age 10.

Aim 2: To examine the moderating role of children's physiological regulation, as indexed by RSA withdrawal, on the association between hostile attribution bias and preadolescent physical and relational aggression. Although the regulation of children's sympathetic nervous system activity has been broadly researched as a risk factor for their use of aggression, less is known about how children's parasympathetic nervous system activity might affect their use of physical and relational aggression. It was hypothesized that differences in children's physiological regulation, as indexed by RSA withdrawal at age 7, would moderate the association between hostile attribution bias and physical and relational aggression at age 10. In addition, it was hypothesized that differences in children's RSA withdrawal would predict the differential use of each form of aggression in preadolescence. For children with low RSA withdrawal, greater hostile attribution bias would increase their use of physical aggression at age 10. Alternatively, for children with high RSA withdrawal, greater hostile attribution bias would increase their use of relational aggression at age 10.

Aim 3: To examine the moderating role of executive functioning on the association between the hostile attribution bias and physical and relational aggression. Although children's early executive functioning abilities have not been studied as a factor that contributes simultaneously to their use of both physical and relational aggression in preadolescence, children's executive functioning abilities affect their emotional problem solving and should be included in a model of preadolescent aggression. It was hypothesized that executive functioning, as indexed by planning ability, response inhibition, and working memory at age 7, would moderate the association between hostile

attribution bias and physical and relational aggression at age 10. In addition, it was hypothesized that children's executive functioning abilities would predict each form of aggression differently. For children who scored lower on executive functioning tasks, greater hostile attribution bias would increase their use of physical aggression at age 10. Alternatively, for children who scored higher on executive functioning tasks, greater hostile attribution bias would increase their use of relational aggression at age 10.

Aim 4. To examine the moderating role of executive functioning on the association between the hostile attribution bias, physiological regulation, and physical and relational aggression. Research has suggested that physiological, social, and cognitive factors interact and increase children's likelihood of using aggression (Sijtsema et al., 2011). It was hypothesized that the moderating effect of executive functioning would bolster the effect of physiological regulation on the association between hostile attribution bias and physical and relational aggression. Children who had poor physiological regulation and poor executive functioning abilities at age 7 would use the most physical aggression at age 10 as their hostile attribution bias increased. In contrast, children who had better physiological regulation and more advanced executive functioning abilities at age 7 would use the most relational aggression at age 10 as their hostile attribution bias increased.

CHAPTER IV

METHODS

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 whose mothers completed the CBCL at 2-

years of age (N = 140) were then included in the larger study. Of the entire sample (N = 447), 37% of children were identified as being at risk for future externalizing problems. There were no significant demographic differences between cohorts with regard to gender, χ^2(2, N = 447) = .63, p = .73, race, χ^2(2, N = 447) = 1.13, p = .57, or 2-year SES, F (2, 444) = .53, p = .59.

Of the 447 originally selected participants, 6 were dropped because they did not participate in any data collection at 2 years old. At 7 years of age, 350 families participated, including 19 that did not participate in the 5-year assessment. Families lost to attrition included those who could not be located, moved out of the area, declined participation, or did not respond to phone and letter requests to participate. There were no significant differences between families who did and did not participate in terms of gender, χ^2 (1, N = 447) = 2.12, p = .15, race, χ^2 (3, N = 447) = .19, p = .67, and 2-year externalizing T score, t (445) = 1.30, p = .19. Families with lower 2-year SES, t (432) = -2.61, p < .01, were less likely to participate in the 7-year assessment. 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.

Participants.

The sample for the current study included children who participated in the 7- or 10-year assessments. Children were included in the current study if they had completed

sociometric nominations in second grade or fifth grade (corresponds to 7- and 10-year lab assessments), or if they had participated in lab-based assessments at 7- or 10-year. Four participants were dropped from the current study due to developmental delays. Participants also were excluded if they did not complete the hostile attribution measure at 10 years old, because it did not significantly relate to any other variable in the overall study and it was a focal variable of the current study. Three of the participants did not have demographic information and were also excluded. The total sample for the current study was 308 participants (male = 138, female = 170). The majority of the sample was European American (65.3%), 29.5% of the sample was African American, 3.6% biracial, and 1.6% of the sample identified as other race or ethnicity. Families were economically diverse based on Hollingshead (1975) scores at the 10-year assessment, with a range from 12.00 to 66.00 (M = 44.76, SD = 11.83), thus representing families from each level of social strata typically captured by this scale. Hollingshead scores that range from 40 to 54 reflect minor professional and technical occupations considered to be representative of the middle class.

Procedures.

7- and 10-Year Laboratory Assessments. When the children were approximately 7 and 10 years old, participants were contacted by research assistants via telephone and mailings. Children and their mothers were asked to come to the laboratory and participate in a series of lab tasks to assess social, cognitive, emotional, and behavioral factors. Some of the tasks were conducted with the child alone, and some tasks were conducted with the mother and child. These tasks took about two hours to complete. Trained research

assistants and graduate students administered all laboratory tasks. Cardiac vagal regulation was assessed throughout all the laboratory tasks. Participants were asked to wear electrodes that monitored their physiological functioning while they completed a set of laboratory tasks. Only tasks that were included in the current study are described, however neutral and positive tasks occurred in between baseline and challenge tasks. Mothers were also asked to complete questionnaires during these visits to the laboratory to assess demographics information at age 7 and 10.

Baseline cardiac activity was assessed at the beginning of each visit: participants were asked to sit still for 4 minutes and watch a brief movie. Later during the visits, challenge tasks were administered to assess physiological regulation. Participants were asked to solve a puzzle at 7 year and 10 year that was inside a constructed box, where they could put their hands inside to feel, but not see the pieces. The child was alone and given 5 minutes to complete the puzzle task. Challenge tasks were similar between 7 and 10 year; however, they were modified in order to be developmentally appropriate (e.g. the use of a more complicated puzzle). Also during these visits to the laboratory, participants were told several short vignettes that described ambiguous peer behaviors. Their responses about the intent of the peer were used to assess hostile attribution bias. In addition, participants were administered three separate tasks that assessed executive functioning. Participants were asked to build block towers, name color-words, and repeat number-strings backward. Each of these tasks took approximately 2-5 minutes to complete.

Second Grade and Fifth Grade Sociometric Nomination. In addition to completing laboratory tasks, sociometric nomination procedures were used to assess aggression in both the second and fifth grades. Participants' parents were asked if students and teachers in their child's classrooms could be contacted. Teachers were contacted and all of the students in the classrooms (2nd grade) and grade (5th grade) of the participants were given consent forms. Parents were required to consent to their children's participation in sociometric nomination procedures. Students who had parental consent were interviewed individually (2nd grade) or as a group (5th grade) by classroom. Trained research assistants were available to answer questions during the sociometric nomination procedure or to help any student who needed additional guidance. All interviews took place at least eight weeks into the school year, so children had an opportunity to become acquainted with their peers. The sociometric procedures used were a modified version of Coie, Dodge, and Copotelli's (1982) original procedures (Terry, 2000), in which children were allowed to make unlimited nominations and were not constrained to same-gender nominations. This procedure allows for increased precision and reduced measurement error compared to limited nomination procedures (Marks, Babcock, Cillessen, & Crick, 2013).

In the second grade, participants were asked to nominate children within their classroom only. Data were collected in 147 classrooms at 64 schools. Classrooms had an average of 20 students (range = 10-27). The mean rate of participation was 84% of students across classrooms. According to Terry (2000), this participation rate is acceptable for the unlimited nomination procedure. In the fifth grade, data collection

occurred at the grade level due to the structural changes from elementary to middle school. Students in the fifth grade at participating schools typically take classes with a variety of students throughout the day, and therefore they know most of their peers. Data were collected from 42 schools in 347 classrooms, with an average of 49 students participating at each school (SD = 22.30). The average participation rate was 63%, which is an adequate participation rate (Marks et al., 2013). Only the nominations for our subsample were used. Our participants were clustered 5 students or less per school.

Measures.

Physical Aggression. Physical aggression was assessed using sociometric peer nomination of the behavioral description: "kids who fight." Although this is a single item nomination, this item has increased reliability because multiple children are raters (Marks et al., 2013). The total number of nominations for children was used and standardized within second grade classroom or fifth grade school for all children who participated, which allows the comparison of different size classrooms and grades. For the analyses this item only reflects the participants' scores from the larger project and not all children who were nominated, therefore this is not a true z-score ($M \neq 0.00$, $SD \neq 1.00$). Higher scores indicate greater peer perception of children's engagement in physical aggression compared to the average rating of physical aggression in their classroom or grade. By using a sociometric z-score of physical aggression standardized within classroom or grade, children's ratings of physical aggression are compared to the average use of their peer's use of physical aggression in the specific school context.

Thus, these ratings are not an objective measure of children's use of physical aggression and might fluctuate if their peers use more or less physical aggression. A sum score of total nominations of physical aggression (controlling for exposure: how many nominators multiplied by how many behavioral indicators) were used in post-hoc analyses in order to account for the effect of school aggression context on these z-scores. Proportion scores were also calculated from how many nominations the child received to how many nominations were possible in the classroom or grade in order to examine mean differences across time and by gender.

Relational Aggression. Relational aggression was assessed through sociometric peer nomination of three separate behaviors that conceptually map onto the relational aggression construct (Crick & Grotpeter, 1995): "kids who spreads rumors about others," "kids who exclude others," and "kids who say they will stop liking you." The total number of nominations of children for these behaviors was used to create three separate z-scores for all children at second and fifth grade, which allows the comparison of different size classrooms and grades. Only those scores from the participants of the larger project were included, therefore these items were not true z-scores ($M \neq 0.00$, $SD \neq 1.00$). These items had a high internal reliability at second ($\alpha = .77$) and fifth grade ($\alpha = .89$), so a composite was created from these three items at second and fifth grade and restandardized. Higher scores indicated greater peer perception of children's engagement in relational aggression compared to the average rating of relation aggression in their classroom or grade.

By using a sociometric z-score of relational aggression standardized within classroom or grade, children's ratings of relational aggression are compared to the average use of their peers' relational aggression in their specific school context. Thus these ratings are not an objective measure of children's use of relational aggression and might fluctuate if their peers use more or less relational aggression. A sum score of total nominations of relational aggression (controlling for exposure: how many nominators multiplied by how many behavioral indicators) were used in post-hoc analyses in order to account for the effect of context on the standardized scores. Proportion scores were also calculated from how many nominations the child received to how many nominations possible in order to examine mean differences across time and by gender.

Hostile Attribution Bias. Hostile attribution bias was assessed with the Intent Attributions and Feelings of Distress questionnaire (IAFD; Crick, 1995). The IAFD includes five stories that describe ambiguous scenarios of provocation. Participants were asked to determine if these scenarios are hostile or benign, and if the children in these scenarios meant to be mean or not mean. Possible scores for these two questions are 0 (benign/not mean) to 1 (hostile/mean). Three of these stories describe potential overt aggressive behaviors (e.g. broken objects), and two of these stories describe potential relational aggressive behaviors (e.g. peer rejection). A total hostile attribution bias score was computed as a mean of all 10 hostile attribution bias items (questions 1 and 2 for all scenarios). Higher scores indicated a greater likelihood of perceiving negative events as having hostile intent and greater hostile attribution bias.

Physiological Regulation. Physiological regulation was assessed by measuring cardiac vagal tone (baseline RSA and RSA withdrawal). In order to measure baseline RSA and RSA withdrawal, heart rate and inter-beat intervals were assessed using an electrocardiogram (EKG). Experimenters placed disposable electrodes in a triangle formation on the participant's chest (right collarbone, lower left rib, and lower side of stomach). These electrodes used Fetrode leads connected to a preamplifier, which outputs to either a vagal tone monitor (VTM-I, Delta Biometrics, Inc., Bethesda, MD) for 7-year all cohorts and 10-year cohort 1 or a heart interbeat interval (IBI) monitor (Biolog 399x; UFI; Morro Bay, CA) for 10-year cohorts 2 and 3. Because of the update in equipment, age 10 cohorts 2 and 3 data varied slightly. Cardiac inter-beat intervals were measured between successive R waves of the EKG. The data was edited and analyzed using MXEDIT for 7-year all cohorts and 10-year cohort 1 data and Cardio batch/Edit software (Brain-Body Center, University of Illinois at Chicago, Chicago, IL) for 10-year cohorts 2 and 3 data. However, both of these programs use Porges' (1985) method to calculate RSA. Data was scanned for artifacts, by removing outliers of adjacent data and replacing with points consistent with the surrounding data. We only used data with less than 10% of the data required editing. Frequency band parameters, set between 0.24-1.04 Hz, were used to extract spontaneous cardiac rhythms in HP associated with respiration using a 21-point detrending polynomial algorithm. The natural log of this variance was taken and reported in units of $\ln(msec)^2$. The time series method extracted RSA in sequential 30-s epochs of the inter-beat intervals. Data will be excluded if the standard deviation for the episode was greater than 1.0. The mean of the RSA for the epochs was computed to

indicate an average RSA. When using the Porges method, RSA assessments are robust to changes in respiration rate (Lewis, Furman, McCool, & Porges, 2012); thus respiration rate was not assessed separately.

Baseline RSA was collected while participants are asked to sit still and watch a short clip of a movie for four minutes. This minimized movement, but with very little stimulation. To assess physiological regulation, RSA was collected while participants engaged in a challenge task, which elicited negative affect. Negative affect has been shown to relate to greater RSA withdrawal than positive affect (e.g. Calkins et al., 2002). During the challenge task, participants were asked to complete a puzzle that is in a covered box, so that the participant cannot see the puzzle. Mothers then directed their children how to complete the puzzle. Tasks with another person present have also shown to increase RSA withdrawal (e.g. Calkins et al., 2002). In accordance with previous research (Calkins, 1997; Moore & Calkins, 2004), RSA withdrawal was calculated by a difference score of mean RSA during challenge subtracted from mean RSA during baseline. Lower or negative RSA scores indicated less RSA withdrawal in response to stress and poorer physiological regulation, whereas high or positive RSA scores indicated greater RSA withdrawal in response to stress and greater physiological regulation.

Executive Functioning. Executive functioning was assessed with the use of the DKEF's Tower task (Delis, Kaplan, & Kramer, 2001) at age 7 and at age 10, Stroop Color-Word Interference task (Stroop, 1935), and the Wechsler Intelligence Scale for Children – third edition (WISC-III; Wechsler, 1991). These tasks allowed the integration of multiple primary components of executive functioning: inhibitory control, planning

ability, and working memory. These components are theoretically associated with aggression. In the DKEF's tower task, participants were instructed to move five circular pieces onto three wooden pegs to replicate pictures of towers they had been shown by the experimenter. Participants were then asked to move the pieces to replicate the pictures as quickly as possible. They were told there are two rules to follow: never place a big piece on top of a little piece, and only move one piece at a time. The total amount of time per moves ratio was used to indicate the planning ability component of executive functioning. Lower scores indicated better executive functioning ability.

Executive functioning was also assessed using the Stroop Color-Word Interference task (Stroop, 1935). Participants were asked to name color blocks, read color words, name the ink color of color words printed in different colored ink (inhibition trial), and name the ink of color words printed in different colored ink and say color words when the words are in boxes. The total number of self-corrections during the inhibition trial indicated response inhibition; lower scores indicated better executive functioning ability.

The digit span backward task of the WISC-III was used to indicate working memory (Luo, Chen, Zen, & Murray, 2010). Participants were asked to orally repeat back a string of digits to the experimenter in the reverse order. The number of correct trials indicates working memory, such that higher scores indicated greater working memory and better executive functioning ability.

Research has suggested that working memory, planning ability, problem solving, and response inhibition are associated with children's aggression (Granvald &

Marciszko, 2015; McQuade et al., 2014; Ellis et al., 2009), therefore a composite was created using the standardized digit span backward, reverse scored time per move ratio, and reverse scored total number of self-corrections to index executive functioning (Cronbach's $\alpha = .37$). The lower alpha of these indicators is not problematic, because these items are formative indicators of a construct and not causal indicators of a construct. Formative indicators do not necessarily need to be related in order to form a composite variable (Bollen & Bauldry, 2011). However, the individual items were also analyzed as separate predictors of physical and relational aggression nominations.

Covariates. Participant demographic information also was collected. Mothers reported on child gender. They also reported on family socioeconomic status (SES) at the age 7 and age 10 assessments by reporting on education level and employment of themselves and their spouse or partner. This information was used to generate the Hollingshead four-factor index of socioeconomic status. Participants' verbal ability was also used as a covariate, since verbal ability has also been linked to social behaviors and executive functioning. A verbal comprehension index score was derived from the Information, Similarities, Vocabulary, and Comprehension sub-tests of the WISC-III (Wechsler, 1991). A higher index score indicates greater verbal ability.

CHAPTER IV

RESULTS

Missing Data.

Missing data occurred in this project due to attrition and failure to complete all assessments. Using Little's MCAR test, data was missing completely at random ($\chi 2$ = 1279.543, df = 1284, p = .530). Missing data were imputed using multiple imputation (Rubin, 1987; Schafer, 1997; Schafer & Graham, 2002). Demographic and family characteristics, along with longitudinal child characteristics were used as predictors in the imputation dataset to estimate missing data. Using Schafer's (1997; Schafer & Graham, 2002) recommended procedures, an iterative EM algorithm was used. Ten datasets were created in which all observed data were represented and missing data estimated. The resulting values from the 10 datasets were then used to create an average for a final imputed dataset, which was used in the current analyses. A total sample size of 308 participants was used for the focal analyses.

Preliminary Analyses.

Descriptive statistics were conducted in SPSS version 22.0 (SPSS, Inc., Chicago IL). Means, standard deviations, skew and kurtosis, and first order correlations are provided for all primary variables of interest (see Table 1 and Table 2). As with previous research, the physical aggression variable at age 10 had four outliers and demonstrated a high level of skew (e.g. Rose, Swenson, & Waller, 2004). The top four outliers were

changed to the next largest value to correct for this skewness. The total number of moves to time ratio also had nine significant outliers at age 10; these scores were changed to the next highest value to correct for this skewness.

Physical and relational aggression at age 10 were significantly and positively correlated ($r = .59$, $p < .01$), such that children who were nominated as using more physical aggression at age 10 were also more likely to be nominated as using more relational aggression at age 10. In addition, peer nominated physical aggression at age 7 was significantly and positively correlated with both peer nominated physical aggression ($r = .39$, $p < .01$) and relational aggression ($r = .23$, $p < .01$) at age 10. Peer nominated relational aggression at age 7 also was significantly and positively correlated with both peer nominated physical aggression ($r = .35$, $p < .01$) and peer nominated relational aggression ($r = .30$, $p < .01$) at age 10. Children who were nominated as using more aggression at age 7 also were nominated as using more aggression at age 10.

A repeated measures ANOVA demonstrated that for all participants the mean proportion of nominations for physical aggression significantly decreased over time (Age 7 $M = .17$, $SD = .17$, Age 10 $M = .12$, $SD = .12$, F (1,307) = 31.31, $p = .000$). For this analysis proportion scores of total nominations received to total nominations possible was used, rather than z-scores because z-scores have a mean of zero at every time point. For males only, the mean proportion of nominations significantly decreased over time (Age 7 $M = .22$, $SD = .19$; Age 10 $M = .15$, $SD = .14$, F (1,137) = 19.24, $p < .001$) and for females only, the mean proportion of nominations significantly decreased over time (Age 7 $M = .14$, $SD = .14$; Age 10 $M = .10$, $SD = .10$, F (1,169) = 12.35, $p < .01$).

Similarly, a repeated measures ANOVA demonstrated that for all participants, the mean proportion of nominations for relational aggression significantly decreased over time (Age 7 $M = .14$, $SD = .10$; Age 10 $M = .11$, $SD = .08$; F (1,307) = 28.10, $p < .001$) and this was observed for males only (Age 7 $M = .16$, $SD = .11$; Age 10 $M = .09$, $SD = .07$; F (1,137) = 43.09, $p < .001$). For females only, the mean proportion of relational aggression nominations did not change over time (Age 7 $M = .13$, $SD = .09$; Age 10 $M = .12$, $SD = .09$; F (1,169) = 1.47, $p = .23$). Because of the general decrease in mean aggression nominations over time (see Figure 2), controlling for age 7 physical and relational aggression does not allow a test of how other processes in middle childhood might predict greater physical and relational aggression, which is the primary aim of the current study. Therefore, focal analyses were conducted without controlling for earlier aggression and do not identify a developmental progression in physical and relational aggression.

There were significant gender differences in aggression. Males ($M = .15$, $SD = .14$) were more likely to receive more peer nominations of physical aggression than females at age 10 ($M = .10$, $SD = .10$) ($t = 3.25$, $df = 306$, $p < .01$). Males ($M = .22$, $SD = .19$) also were more likely to receive more peer nominations of physical aggression at age 7 than females ($M = .14$, $SD = .14$) ($t = 4.30$, $df = 306$, $p < .001$). Females ($M = .12$, $SD = .09$) were more likely to receive more peer nominations of relational aggression at age 10 than males ($M = .09$, $SD = .07$) ($t = -2.41$, $df = 306$, $p < .05$). Interestingly, males ($M = .16$, $SD = .11$) were more likely to receive more peer nominations of relational aggression at age 7 than females ($M = .13$, $SD = .09$) ($t = 2.81$, $df = 306$, $p < .01$). These results

demonstrate that in middle childhood males are generally perceived as more aggressive than females. These preliminary differences in males and females peer-nominated use of physical and relational aggression suggest that it is important to explore the effect of gender on the focal analyses.

Analyses Addressing Research Questions.

To investigate the focal research questions, multivariate multiple regression analyses were conducted using generalized linear models in SPSS version 22.0 (SPSS, Inc., Chicago IL). These analyses allowed for the inclusion of multiple continuously distributed independent and dependent variables and accounted for possible intercorrelations between the dependent and independent variables (Haase & Ellis, 1987). A test of multivariate multiple regression also reduced Type I errors. *Pillais' Trace* was used to evaluate multivariate significance given its robustness when sample sizes are unequal and when the assumption of homogeneity of variance-covariance matrices is violated (Tabachnick & Fidell, 2007).

Aim 1 (Hypothesis 1): Age 7 Hostile Attribution Bias and the Prediction of Age 10 Physical and Relational Aggression. To investigate the first hypothesis that greater hostile attribution bias at age 7 predicted more physical and relational aggression at age 10, hostile attribution bias at age 7 was entered as a predictor of age 10 physical and relational aggression nominations. Gender, child SES, and verbal comprehension at age 7 were included as covariates. *Pillais' Trace* = .21, $F(10, 604) = 6.89$, $p < .001$ indicated that this model significantly accounted for peer nominations of physical and relational

aggression at age 10. The total model explained .10 of the variance in physical aggression and .03 of the variance in relational aggression at age 10 (η^2).

Univariate follow-up F-tests demonstrated that peer nominations of physical aggression at age 10 were different for males and females (β = -.37, *SE* = .09, $p < .01$). Male children were more likely to be perceived as using more physical aggression at age 10. However, hypothesis 1a was not supported: hostile attribution bias at age 7 did not significantly predict greater peer nominated physical aggression at age 10 (β = .04, *SE* = .03, *n.s.*).

The univariate follow-up F-test indicated that peer nominated relational aggression at age 10 were different for males and females (β = .27, *SE* = .09, $p < .01$). In contrast to the prediction of physical aggression nominations, female children were more likely to be perceived as using more relational aggression at age 10. Hypothesis 1b was also not supported: hostile attribution bias at age 7 did not significantly predict greater peer nominations of relational aggression at age 10 (β = .03, *SE* = .03, *n.s.)*.

Aim 2 (Hypothesis 2) Age 7 Physiological Regulation Moderates the Association Between Age 7 Hostile Attribution Bias and Age 10 Physical and Relational Aggression. To investigate the second hypothesis and determine if physiological regulation moderated the association between hostile attribution bias and physical and relational aggression, RSA withdrawal at age 7 and the two-way interaction term of RSA withdrawal and hostile attribution bias were included in a multivariate multiple regression predicting age 10 peer nominated relational and physical aggression. This model also included the covariates. An interaction term was computed by multiplying together the centered

hostile attribution bias and the centered RSA withdrawal variable. *Pillai's Trace* indicated this model was multivariate significant (*Pillai's* Trace = .22, F(14, 600) = 5.23, p < .001). The total model explained .11 of the variance in physical aggression and .03 of the variance in relational aggression at age 10 (η^2).

Although the overall model was significant, univariate follow-up F-tests did not support the second hypothesis. RSA withdrawal at age 7 did not have a significant main effect on peer nominated physical aggression at age 10 (β = .09, *SE* = .06, *n.s.*). The interaction of hostile attribution bias and RSA withdrawal was also not significant (β = -.04, *SE* = .03, *n.s.*), controlling for the covariates. Thus, no further analyses were conducted to probe this association.

Similar to the null effects of RSA withdrawal on age 10 physical aggression peer nominations, univariate follow-up F-tests of peer nominated relational aggression at age 10 showed that there was no significant main effect of RSA withdrawal (β = .04, *SE* = .06, *n.s.*). In addition, the interaction of hostile attribution bias and RSA withdrawal (β = -.04, *SE* = .03, *n.s.*) did not significantly predict peer nominated relational aggression at age 10, controlling for the covariates. Thus, no further analyses were conducted to probe this association.

Aim 3 (Hypothesis 3) Age 7 Executive Functioning Moderates the Association Between Age 7 Hostile Attribution Bias and Age 10 Physical and Relational Aggression. In order to investigate the third hypothesis and determine if executive functioning moderated the association between hostile attribution bias and peer nominated relational and physical aggression at age 10, executive functioning at age 7 and the two-way

interaction term of executive functioning and hostile attribution bias were included in a multivariate multiple regression. An interaction term was computed by multiplying together the centered executive functioning composite and the centered hostile attribution bias variable. *Pillai's Trace* indicated that the model was multivariate significance (*Pillai's Trace* = .23, $F(14, 600) = 5.65$, $p < .001$). The total model explained .11 of the variance in physical aggression and .04 of the variance in relational aggression at age 10 (η^2).

Follow-up univariate F-tests of peer nominated physical aggression at age 10 indicated that there was a significant main effect of executive functioning ($\beta = -.14$, $SE = .07$, $p < .05$), such that greater executive functioning scores at age 7 predicted lower peer nominated physical aggression at age 10. These results suggest that children who had higher executive functioning scores at age 7 received fewer peer nominations of physical aggression at age 10. However, the two-way interaction of hostile attribution bias and executive functioning did not significantly predict peer nominated physical aggression at age 10 ($\beta = .04$, $SE = .03$, *n.s.*). Thus, no further analyses were conducted to probe this association. These results do not support hypothesis 3a and do not demonstrate that executive functioning at age 7 significantly moderated the association between hostile attribution bias at age 7 and peer nominated physical aggression at age 10.

Follow-up univariate F-tests of peer nominated relational aggression at age 10 indicated that there was not a significant main effect of executive functioning predicting relational aggression at age 10 ($\beta = -.01$, $SE = .07$, *n.s.*). However, the two-way interaction of hostile attribution bias and executive functioning significantly predicted

peer nominated relational aggression at age 10 (β = .06, *SE* = .03, $p < .05$), including the covariates. Probing the significant two-way interaction using a simple slopes analysis (Aiken & West, 1991) showed that the association between peer nominated relational aggression and hostile attribution bias was significant at high (β = .08, *SE* = .04, $p < .05$) levels of executive functioning. Therefore, among children who have high scores on executive functioning tasks, increased hostile attribution bias was associated with more peer nominations of relational aggression at age 10. This association was not significant at low levels of executive functioning (β = .00, *SE* = .03, *n.s.*). As can be seen in Figure 3, for children who scored high in executive functioning at age 7, as hostile attribution bias increased they received more nominations of relational aggression at age 10.

As an adjunct analysis, three separate multivariate multiple regressions were conducted to explore the individual associations between the separate components of executive functioning and peer nominated aggression. Because executive functioning research has proposed that the different components of executive functioning have unique effects on social functioning (e.g. McQuade et al., 2013), these adjunct analyses tested the separate effects of planning ability, working memory, and inhibitory control on peer nominated aggression. Unique interaction terms were created by multiplying together the centered hostile attribution bias and the centered individual executive functioning components. Although all models were multivariate significant (Color Word Total Errors *Pillai's Trace* =.22, $F(14, 600) = 5.36$, $p < .001$; Time per move ratio *Pillai's Trace* =.23, $F(14, 600) = 5.44$, $p < .001$; Digit Span Backward *Pillai's Trace* = .22, $F(14, 600) = 5.26$, $p < .001$), none of the separate executive functioning components significantly predicted

children's peer nominated use of physical aggression at age 10. Children who had lower inhibition did not receive more peer nominations of physical aggression at age 10 (β = .02, *SE* = .01, *n.s.*). Children who had poorer planning ability did not receive more peer nominations of physical aggression at age 10 (β = .01, *SE* = .01, *n.s.*). Children who had poorer working memory did not receive more peer nominations of physical aggression at age 10 (β = -.08, *SE* = .04, *p* = .065). None of the two-way interactions significantly predicted children's peer nominations of physical aggression at age 10 (hostile attribution x inhibitory control β = .00, *SE* = .00, *n.s.;* hostile attribution x planning ability β = .01, *SE* = .02, *n.s.*; hostile attribution x working memory β = .01, *SE* = .02, *n.s.*). Therefore, no follow-up analyses were conducted.

Children's peer nominations of relational aggression at age 10 were not significantly predicted by inhibition (β = .02, *SE* = .01, *n.s.*), planning ability (β = -.01, *SE* = .01, *n.s.*), nor working memory (β = -.02, *SE* = .04, *n.s.*). In addition, none of the two-way interactions significantly predicted children's peer nominations of relational aggression at age 10 (hostile attribution x inhibitory control β = -.01, *SE* = .01, *n.s*; hostile attribution x planning ability β = -.01, *SE* = .00, *n.s.*; hostile attribution x working memory (β = .02, *SE* = .02, *n.s).* Therefore, no follow-up analyses were conducted.

Aim 4 (Hypothesis 4) Age 7 Executive Functioning Moderates the Association Between Age 7 Physiological Regulation, Hostile Attribution Bias, and Age 10 Physical and Relational Aggression. Lastly to test the fourth hypothesis and examine the moderating role of executive functioning on the association between hostile attribution bias, physiological regulation, and peer nominated aggression, the three-way interaction

term of hostile attribution bias, RSA withdrawal, and executive functioning at age 7 was included in the multivariate multiple regression. Although the model was multivariate significant (*Pillai's Trace* = .26, $F(26, 592) = 4.06$, $p < .001$), the three-way interaction of hostile attribution bias, RSA withdrawal, and executive functioning at age 7 did not significantly predict greater peer nominations of age 10 physical aggression ($\beta = -.03$, $SE = .04$, *n.s.*) or relational aggression ($\beta = -.04$, $SE = .04$, *n.s.*). Therefore, no follow-up analyses were conducted and hypothesis 4 was not supported. The total model explained .13 of the variance in peer nominated physical aggression and .05 of the variance in peer nominated relational aggression at age 10 (η^2). Table 2 includes all parameter estimates for the separate hypotheses.

Gender Effects on the Models. In addition to including sex as a covariate in the model, in order to investigate gender differences in these associations two-way, three-way, and four-way interactions between the focal variables and sex were included. Significant interactions were thus probed at high and low levels of the moderators for males and females separately. In order to examine the moderating role of sex on the association between hostile attribution bias, physiological regulation, executive functioning, and peer nominated physical and relational aggression, the four-way interaction term of sex, hostile attribution bias, RSA withdrawal, and executive functioning at age 7 was included in a multivariate multiple regression.

The model was multivariate significant (*Pillai's Trace* = .32, $F(32, 578) = 3.34$, $p < .001$), and the inclusion of the sex interactions explained .16 of the variance in peer nominated physical aggression and .07 of the variance in peer nominated relational

aggression at age 10 (η^2). Univariate analyses demonstrated that in general the associations between individual processes in childhood and peer nominated aggression at age 10 did not differ for males and females. The only significant interaction with sex was the two-way interaction between hostile attribution bias and sex predicting children's relational aggression (β = .11, *SE* = .05, p< .05). Probing this interaction demonstrated that for girls only, greater hostile attribution bias predicted greater peer nominations of relational aggression. Hostile attribution bias did not significantly predict relational aggression nominations for boys (β = -.02, *SE* = .03, *n.s).* The four-way interaction of hostile attribution bias, RSA withdrawal, and executive functioning, and sex at age 7 did not significantly predict greater peer nominations of age 10 physical aggression (β = -.06, *SE* = .09, *n.s.*) or relational aggression (β = -.07, *SE* = .09, *n.s.*). No follow-up analyses were conducted.

Post-Hoc Analyses—Addressing Classroom Effects on Peer Nominations.

Due to the use of z-scores to measure peer nominated physical and relational aggression at age 10, participants' nominations of aggression were not objective measures of aggression engagement. These scores were created by comparison to a classroom average of nominations, and thus participants' aggression scores might be influenced by school context. For example, a school with highly aggressive children might have more average nominations of physical aggression, so that a participant who receives 36 nominations of fighting others might only have a z-score of 1.00. In contrast, a school with less aggressive children might have lower average nominations of physical aggression, so that a participant who receives 10 nominations of fighting would receive a

z-score of 2.00. And in comparison, the participant with 10 nominations would be rated as more aggressive than the participant with 36 nominations, because of their school context. Although there is an assumption that the relationships between the focal variables and aggression z-scores are the same in every school, raw nominations can also be used in the analyses to account for differences in participants' school contexts.

In order to test the hypotheses using physical and relational aggression raw peer nominations at age 10, generalized linear mixed models in SAS v. 9.4 (SAS Institute Inc., 2011) were conducted. Physical and relational aggression raw nominations are counts, thus ordinary least square regressions were not appropriate (residuals are not normally distributed; Cohen, Cohen, West, & Aiken, 2003). The glimmix procedure was used, which allows for modeling of non-normal distributions and the inclusion of random effects. A negative binomial regression was chosen to model the data over a Poisson regression, because of the overdispersion in the aggression nominations (Coxe, West, & Aiken, 2009). Negative binomial regression models estimate rates of peer nominations, adjusted for exposure (opportunity to receive nominations, calculated by multiplying number of peer nominators by number of aggression items). Raw nominations could not be imputed, because the exposure variable required knowing the number of peer nominators in the participants' schools. Thus, for these analyses a subset of participants was used (n = 210). Negative binomial regression models are estimated using maximum likelihood procedure and yield log(λ) parameter estimates. Thus, parameter estimates are multiplicative and not additive, and they must be exponentiated for interpretation. Two models were conducted to separately examine the effects of the focal variables at age 7

on age 10 peer nominated physical aggression and on age 10 peer nominated relational aggression, because of the nature of the glimmix procedure did not allow modeling both outcomes simultaneously.

A negative binomial regression model was conducted to examine the effects on age 10 physical aggression of individual characteristics: sex, race, SES, verbal comprehension, hostile attribution bias, RSA withdrawal, executive functioning, and two-way and three-way interactions. The negative binomial model (AIC= 999.35, Pearson χ^2/df = 1.10) fit the data better than a Poisson model (AIC= 1317.11, Pearson χ^2/df = 5.23) (smaller numbers are better; Kline, 2011). Table 3 shows the coefficients, their standard errors, and the exponentiated values of the significant coefficients. Surprisingly, the two-way interaction of hostile attribution bias and executive functioning significantly predicted age 10 physical aggression nominations.

Probing the significant two-way interaction (Aiken & West, 1991) showed that the positive association between hostile attribution bias and physical aggression was significant at high (β = .23, SE= .08, ARR = 1.26, $p < .05$) levels of executive functioning, but not significant at low levels of executive functioning (β = .06, SE = .06, n.s.). For children rated as high in executive functioning, those who scored 1 unit higher on the hostile attribution measure, on average, were expected to be rated as 1.26 times more physically aggressive than a person who scored 1 unit less on hostile attribution bias (see Figure 4).

A separate negative binomial regression model was conducted to examine the effects on age 10 relational aggression of individual characteristics: sex, race, SES, verbal

comprehension, hostile attribution bias, RSA withdrawal, executive functioning, and two-way and three-way interactions. The negative binomial model (AIC = 1435.99, Pearson χ^2/df = .93) fit the data better than a Poisson model (AIC= 2320.75, Pearson χ^2/df = 8.43) (smaller numbers are better; Kline, 2011). Table 3 shows the coefficients, their standard errors, and the exponentiated values of the significant coefficients. Similar to the multivariate multiple regression the interaction of hostile attribution bias by executive functioning significantly predicted age 10 peer nominations of relational aggression.

Probing the significant two-way interaction (Aiken & West, 1991) showed that the positive association between hostile attribution bias and relational aggression was significant at high (β = .12, SE= .06, ARR = 1.13, $p < .05$) levels of executive functioning, but not significant at low levels of executive functioning (β = .01, SE = .05, n.s.). For children rated as high in executive functioning, those who scored 1 unit higher on the hostile attribution measure, on average, were expected to be rated as 1.13 times more relationally aggressive than a person who scored 1 unit less on hostile attribution bias (see Figure 5).

Sensitivity Analyses: Examining Concurrent Predictors of Age 10 Aggression.

In order to assess whether peer nominated physical and relational aggression were better explained by the same individual processes concurrently in preadolescence, age 10 predictors were also included in separate multivariate multiple regressions. These analyses were identical to the analyses that examined age 7 predictors.

Age 10 Hostile Attribution Bias and the Prediction of Age 10 Physical and Relational Aggression. When age 10 hostile attribution bias was added to the model, the

model was multivariate significant (*Pillai's Trace* = .23, $F(10, 604) = 7.88$, $p < .001$). The model explained .11 of the variance in peer nominated physical aggression and .04 of the variance in peer nominated relational aggression at age 10 (η^2). Univariate follow-up analyses showed that hostile attribution bias at age 10 did not significantly predict peer nominated physical aggression at age 10 ($\beta = .04$, $SE = .02$, *n.s.*), controlling for sex, race, child SES, and verbal ability at age 7. Hostile attribution bias at age 10 significantly predicted peer nominated relational aggression at age 10 ($\beta = .06$, $SE = .02$, $p < .01$), controlling for sex, race, child SES, and verbal ability at age 7. Children who had increased hostile attribution bias at age 10 were nominated as using more relational aggression at age 10.

Age 10 Physiological Regulation Moderates the Association Between Age 10 Hostile Attribution Bias and Age 10 Physical and Relational Aggression. In a model that included RSA withdrawal at age 10 and the interaction of hostile attribution bias and RSA withdrawal at age 10, the model was multivariate significant (*Pillai's Trace* = .25, $F(14, 600) = 6.05$, $p < .001$). The model explained .11 of the variance in peer nominated physical aggression and .06 of the variance in peer nominated relational aggression at age 10 (η^2). The interaction of hostile attribution bias and RSA withdrawal at age 10 did not significantly predict peer nominated physical aggression at age 10, controlling for sex, race, child SES, and verbal ability ($\beta = -.06$, $SE = .03$, *n.s.*). However, the interaction of hostile attribution bias and RSA withdrawal at age 10 significantly predicted peer nominated relational aggression at age 10, controlling for gender, race, and child SES ($\beta = -.07$, $SE = .03$, $p < .05$). Probing the significant two-way interaction using a simple

slopes analysis (Aiken & West, 1991) showed that the association between peer nominated relational aggression and hostile attribution bias was significant at low (β = .08, *SE* = .03, $p < .01$) levels of RSA withdrawal. Therefore, among children who have lower RSA withdrawal at age 10, greater hostile attribution bias at age 10 is associated with more peer nominations of relational aggression at age 10. This association was not significant at high levels of RSA withdrawal (β = .04, *SE* = .03, *n.s.*). As can be seen in Figure 6 for children who had low RSA withdrawal at age 10, as hostile attribution bias increased they had greater nominations of relational aggression at age 10.

Age 10 Executive Functioning Moderates the Association Between Age 10 Hostile Attribution Bias and Age 10 Physical and Relational Aggression. In a model that included executive functioning scores at age 10 and the interaction of hostile attribution bias and executive functioning scores at age 10, the model was multivariate significant (*Pillai's Trace* = .28, $F(14, 600) = 6.89$, $p < .001$). The model explained .13 of the variance in peer nominated physical aggression and .04 of the variance in peer nominated relational aggression at age 10 (η^2). Lower executive functioning scores at age 10 significantly predicted more peer nominated physical aggression at age 10 (β = -.21, *SE* = .07, $p < .01$). However, the interaction of hostile attribution bias and executive functioning scores at age 10 did not significantly predict peer nominated physical (β = .03, *SE* = .04, *n.s.*) or relational aggression (β = .02, *SE* = .04, *n.s.*) at age 10.

Age 10 Executive Functioning Moderates the Association Between Age 10 Physiological Regulation, Hostile Attribution Bias, and Age 10 Physical and Relational Aggression. When the three-way interaction of hostile attribution bias, RSA withdrawal,

and executive functioning scores at age 10 was included as a predictor of age 10 peer nominations of physical and relational aggression, the model was multivariate significant (*Pillai's Trace* = .30, $F(22, 592) = 4.70$, $p < .001$). The model explained .15 of the variance in peer nominated physical aggression and .06 of the variance in peer nominated relational aggression at age 10 (η^2). The three-way interaction of hostile attribution bias, RSA withdrawal, and executive functioning scores at age 10 did not significantly predict peer nominated physical (β = -.04, *SE* = .04, *n.s.*) or relational aggression (β = -.03, *SE* = .04, *n.s.*) at age 10. Therefore, no follow-up analyses were conducted.

Gender Effects on the Models that include Age 10 Predictors. Lastly, in order to identify if the concurrent associations between age 10 predictors and peer nominations of physical and relational aggression differed for males and females, two-way, three-way, and four-way interactions with sex were also included. The model was multivariate significant (*Pillai's Trace* = .31, $F(32, 578) = 3.34$, $p < .001$), and it explained .16 of the variance in peer nominated physical aggression and .07 of the variance in peer nominated relational aggression at age 10 (η^2). However, univariate follow-up analyses showed that there were no significant differences in the associations for males and females in these processes at age 10 and peer nominations of aggression at age 10. Therefore, no follow-up analyses were conducted.

CHAPTER V

DISCUSSION

Childhood Predictors of Preadolescent Physical and Relational Aggression.

Due to the high costs of aggressive behaviors, a substantial literature has examined factors that predict children's use of aggression. However, this literature has had a limited scope of analysis and has primarily examined the effect that parents and peers have on children's use of physical aggression in early childhood (e.g. Monographs, 2006). Less is known about whether children's individual processes predict their use of both physical and relational aggression in preadolescence. A primary goal of the current study was to examine whether preadolescents' use of physical and relational aggression was a consequence of the interaction of children's hostile attribution bias, RSA withdrawal, and executive functioning abilities in middle childhood.

The current study also evaluated whether these factors differentially predicted children's use of physical aggression versus relational aggression in preadolescence. Based on the heterotypic continuity model of aggression (Björkqvist et al., 1992) it was hypothesized that children who have poor physiological regulation and less advanced executive functioning abilities would use more peer nominated physical aggression as a response to their increased hostile attribution bias. In contrast, it was hypothesized that children who have better physiological regulation and more advanced executive

functioning abilities would use more peer nominated relational aggression as a response to their increased hostile attribution bias.

Aim 1: The Effect of Hostile Attribution Bias. First the relation between children's hostile attribution bias and preadolescent peer nominated aggression was examined. The findings did not support the hypothesis: children who had increased hostile attribution bias in middle childhood did not receive more peer nominations of physical and relational aggression in preadolescence. These findings are surprising, particularly for preadolescents' use of physical aggression, given that extant research has demonstrated that children who have increased hostile attribution bias used more physical aggression concurrently and over time (e.g. Dodge et al, 1995). However, previous work has not consistently linked children's hostile attribution bias to their use of relational aggression (e.g. Nelson et al, 2008).

The unexpected null findings might be explained by the complexity of children's social information processing. The social information processing model delineates six steps that affect children's behaviors; however, similar to other research the current study only examined how children's misinterpretation of information contributed to their use of aggression. Children who have deviations in how they interpret information may not use more aggression in preadolescence, because the other ways they process social information also might have affected their behaviors. For example, if children who have increased hostile attribution bias also selected a goal of being liked by their peers, they may be more likely to cooperate with their peers instead of fighting. Future research should examine how other aspects of children's social information processing exacerbate

or mitigate the effect of their hostile attribution bias and contribute to their use of aggression in preadolescence.

Another explanation for these null findings might lie in the failure to meet the inherent assumptions of the hostile attribution bias model of aggression. The model posits that children who have increased hostile attribution bias will become emotionally upset by the false perception of threats, and they will then use aggressive behaviors as a retaliatory response to cope with these perceived threats. However, not all children use aggression as a retaliatory behavior. Children may have other motives for using aggression in preadolescence. Children may have learned over the course of childhood that aggression can be an effective tool to achieve their goals. Indeed, evidence suggests that preadolescents use aggression combined with social skills to attain and maintain increased perceived popularity (Gangel et al., 2016). In addition, children may use more aggression to bond with their peers. Consequently, they might use more physical aggression to fit into a physically aggressive clique, or they might use more relational aggression as a conversational tool to fit in with a group of peers. Alternatively, some children might use aggression to increase their self-worth and feel better about themselves. It is important to consider the many other ways in which children use aggression, not just as a retaliatory or coping behavior.

Another underlying assumption of the social information processing model that might have influenced the current studies' null findings regards several unexamined extrinsic factors. The social information model (Dodge, 1986) suggests that proximal and distal contextual factors contribute to deviations in children's interpretations of their

social world. And thus, these contextual factors indirectly predict children's use of aggression through the mechanism of hostile attribution bias. For example, children who have more aggressive parents will learn to interpret other people's behaviors as having hostile intent, and they will use more aggression as a response to their hostile intent. However, Bronfenbrenner's ecological systems theory (1979) posits that behaviors are nested within contexts and these proximal and distal extrinsic factors have a direct effect on children's use of aggression. And Bandura (1978) suggests that parents and peers directly and indirectly socialize children to use aggression, and consequently, they will influence children's behaviors and not children's cognitions. For example, children who have aggressive parents might not learn other social behaviors, and they might only know how to respond to social situations by using aggression. And children who experience parental aggression might not interpret hostile behaviors as mean or intentionally threatening, but they will view these behaviors as normative social responses. Consequently, children will use more aggression because they have learned to use aggression from parents, peers, and society, and these contextual factors, not cognitive interpretations, have normalized their aggressive behaviors.

Furthermore, children's earlier hostile attribution bias might not affect their use of aggression in preadolescence, because children's social information processing changes over time. For example, a child who has increased hostile attribution bias in middle childhood might learn to reinterpret current threatening events, because he or she is in a classroom that emphasizes clear communication of intent and values positive social interactions over aggression. In addition, the social situations that seemed threatening and

emotionally arousing in middle childhood may no longer dictate children's behaviors in preadolescence, because children's current social and emotional challenges in preadolescence may be more emotionally arousing. Thus, children's use of retaliatory aggression might be driven by their current emotional responses to the interpretation of hostility, because it is a direct reaction to challenges in their social environment.

Aim 2: The Effect of Physiological Regulation. The moderating effect of physiological regulation on the relation between hostile attribution bias and aggression was also examined. Unexpectedly, the findings did not support the first part of the second hypothesis: children who had poor physiological regulation did not receive more peer nominations of physical aggression in preadolescence as their hostile attribution bias increased. The findings are not consistent with Porges' polyvagal theory (1995), which suggests that children who have poor physiological regulation cannot successfully engage and disengage with others in their environment. Subsequently, children with poor physiological regulation will be rejected by their peers, and they will not learn more appropriate social skills, and this results in incompetent social functioning. However, preadolescents may not always use physical aggression in an incompetent manner.

In addition, the second part of the second hypothesis was also not supported: children who had better physiological regulation did not receive more nominations of relational aggression in preadolescence as their hostile attribution bias increased. This is surprising given that some research has suggested that children who have better physiological regulation are able to successfully engage with their peers. And over time they will develop more advanced social skills (Calkins & Keane, 2004) that will allow

them to use more covert and deliberate relational aggression. An underlying assumption of the hypothesis was that preadolescents use relational aggression in the context of relationships, and due to the covert and deliberate nature of relational aggression in preadolescence it might reflect children's increased social competence (Xie et al., 2005). However, preadolescents may not always use relational aggression in a skillful and competent manner.

The null effects of children's physiological regulation on their use of aggression might be explained by the development of other regulatory behaviors. Children's physiological regulation is just one aspect of self-regulation that affects children's early social behaviors (Porges & Furman, 2011). Children's physiological regulation in middle childhood might not affect their use of aggression in preadolescence, because most children are able to control their physiological responses to challenging situations. Over time children will develop more sophisticated forms of self-regulation (Vohs & Baumeister, 2011), and these more sophisticated control abilities may have a greater effect on their use of aggression in preadolescence. Children's physiological regulation might only affect children's use of aggression in early childhood. It is important to consider the developmental implications of these null findings, and the role of children's more advanced regulatory abilities on their use of preadolescent aggression.

Furthermore, the null findings regarding the role of children's physiological regulation might be explained by the current models' assumptions of why children use aggression: as a coping response to emotional challenges. And based on these assumptions the current study posited that children use their physiological regulatory

abilities to control their negative emotions, which resulted from their increased hostile attribution bias. However, some preadolescents might not use aggression as an emotionally reactive response to social challenges; and thus, they do not require increased physiological regulation to modulate their emotions. Instead, children might use aggression proactively to facilitate social bonding (Maccoby, 2004) or to increase their social status (Rose et al., 2004). Also, some children might not be as susceptible to the emotional challenges posed by increased hostile attribution bias, and subsequently they do not have a negative emotional response that they need to physiologically regulate. For example, boys might not be particularly sensitive to the perception of peer rejection, which is a specific relational form of hostile attribution bias. Although they might recognize that children choose not to invite them to activities to be mean, they will not experience emotional distress to their cognitive interpretation of a social threat. Thus, preadolescents who are not susceptible or do not use aggression as a coping response may not require these basic emotional regulatory abilities to control their aggressive behaviors as a result of increased hostile attribution bias.

Aim 3: The Effect of Executive Functioning Abilities. The moderating effect of executive functioning abilities on the relation between hostile attribution bias and aggression was also examined. The findings only partially supported the hypothesized predictions. Although children who had poor executive functioning abilities did not use more peer nominated physical aggression as their hostile attribution bias increased, consistent with prior research (e.g. Bohlin et al., 2012), children who had lower executive

functioning scores received more peer nominations of physical aggression in preadolescence, regardless of their hostile attribution bias.

In general, preadolescents who have poor executive functioning abilities used more peer nominated physical aggression, which may be explained by their poor behavioral control. Children with poor executive functioning might fail to inhibit dominant behavioral responses when interacting with their peers. Over time, children who have poor behavioral control might be rejected by their peers, and subsequently they might not have the opportunity to learn more positive social skills, such as better communication abilities. And consequently, they might be more likely to use physical aggression as an overt and automatic response to most social situations, whether or not these situations are perceived as threatening.

Unexpectedly, post-hoc analyses that predicted raw nominations of physical aggression demonstrated that children who had more advanced executive functioning abilities received more raw nominations of physical aggression as their hostile attribution bias increased. These findings are in the opposite direction of the hypothesis and might reflect a developmental difference in how children versus preadolescents use physical aggression. The hypothesis was based on the assumption that children use physical aggression as an overt and impulsive response to hostile attribution bias, because they have not developed the cognitive and behavioral abilities to refrain from using these behaviors. However, some preadolescents who have more advanced executive functioning abilities might use more covert and deliberate physical aggression as a

controlled and planful response to perceived threats. Additional research is needed to further explain this unexpected direction of findings.

In contrast to the unexpected findings that predicted preadolescents' peer nominations of physical aggression, the primary and post-hoc analyses supported the relational aggression hypothesis. Children who had better executive functioning abilities received more peer nominations of relational aggression in preadolescence as their hostile attribution bias increased. These findings are consistent with the problem solving framework of executive functioning (Zelazo & Cunningham, 2007), which posits that children who have more sophisticated executive functioning abilities are able to reframe their cognitions, control their automatic responses to challenges, and deliberately plan out more advantageous behaviors. Thus, preadolescents who have advanced executive functioning abilities in middle childhood are able to inhibit their dominant aggressive responses. They may be more successful at covertly manipulating their peers, because they can delay and plan future relationally aggressive behaviors. And they learn that they can use relational aggression in a deliberate way that allows them to meet their social goals and resolve their emotional problems.

Theoretically this hypothesis assumes that preadolescents use relational aggression as a complex response to their emotional challenges, which requires the development of more advanced cognitive control abilities. Children's executive functioning abilities become more refined in middle childhood. As children begin to control their behaviors and understand the effect these behaviors have on others, they become increasingly skillful at interacting with their peers. Children's early development

of these abilities in middle childhood will set the stage for them to have more relationships with their peers and will increase the opportunity to use more relational aggression, since relational aggression is inherently a relational process. And over time, children might value the peer relationships they have developed, and they may use more relational aggression to maintain these relationships, while they also respond to their emotional challenges.

In a post-hoc analysis, children's executive functioning abilities were further delineated into three separate behavioral components in order to identify the skills that specifically might affect the link between children's hostile attribution bias and aggression nominations. However, results showed that neither children's inhibitory control, planning ability, nor working memory components of executive functioning increased their peer nominations of aggression as their hostile attribution bias increased. This is surprising given that previous research has suggested that distinct components of executive functioning have unique effects on children's aggression (Granvald & Marciszko, 2015). The findings generally support a unitary perspective of children's executive functioning abilities and the effect that this global measure has on their use of peer nominated aggression.

Aim 4: The Interactive Effect of Hostile Attribution Bias, Physiological Regulation, and Executive Functioning. The current study did not find an additive effect of the individual factors on children's peer nominated use of physical and relational aggression. The non-significant findings might have resulted from the assumptions that preadolescents use aggression as a retaliatory response to negative emotions. Although

children's early aggressive behaviors might reflect a more reactive and emotional process, preadolescents' aggressive behaviors might reflect a more deliberate and cognitive process. And children's physiological regulatory abilities reflect a more basic emotional control process, which might affect their social competencies and aggression in early childhood (Porges & Furman, 2011), but not their peer nominated use of aggression in preadolescence. Alternatively, children tend to develop more advanced executive functioning abilities later in childhood (Garcia-Barrera et al., 2013), which will affect their use of aggression in preadolescence.

Gender Differences. Lastly, gender differences were also examined in the relations between children's individual factors and their use of peer nominated aggression in preadolescence. Similar to previous aggression research (e.g. Campbell et al., 2010; Spieker et al., 2012), males used more peer nominated physical aggression in preadolescence than females, and females used more peer nominated relational aggression in preadolescence than males. These findings support gendered theories of aggression, which suggest that due to differences in relationships, socialization, and evolution, males and females use different forms of aggression. However, follow-up analyses revealed that although males and females used different forms of aggression, generally males and females exhibited similar relations between these childhood factors and their use of preadolescent peer nominated aggression.

The only significant gender difference in the findings was that for females only those who had increased hostile attribution bias received more relational aggression peer nominations in preadolescence. These gendered findings suggest that females might be

more emotionally upset by the perception of threats within their social environment than males. Therefore, females might be more likely to retaliate and use more relational aggression to cope with their negative emotional response. Some aggression research has indicated that females experience more distress than males in response to actual peer aggression (Crick, Grotpeter, & Bigbee, 2002). Females also may experience more distress than males in response to the perception of hostility, and as a result, females may be more likely to use peer nominated relational aggression to cope with their increased emotional distress.

In sum, the findings demonstrated that children's individual factors examined in the current study have some small effects on preadolescents' peer nominated use of physical and relational aggression. These results suggest that preadolescents' use of aggression might be a predominantly cognitive problem solving process. This is surprising given that aggression literature has emphasized the role of negative emotions (Buss, 1961), and children's ability to physiologically regulate these emotions (Calkins & Keane, 2004) on their use of aggression.

Given the overall lack of support for the hypotheses, it raises several questions about the underlying assumptions and theories of the current study. First, developmental assumptions about children's increasing autonomy from parents and maturing socio-emotional, cognitive, and behavioral abilities led to the examination of children's individual factors as predictors of preadolescent aggression. However, this fails to consider the continued effect of external factors, such as the home environment and the role of parents. Children might not use more aggression because they are coping with

perceived hostility, but rather they might use more aggression because parents have modeled aggressive social responses. In addition, societal conventions might encourage children's use of physical and relational aggression. Consequently, children might not use more aggression because they interpret hostile events as threatening and mean, but rather they use more aggression because it is a justified social response based on these contextual factors.

The current study also assumed that it is important to capture children's use of aggression during the middle childhood to preadolescent time period, because this is when some children shift from predominantly using more physical aggression to predominantly using more relational aggression (Ojanen & Kiefer, 2013). However, this ignores the heterogeneous development of children's use of aggression. Theoretical models of the development of children's aggression suggest that there are different subgroups of aggression users. These aggression subgroups are influenced by the age at which children begin to use aggression. And some research has highlighted the differences in emotional, cognitive, and behavioral correlates between children who use aggression at a much younger age versus those children who only begin to use aggression in preadolescence (Moffitt & Caspi, 2001). For example, children who are early onset users of aggression might have more callous-unemotional traits or be genetically predisposed to behave aggressively. And these underlying propensities to be aggressive might create a chain of transactional events with negative environmental stimuli, such as increased parental punishment, that predict children's continued use of aggression over time. Whereas, children who are adolescent onset users of aggression might have an

increased gap between their biological and cognitive maturity, and they might have increased susceptibility to peer group influences. However, the current study's analyses cannot differentiate between the age at which children begin to use aggression. Future research should use more advanced statistical analyses, such as latent class growth analysis to capture the unique correlates that predict children's heterogeneous use of aggression over time.

The null findings also challenge the overall conceptualization of physical and relational aggression, which guided the hypotheses of the current study. Based on Bandura's (1978) characterization of physical aggression as an overt, immediate, and reactive response to negative emotions, it was hypothesized that children who have more immature physiological and cognitive-behavioral control would use more physical aggression. And based on Xie and colleagues (2005) characterization of relational aggression as a covert and deliberate relational process, it was hypothesized that children who have more sophisticated physiological and cognitive-behavioral control would use more relational aggression. However, this is an overly simplistic conceptualization of both physical and relational aggression and does not consider the various ways in which children can aggress. Some children might use physical aggression in a covert, mature, and deliberate manner. And alternatively, some children might use relational aggression in a retaliatory, overt, reactionary, and unplanned manner. In addition, there might be unique correlates of the mature and immature forms of physical aggression and mature and immature forms of relational aggression. Future research must consider how children might use physical and relational aggression in both sophisticated, controlled ways and in

unsophisticated, uncontrolled ways, and whether similar or dissimilar factors predict all unique variations of aggression use in preadolescence.

The current study also examined a joint model of aggression, which may explain these null findings. Based on the heterotypic continuity model of aggression (Björkqvist, 1994), it was assumed that children who are aggressive use both physical and relational behaviors to manifest their aggression across childhood. And thus, it was hypothesized that the same factors would predict children's use of both physical and relational aggression, but in different ways. However, there are individual differences in the use of aggression forms, and some aggressive children may use physical aggression only, and some aggressive children may use relational aggression only. And different factors might predict children's use of physical aggression compared to relational aggression. Children might use more physical aggression because of a basic evolutionary drive to physically dominate others. Or children might use physical aggression, because they live in a society that promotes physical violence. Alternatively, children might use more relational aggression, because they value peer relationships. Consequently, they might want to maintain these relationships and are more likely to manipulate their relationships. In addition, children who use more physical aggression in preadolescence are deviating from the normative decline in the use of physical aggression. Therefore, preadolescents who continue to use physical aggression might have more inherent aggressive characteristics, such as more callous unemotional traits, or have experienced early physical maltreatment. In contrast, most children use relational aggression in preadolescence; thus, children who use relational aggression might just be conforming to

socio-cultural norms that encourage relational manipulative behaviors. Thus, children who are more susceptible to societal standards might use more relational aggression. Future research should examine the unique predictors of physical and relational aggression across development and address the underlying assumptions of the current study.

Limitations, Strengths, and Implications.

In addition to the problematic assumptions of the current study, there are several methodological limitations that might explain the null findings. The current study examined aggression within a community sample, and overall children had low nominations of peer perceived physical and relational aggression. Approximately only 10% of the sample was nominated as children who use high levels of physical and relational aggression. Although this is consistent with other studies that use non-clinical samples (Crick et al., 2002), the hypothesized effects of the individual factors on aggression might have emerged in a clinical sample of preadolescents who use much more aggression. Other aggression studies have compensated for children's decreased use of aggression by categorizing children as high and low aggressors, and over-selecting children who used more aggression (Crick et al., 2002). However, this methodology truncates the variance, reduces power, creates bias, and artificially inflates the effects of the predictors (Streiner, 2002). Thus, it is important to identify the factors that predict the normative use of aggression in a community sample.

It is also important to consider that low peer nominations of children's aggressive behaviors might not be due to children not using aggression, but aggressive children

might be less likely to participate in sociometric nomination research. Children who are more aggressive, might be less liked by their peers, and subsequently they might not want to have their peers evaluate their social behaviors (Babcock, Mark, van den Berg, Cillessen, 2016). And this resulting systematic missingness might affect the links between children's individual processes and their use of aggression. Systematic missingness is a major limitation of the current study, because it violates the assumption of our longitudinal research design that data is missing at random. And due to this, it is important to account for missing data; the current study used maximum likelihood estimation procedures to impute missing data. It is important to note that the multiple imputation procedure has not yet been validated with sociometric peer nomination data. And at this time there are no estimation techniques that have been validated with sociometric peer nomination data (Babcock et al., 2016). Future research should identify the appropriate estimation procedures for handling missing data collected by sociometric nomination procedures.

A related limitation that resulted from our samples' low peer nominated use of aggression in preadolescence was the inability to control for earlier aggression. Unexpectedly, children in our sample used more peer nominated physical and relational aggression in middle childhood than in preadolescence. This is inconsistent with previous research that has demonstrated that most children use more relational aggression in preadolescence and some children continue to use more physical aggression in preadolescence (Côtè et al., 2007; Ojanen & Kiefer, 2013). Controlling for earlier aggression would not have allowed for the examination of the specific aims of the current

study, so children's earlier aggression nominations were not included in the focal analyses. Hence, the results cannot be interpreted as children's increased use of aggression over development. Rather the current study provides evidence about what processes in middle childhood predict later preadolescent aggressive behaviors.

Another limitation was the examination of children's physiological regulation as a predictor of preadolescents' peer nominated aggression, because children's physiological regulation is an indicator of their emotional control abilities (Thompson, Lewis, & Calkins, 2008). Thus, the null findings were interpreted such that preadolescents' peer nominated use of aggression was not a consequence of children's emotional regulation processes. However, children's physiological regulation is only one strategy of children's emotional control, which limits this conclusion. A more direct measure of emotional control, such as a behavioral observation of children's anger regulation, might have affected their use of aggression in preadolescence. Future research should incorporate additional indices of emotion and emotional control in order to identify whether preadolescents' use of peer nominated aggression is a result of both cognitive and emotional processes.

Moreover, the current study only examined the two major forms of aggression that children use: physical and relational aggression. Other aggression research has further categorized children's aggressive behaviors by its function: reactive or proactive aggression (Card & Little, 2006). A four-factor model of aggression (reactive physical aggression, proactive physical aggression, reactive relational aggression, proactive relational aggression) posits that the unique forms and functions of children's aggressive

behaviors are theoretically distinct and have different predictors. However, in a longitudinal analysis, children who use one functional form of aggression are more likely to use all functional forms of aggression (Card & Little, 2006). As a result, children's use of these aggressive behaviors might not be distinguishable over time and the processes that predict children's use of one functional form of aggression might not differentiate their use of the other functional forms of aggression in a longitudinal study. It should be noted that the functional subtypes of aggression might have explained the unexpected direction of findings in the post-hoc and sensitivity analyses. However, we could not test these assumptions, because we did not measure children's use of the functional subtypes of physical and relational aggression.

Another limitation that might have contributed to the unexpected null effects was the use of the Intent Attributions and Feelings of Distress questionnaire to measure children's hostile attribution bias. Although this measure has been used in previous research with similar samples (e.g. Godleski & Ostrov, 2010), it is possible that 7-year-old children do not fully understand behavioral intent. And yet this measure forces children to choose a response, even if they cannot determine the intent of the ambiguous situation. Although "being mean" is a basic intent that children might be able to understand and accurately assess, future work should allow children to select a "do not know" option. Children's intent attributions should also be verified with an alternative measure.

We must also consider the effect of children's school context on the findings of the current study. Participants were initially recruited for the original study well before

they entered school. Thus, by the time they entered elementary school, they were not all in the same school. This poses a methodological limitation, because the primary analyses examined z-scores of participants' peer aggression nominations, which are context dependent. Z-scores were calculated by subtracting the participant's nominations from the average number of aggression nomination of the participant's grade (divided by the standard deviation of the nominations of the participant's grade). The average use of aggression from each school contextualized the participants' use of aggression. Although this methodology is similar to other sociometric nomination research due to differences in grade or classroom size (e.g. van der Berg, Lansu, & Cillessen, 2015), it might have introduced an effect of school variation on the examined relations.

A strength of the current study was the use of raw nominations in post-hoc analyses to account for school context. These post-hoc analyses also included both fixed and random effects in the model, which allows for school effects to be modeled. The results from these analyses generally supported the primary findings, which strengthen the reliability of primary findings and support the use of the context dependent standardized scores. Although these analyses indirectly account for school effects, school effects were not directly measured. Children were not equally distributed among schools, and we did not measure the characteristics of the individual schools, therefore we could not test for the nested effect of our data. Future research should identify whether children's school environments affected their aggressive behaviors, by nesting the data by school in a hierarchical linear model.

In spite of these limitations, the current study has several strengths and contributes to the preadolescent aggression literature. One important strength of the current study was the inclusion of preadolescents' use of both physical and relational aggression in a single model. By including both forms of aggression in a single model, we identified whether children's individual processes worked the same or differently to predict peer nominated use of physical and relational aggression in preadolescence. Previous aggression research often has examined children's use of one form of aggression only (e.g. Ellis et al., 2009), which fails to account for the interdependencies of children's physical and relational aggression. The current study's examination of children's aggressive behavior was also strengthened but the multivariate statistical techniques, which directly controlled for the statistical overlap between children's peer nominations of physical and relational aggression and reduced Type I errors.

In addition to what form of aggression was examined, how preadolescents' physical and relational aggression was measured was also a strength of the current study. The use of sociometric peer nomination allows for a more accurate measurement of preadolescents' use of aggression (McEvoy et al., 2003). While parents and teachers might only observe children's aggressive behaviors that are obvious and used in the classroom or in the home setting, peers might observe children's aggressive behaviors that are more covert and used in a wider variety of settings, such as in the cafeteria or on the school bus. Peers might have a more accurate perspective of children's covert aggressive behaviors, because they are the victims of these aggressive behaviors. Sociometric peer nomination procedures also allows for multiple reporters to assess these

behaviors, which increases the reliability of the measurement of children's aggression (Marks et al., 2013).

The current study was also benefitted by the inclusion of both male and female participants. Previous aggression research often included only male or only female participants, because of the assumption that males use more physical aggression than females, and females use more relational aggression than males (e.g. Crick & Grotpeter, 1995). However, males and females do not consistently exhibit these mean differences in the use of physical and relational aggression (Archer, 1994). And in the current study, males actually used more peer nominated relational aggression than females in middle childhood. By including both male and female participants, this study has created a more comprehensive picture of aggression use for all children.

The current study's examination of preadolescent aggression has implications for future research. Specifically, the null findings suggest that the theoretical assumptions of children's hostile attribution bias might be incorrect and these assumptions should be directly examined. Children's deviant social information processing theoretically is a result of ecological inputs, such as aggressive and controlling families (Dodge, 1986). Children who have aggressive families might normalize these behaviors and will be more likely to perceive ambiguous events as hostile. As such, they will have more emotional and physiological arousal and use more retaliatory aggression. However, children's ecological inputs might directly affect their use of aggression, not indirectly through children's deviant socio-cognitive processing of increased hostile attributions. It is

important that future research test both the direct and indirect effects of children's ecological inputs, such as family norms and values, on their use of aggression.

Future research should also examine the role of children's constitutional inputs on their interpretation of social information and subsequent use of aggression. Dodge (1986) posited that children who have more reactive temperaments and struggle with attentional control, memory, and goal setting will be more likely to have deviant cognitive processing. For example, children who have the underlying biological disposition to react negatively to stimuli will be more likely to be upset by ambiguous situations and describe these situations as hostile. Consequently, more reactive children will develop increased hostile attribution bias and use more retaliatory aggression. However, it is possible that children who have a more reactive temperament might not process information in a different way, but simply be more impulsive in their behavioral responses. It is important to identify whether children's constitutional inputs have a direct effect on their aggressive behaviors that are explained by their increased behavioral impulsivity compared to an indirect effect through children's deviant cognitive interpretations.

Another direction for future research is to examine the interactive effects of children's individual factors and external risk factors. Children's individual abilities might protect them from extrinsic risk factors and reduce the likelihood that they will use physical and relational aggression in preadolescence. For example, children who are victimized by their peers are more likely to behave aggressively (Masten, Juvonen, & Spatzier, 2009), but children who have better executive functioning abilities might not respond to increased peer victimization by using more aggression. Instead children who

have better executive functioning abilities might cognitively reframe their negative peer experiences and engage in more positive coping behaviors. By investigating the joint and interactive effects of extrinsic factors and children's individual factors, we might have an even better understanding of what contributes to preadolescents' use of physical and relational aggression.

Future research should also directly examine the factors that predict the developmental heterogeneity of children's aggression use over childhood. Although we could not examine the developmental progression of aggression, the current study hypotheses were based on the heterotypic continuity model of aggression (Björkqvist, 1994). This model ignores the heterogeneity within children's use of aggression; some children may only use one form of aggression across childhood, and some children may use both forms of aggression in early childhood. And there might be unique emotional, cognitive, and behavioral correlates that affect individual differences in children's use of one or both forms of aggression over time. Future research could utilize more advanced statistical techniques, such a latent class growth analysis, to directly examine the developmental assumptions of the heterotypic continuity hypothesis and identify the unique correlates that predict the heterogeneous development of children's aggressive behaviors.

Overall, the current study provides several contributions to the study of aggression. First, these results suggest that it is important to examine preadolescents' use of both physical and relational aggression. Recent preadolescent aggression research has primarily focused on children's use of relational aggression, because some evidence has

suggested that children use more relational aggression and almost no physical aggression in preadolescence (e.g. Ojanen & Kiefer, 2013). However, as evidenced in the current study, some children continue to use physical aggression in preadolescence. And as a result of this use of physical aggression in preadolescence, these children are at an even greater risk of exhibiting more severe behavior problems as they get older (Cleverley et al., 2012). Consequently, the identification of children's executive functioning ability as a predictor of preadolescents' peer nominated use of physical aggression importantly guides future research to continue this examination.

The current research also contributes to the study of aggression because it provides evidence that more advanced cognitive and behavioral control in middle childhood predicts preadolescents' use of relational aggression. These findings support the theoretical assumptions of the heterotypic continuity model of aggression (Björkqvist et al., 1992), which posits that children use relational aggression as a result of more advanced cognitive, behavioral, and social abilities. Previously there has been little empirical work that has supported this joint theory of aggression. By studying children's use of both forms of aggression, we have a better understanding of the similar and dissimilar processes that predict children's use of both forms of aggression and a more comprehensive portrayal of aggression in preadolescence.

The inclusion of childhood processes not only provides a richer understanding of what might predict children's use of aggression in preadolescence, but the identification of these processes can also inform more effective aggression interventions. For example, it might be easier to train children to inhibit their aggressive behaviors or reinterpret their

hostile attributions, rather than change a source of external risk, such as their socioeconomic status. Furthermore, by identifying and understanding these similar and dissimilar processes within the child, future work can create more nuanced intervention programs for the specific form of aggression. Specifically, for those children at risk of using physical aggression, an intervention might focus on the inhibition of impulsive behaviors. Whereas, for those children at risk of using relational aggression, an intervention might focus on the reinterpretation of social cues.

In conclusion, the null findings of the current study highlight the need to reexamine the assumptions of the social information processing model and the conceptualization of physical and relational aggression. However, the current study does provide some evidence that as children enter preadolescence their use of aggression might reflect more covert, deliberate, and controlled cognitive processes.

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APPENDIX A

TABLES AND FIGURES

Table 1. Descriptive Information for Study Variables.

	M	SD	Range	N	Skewness
Physical Aggression age 7	0.01	1.00	-1.32-2.91	177	1.27
Relational Aggression age 7	0.06	0.84	-1.36-3.25	177	1.04
Hostile Attribution Bias age 7	0.24	0.11	0.00-.50	169	0.14
RSA withdrawal age 7	0.75	0.81	-1.34-3.72	166	0.71
Time per move ratio age 7	6.26	4.03	1.53-18.40	197	1.86
Color-Word Errors age 7	6.80	4.70	0.00-25.00	202	1.12
Digit Span Backward age 7	3.97	1.41	1.00-8.00	204	0.42
Verbal Comprehension age 7	108.05	15.90	61.00-143.00	204	-0.16
Childhood SES	41.73	9.78	12.33-62.25	265	-0.47
Physical Aggression age 10	0.04	0.95	-1.08-3.39	159	1.84
Relational Aggression age 10	-0.02	0.90	-1.33-4.40	159	1.48

Table 2. Correlations Among Study Variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Child Gender[a]	--	-.12*	.04	-.18	-.25	-.12*	-.07	-.02	.01	-.25**	.12*
2. Child SES		--	-.33**	.31**	.09	.00	-.01	.03	.16**	.07	-.01
3. Child Race[b]			--	-.27**	.12*	.16**	.16**	-.03	-.16**	.13*	.06
4. Verbal Comprehension 7				--	-.01	-.05	-.05	.03	.40**	-.01	.05
5. Physical Aggression 7					--	.70**	.10	.11	-.05	.40**	.23**
6. Relational Aggression 7						--	.10	.01	-.06	.35**	.30**
7. Hostile Attribution Bias 7							--	.09	-.13*	.12*	.07
8. RSA withdrawal 7								--	-.09	.08	.03
9. Executive Functioning 7									--	-.11*	.00
10. Physical Aggression 10										--	.59**
11. Relational Aggression 10											--

[†]p < .10, * p < .05, ** p < .01, ***p < .001

Note. Total N =308 (male = 138, female = 170).

[a]Child Gender is coded such that 0= Male and 1=Female

[b]Child Race is coded such that 0= Caucasian and 1=Minority Status

Table 3. Univariate Logistic Regression of Age 10 Aggression.

		Physical Aggression		Relational Aggression	
	Predictor variables	β	SE	β	SE
Hypothesis 1	Gender[a]	-.37***	.09	.19*	.09
	Race[b]	.26**	.10	.11	.10
	Child SES	.01	.01	.00	.01
	Verbal Comprehension Age 7	.00	.00	.00	.00
	Hostile Attribution Bias 7	.04	.03	.03	.03
Hypothesis 2	RSA withdrawal 7	.09	.06	.04	.06
	HAB x RSAw	-.04	.03	-.04	.03
Hypothesis 3	Executive Functioning 7	-.14*	.07	-.03	.07
	HAB x EF	.04	.03	.06*	.03
Hypothesis 4	HAB x RSAw x EF	-.03	.04	-.04	.04

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

Note. Total N = 308 (male = 138, female = 170).

[a]Child Gender is coded such that 0= Male and 1=Female

[b]Child Race is coded such that 0= Caucasian and 1=Minority Status

HAB = Hostile Attribution Bias; RSAw = RSA withdrawal; EF = Executive Functioning

Table 4. Negative Binomial Generalized Linear Mixed Models Predicting Age 10 Physical and Relational Aggression.

	Physical Aggression			Relational Aggression		
Predictor variables	β	SE	ARR	β	SE	ARR
Exposure	.00**	.00	1.00	.01	.00	
Gender[a]	.35*	.13	1.42	-.78***	.17	0.17
Race[b]	.28	.15		.65***	.19	1.91
SES	.00	.01		.00	.01	
Verbal Comprehension	.01	.01		.01	.00	
Hostile Attribution Bias	.06	.04		.15*	.06	1.16
RSA withdrawal	.08	.10		.22	.13	
Executive Function	-.03	.11		-.18	.15	
HAB x RSAw	-.04	.06		-.04	.08	
HAB x EF	.10*	.05	1.10	.12*	.06	1.13
RSAw x EF	.03	.14		-.15	.18	
HAB x RSAw x EF	-.09	.08		-.09	.10	

[†]p < .10, * p < .05, ** p < .01, ***p < .001

Note. Total N = 210

[a]Gender is dichotomized 0 = Males 1 = Females

[b]Race is dichotomized 0 = Caucasian 1 = Race/Ethnic minority status

SES = Socioeconomic status; HAB = Hostile Attribution Bias; RSAw = RSA withdrawal; EF = Executive Function

ARR = adjusted rate ratio (exponentiated negative binomial beta)

Figure 1. Model of Childhood Predictors of Preadolescent Physical and Relational Aggression.

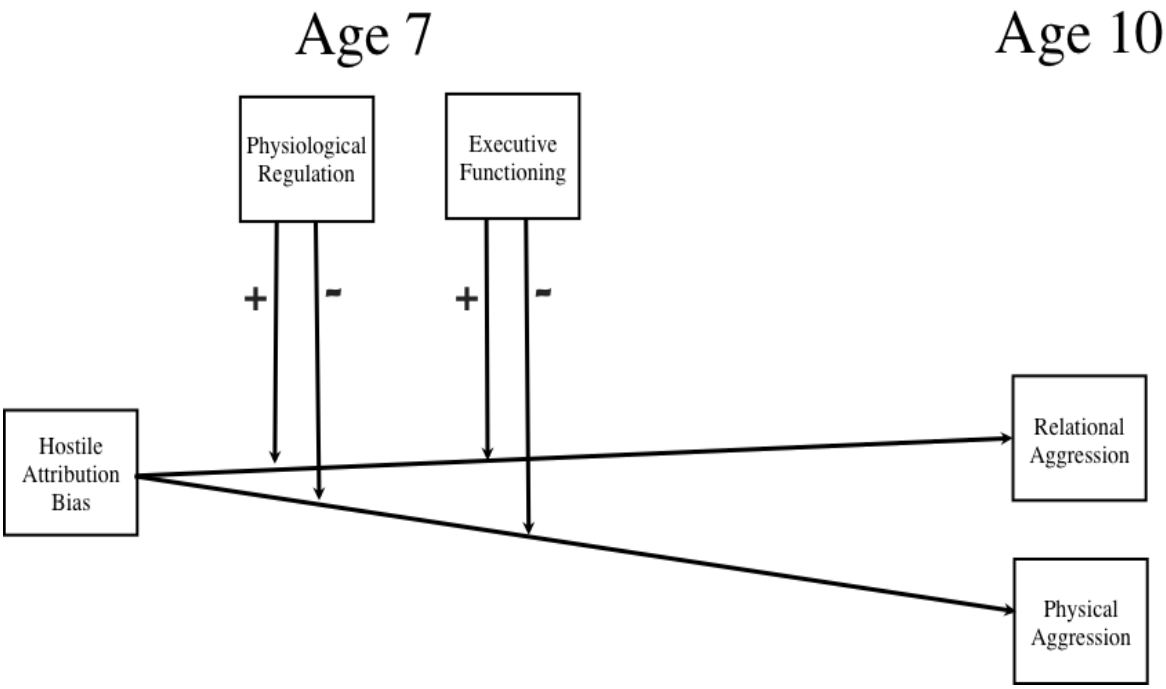

Figure 2. Mean Differences in the Proportion of Physical and Relational Aggression Peer Nominations between Age 7 and Age 10.

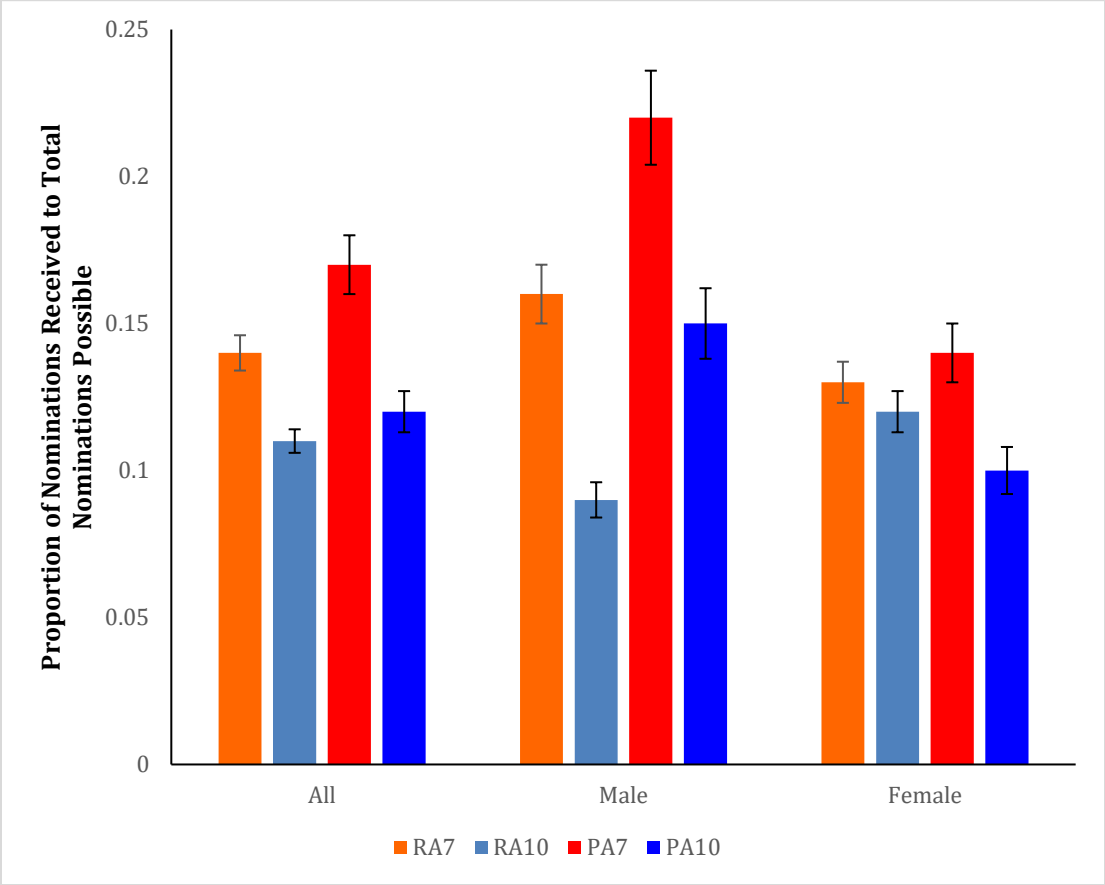

Figure 3. Age 7 Executive Functioning Scores Moderate the Association between Hostile Attribution Bias and Age 10 Z-Scores of Relational Aggression.

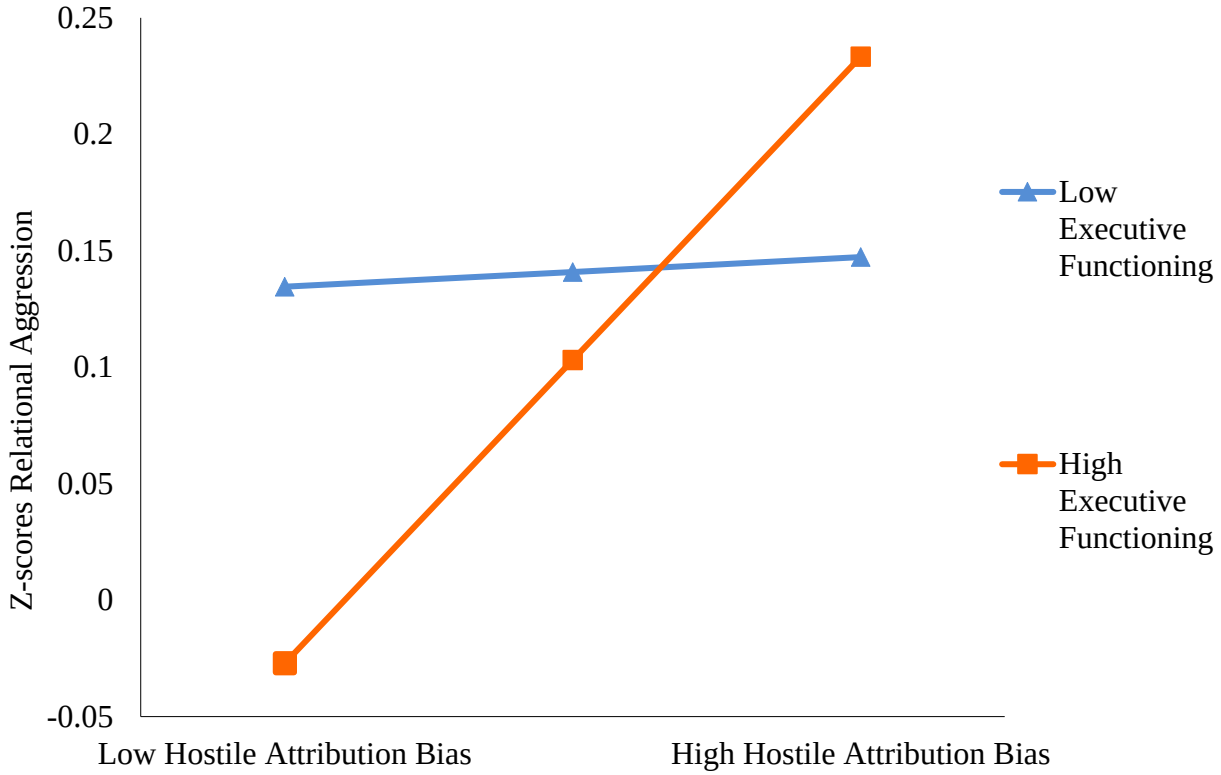

Figure 4. Age 7 Executive Functioning Scores Moderate the Association between Hostile Attribution Bias and Age 10 Raw Nominations of Physical Aggression.

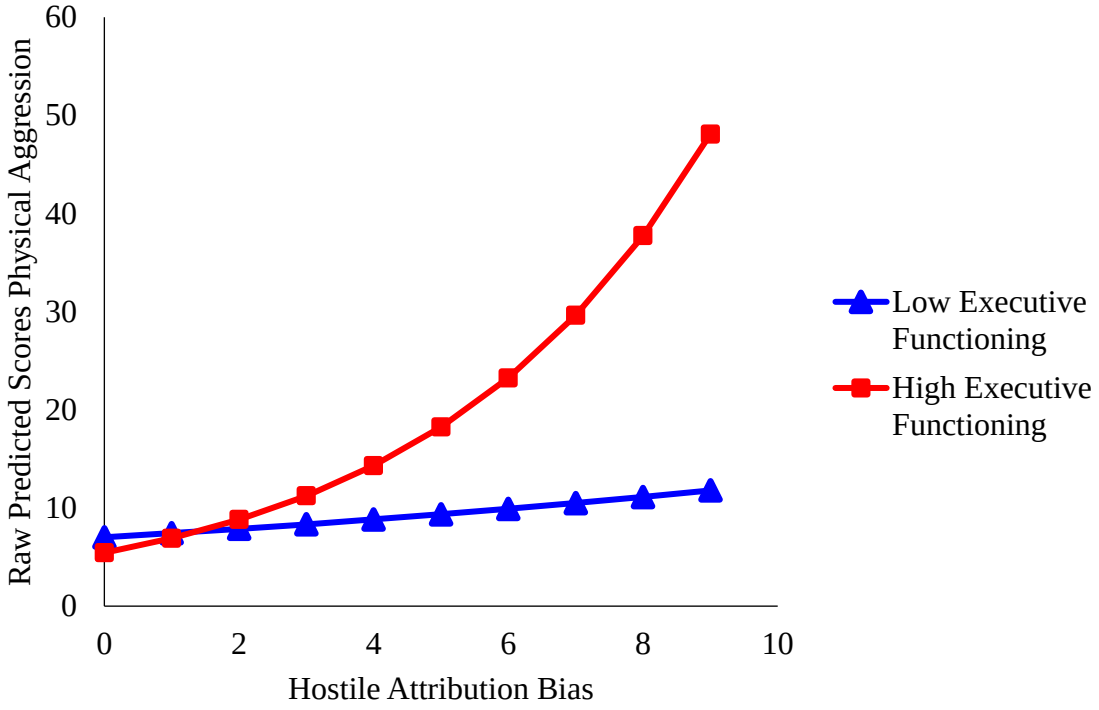

Figure 5. Age 7 Executive Functioning Scores Moderate the Association between Hostile Attribution Bias and Age 10 Raw Nominations of Relational Aggression.

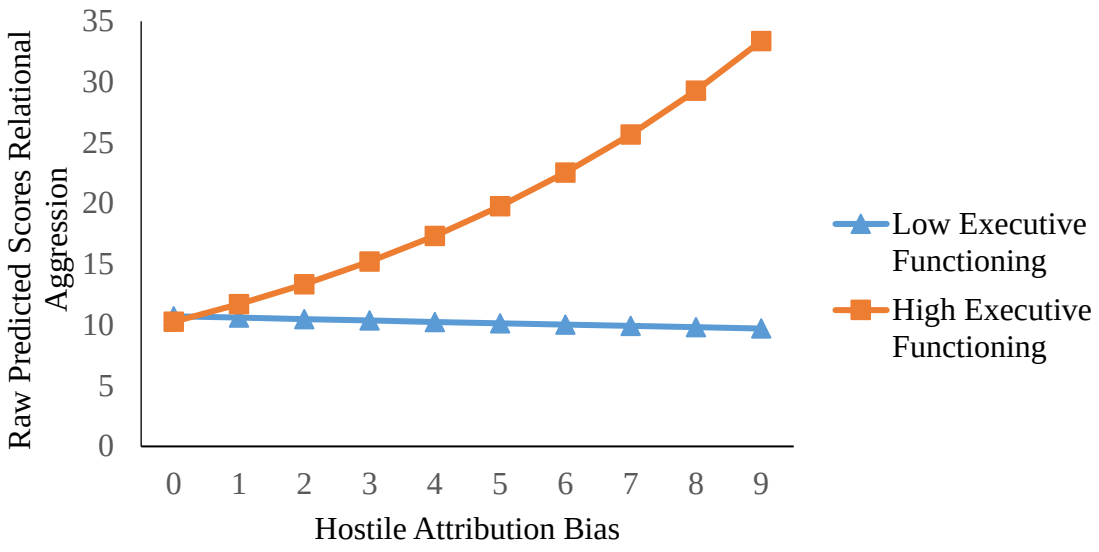

Figure 6. Age 10 RSA Withdrawal Moderates the Association between Hostile Attribution Bias and Age 10 Z-Scores of Relational Aggression.