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EXECUTIVE FUNCTION AND REJECTION REACTIVITY: CORRELATES OF KINDERGARTEN ADJUSTMENT DIFFICULTIES AMONG CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

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Abstract

Affective processing of social information and executive function skills appear important to the school adjustment of children with ADHD, but have rarely been studied conjunctly. The present study examined the role of the intensity of children's emotional reactions to being rejected and executive function (EF) skills as correlates of social behavior problems (aggression, social withdrawal) and academic problems common in children with ADHD, as well as how these problems varied by the number of ADHD symptoms (hyperactivity/impulsivity, inattention). Participants included 133 children with clinical or subclinical levels of ADHD at the beginning of their kindergarten year (73% European American, 11% African American, 4% Latino, 11% multiracial, 2% other; 65% male, M_{age} = 5.2 years). Hyperactivity/impulsivity was associated with heightened rejection reactivity and greater aggression. In structural equation models, rejection reactivity mediated the association between hyperactivity/impulsivity and aggression. Inattention was uniquely associated with poor EF, increased social withdrawal, and greater aggression. In structural equation models, EF marginally mediated the association between inattention and social withdrawal, and fully mediated the association between inattention and academic achievement. Clinical implications and future directions are discussed.

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Introduction

Attention deficit hyperactivity disorder (ADHD) is one of the most common childhood disorders, affecting an estimated 3 to 7% of school-aged children and approximately 2% of preschoolers (American Psychiatric Association [APA], 2000; Lavigne et al., 1996). ADHD is characterized by high levels of inattention, hyperactivity, and impulsivity that interfere with functioning or development (APA, 2013). Most children with ADHD reach diagnostic levels of these symptoms by age seven (Applegate et al., 1997). While more is known about ADHD among older school-aged children, less is known about young children with ADHD or emerging ADHD (DuPaul, McGoey, Eckert, & VanBrakle, 2001).

From an early age, children with ADHD are behind in their school readiness, both academically and socially, as compared to their typically developing counterparts (DuPaul et al., 2001; Mariani & Barkley, 1997). For example, young children with ADHD are more aggressive, less socially skilled, and relatedly, have fewer friends than their normative peers (Barkley, 1998; Brown, 2000; Erhardt & Hinshaw, 1994; Merrell & Wolfe, 1998). Such problems with social adjustment commonly persist into adolescence and adulthood and are often considered one of the most debilitating aspects of ADHD (Barkley & Fischer, 2010; Barkley, Fischer, Smallish, & Fletcher, 2004; Greene, Biederman, Faraone, Sienna & Garcia-Jetton, 1997). Understanding the factors associated with these poor social behaviors and peer relationship difficulties is important, as early peer rejection reduces opportunities for normative socialization and increases risk for escalating aggression and subsequent antisocial activity (Hay, Payne, & Chadwick, 2004).

In addition to their social difficulties, children with ADHD also experience greater academic difficulties than those without ADHD, beginning in preschool (Biederman et al., 2004; Mariani & Barkley, 1997). Children with ADHD often attain poor grades, show delays in the

acquisition of reading and math skills, and are at an increased risk for grade retention, detention and expulsion, and failure to graduate from high school (Biederman et al., 2004). In order to inform interventions that might prevent kindergarten adjustment difficulties from escalating into more serious difficulties in the later school years, it is necessary to examine the processes associated with the academic and social problems of children with ADHD during early childhood, a time when the foundational skills in social and academic domains are developing (Hay et al., 2004).

Two developmental processes have been implicated as factors that might account for the social and learning difficulties experienced by children with ADHD. One pathway is associated with developmental deficits in cognitive control. The other is associated with dysfunction in an affect-related pathway, involving negative emotional reactivity particularly in response to provoking events (Nigg & Casey, 2005). Research on children with ADHD has focused on the former of these two potential pathways, developmental deficits in emerging cognitive self-regulation skills, particularly deficits in executive function (EF) skills (Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005). EF skills, which include working memory, inhibitory control, and attention set-shifting, enhance the capacity to problem solve and thereby contribute to learning in school, regulating emotions, and managing social situations (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Garon, Bryson, & Smith, 2008). Thus, deficits in EF may impair the academic progress of young children with ADHD, and reduce their capacity to navigate social interactions and control aggressive impulses effectively (Biederman et al., 2004; Bierman et al., 2008). While less often studied as a pathway to explain impairment in children with ADHD, affect-related difficulties, such as heightened emotional reactivity, may also be a key factor impairing the school adjustment of children with ADHD (Barkley, 2010; Nigg & Casey, 2005;

Ozdemir, 2011). Individuals with ADHD have been found to have less well-modulated emotional reactions and a greater likelihood of attributing hostile intent in social situations than their normative peers. They are more likely to perceive an ambiguous event as ostracizing and more likely to respond aggressively in hypothetical scenarios (Barkley, 2010; Johnson & Rosen, 2000; King et al., 2009). Some researchers have speculated that children with ADHD are more likely to develop a sensitivity and more intense emotional reactivity to rejection in early childhood because they are more likely than children without behavior problems to experience parental rejection (Kim & Yoo, 2013). Within this framework, their reactivity to rejection may be self-protective, as it heightens their vigilance and readiness for possible rejection (Crick & Dodge, 1994). However, it is also maladaptive, in that the tendency that some children with ADHD have to react intensely to perceived rejection may lead to further rejection by peers and parents and therefore, to fewer opportunities to learn social skills and engage in friendships (Hoza, 2007; Kim & Yoo, 2013; Morrell, & Murray, 2003; Mrug et al., 2012). Thus, although existing research on young children with ADHD has focused primarily on the impact of EF deficits on school difficulties, elevations in rejection reactivity, particularly when combined with EF deficits, may also play a unique and important role in undermining the social effectiveness of children with ADHD, in ways that are distinct from EF deficits alone.

The academic and social adjustment difficulties among kindergarteners with ADHD are especially concerning considering that adjustment problems can put children with ADHD at an increased disadvantage upon entering school as compared to their normal counterparts. A better understanding of the factors associated with school adjustment problems at school entry could inform preventive efforts to support children with ADHD as they transition into kindergarten. This study addressed this issue by examining associations between the number of ADHD

symptoms (hyperactivity/impulsivity and inattention) and school adjustment (e.g., aggression, social withdrawal, and academic achievement) among children in kindergarten. In addition, given that EF and rejection reactivity may be two pathways by which children with ADHD develop school adjustment difficulties, this study examined the extent to which EF and rejection reactivity each served as mediators linking ADHD symptom severity with school adjustment (Gaub & Carlson, 1997; Milich, Balentine, & Lynman, 2001).

Hyperactivity/Impulsivity and Inattention: Associations with Kindergarten Adjustment

In the present study, symptoms of hyperactivity/impulsivity and symptoms of inattention were examined as two dimensions of ADHD. Measures of hyperactivity/impulsivity typically include items such as: fidgets, gets up when remaining in seat is expected, runs about in inappropriate situations, has trouble playing quietly, is often "on the go" or acts as if "driven by a motor", talks excessively, blurts out answers, has trouble waiting one's turn, and interrupts or intrudes on others (APA, 2013). In contrast, measures of inattention include items such as: fails to give close attention to details or makes careless mistakes, has trouble sustaining attention on tasks or activities, does not listen, does not follow through on instructions or fails to finish assigned tasks, has difficulty organizing tasks and activities, is forgetful, loses things, is easily distracted, and avoids, dislikes or is reluctant to engage in activities that require sustained mental effort (such as schoolwork or homework; APA, 2013). These two symptom patterns are the cardinal features characterizing ADHD (APA, 2013). A number of recent studies demonstrate different correlates for these two symptom patterns (e.g. Tannock, 2012; Willcutt et al., 2012), and the severity of each set of symptoms may be associated differentially with child adjustment and functioning (APA, 2013). Hence, this study focused on the severity of each of these dimensions using symptoms counts (Tannock, 2012; Wilcutt et al., 2012).

Past research summarized here includes studies that have examined the severity of hyperactivity/impulsivity and inattention symptoms as continuous variables, and also includes research comparing subtypes. There are three ADHD subtypes, which are defined based on symptom counts as follows: children with six or more symptoms of hyperactivity/impulsivity and less than four symptoms of inattention were categorized as ADHD-Hyperactive/Impulsive subtype (ADHD-HI), children with six or more of nine symptoms of inattention and less than four of nine symptoms of hyperactivity/impulsivity were categorized as ADHD-Inattentive subtype (ADHD-I), and children with six or more symptoms of hyperactivity/impulsivity and six or more symptoms of inattention were categorized as ADHD-Combined subtype (ADHD-C; APA, 2000). Studies comparing these subtypes also provide evidence for differences in the specific characteristics and problems associated with hyperactivity/impulsivity versus inattention.

Specifically, hyperactivity/impulsivity and inattention have differential associations with aggression, social withdrawal, and academic achievement. Consistent across studies, children high in hyperactivity or who are diagnosed with ADHD-HI or ADHD-C have higher rates of conduct disorder, oppositional defiant disorder, and aggressive behavior as compared to highly inattentive children and children with ADHD-I both concurrently and longitudinally (e.g. Burns & Walsh, 2000; Hodgens, Cole, & Boldizar, 2000; Lahey et al., 1998; Maedgen & Carlson, 2000; Willcutt et al., 2012; Wolraich, Hanah, Pinnock, Baumgaertel, & Brown, 1996). For example, in a longitudinal study of over 1,000 boys, hyperactivity in kindergarten predicted aggression at the end of elementary school whereas inattention did not, controlling for kindergarten levels of anxiety/withdrawal, aggression, family configuration and socioeconomic status (Gagnon, Craig, Tremblay, Zhou, & Vitaro, 1995). In the same study, aggression in

kindergarten did not predict hyperactivity at the end of elementary school after accounting for kindergarten levels of anxiety/withdrawal, hyperactivity, inattention, family configuration and socioeconomic status.

In contrast, based on a meta-analysis of 546 studies, inattention is significantly more highly associated with withdrawn behaviors than hyperactivity/impulsivity (Willcutt et al., 2012). Specifically, the average correlation between social passivity/isolation and inattention was $r = .37$, whereas the average correlation between social passivity/isolation and hyperactivity/impulsivity was $r = .18$. In line with these dimensional studies, children with ADHD-I show higher levels of social withdrawal compared to children with ADHD-C and children without ADHD (Gaub & Carlson, 1997; Hodgens et al., 2000; Maedgen & Carlson, 2000; Naglieri, & Goldstein, 2006).

Inattention is also more highly associated with poor academic achievement across the lifespan in comparison to hyperactivity. Across studies, DSM-IV field trials, and meta-analyses, inattention is, on average, correlated with poor academic achievement at twice the magnitude of hyperactivity/impulsivity symptoms; relatedly, children with ADHD-I have significantly more academic difficulties than those who have ADHD-HI (Hodgens et al., 2000; Lahey et al., 1994; Milich et al., 2001; Willcutt et al., 2012; Wolraich et al., 1996). Moreover, inattention in kindergarten predicts academic achievement at the end of elementary school (whereas hyperactivity does not) when accounting for kindergarten levels of prosocial behavior, aggression, family configuration and socioeconomic status (Gagnon et al., 1995).

Given these distinct differences in the poor outcomes associated with inattention symptom severity versus hyperactivity/impulsivity symptom severity, some researchers have argued that it is difficult to develop a unifying theory of ADHD, and suggest that these

differences may be attributable to specific core processing differences associated with each symptom pattern (Milich et al., 2001; Nigg et al., 2005). Thus, this study explored the degree of common and unique variance that hyperactivity/impulsivity and inattention shared with kindergarten adjustment (aggression, social withdrawal, and academic achievement) as well as whether these differences in associations between ADHD symptoms and adjustment were differentially mediated by EF and rejection reactivity.

ADHD, EF Skills, and Kindergarten Adjustment

EF includes a range of complex and overlapping neuropsychological abilities that foster the capacity of individuals to approach novel situations in an adaptive and goal-oriented manner. The greatest growth in EF is seen between the ages of 3 and 7, suggesting that kindergarten is a key developmental period for EF (Blair, Zelazo, & Greenberg, 2005). EF is commonly conceptualized as a combination of the following three inter-related skill sets: working memory, inhibitory control, and attention set-shifting (Garon et al., 2008; Hughes, 1998; Hughes & Graham, 2002; Huizinga, Dolan, & van der Molen, 2006; Lehto, Juujärvi, Kooistra, & Pulkkinen, 2003; Mahone et al., 2002; Miyake, Friedman, Emeson, Witzki, & Howerter, 2000). Each of these components is considered to play an important role in supporting school adjustment, especially in kindergarten as school begins to put greater demands on the cognitive capabilities of children. For example, working memory, the ability to hold and act on mental representations, may contribute to a child's ability to create and retain mental templates for academics and social behavior (Barkley, 2001; Bull & Scerif, 2001; Monette, Bigras, & Guay, 2011). Inhibitory control, the ability to interrupt a prepotent, reactive response and provide a more appropriate response for goal attainment, may help children delay responding sufficiently to allow them to generate, consider, and select strategic responses in the classroom and with

peers (Barkley, 2001; Diamond, 2005; Miyake et al., 2000). Lastly, attention set-shifting, the ability to strategically focus and disengage attention while resisting interference and distractions, can contribute to more flexible problem solving and the regulation of emotion (Chang & Burns, 2005; Derryberry & Rothbart, 1997; Posner & Peterson, 1990). As these components of EF can play an important role in the development of skills as children transition into grade school, deficits in EF can be quite impairing.

Links between poor EF skills and ADHD are well-established, as children with ADHD often perform worse on tasks that require working memory, inhibitory control, and attention set-shifting in comparison to peers (Castellanos & Tannock, 2002; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005; Pennington & Ozonoff, 1996; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Furthermore, while not all children with ADHD have EF deficits, deficits in EF have been found to be more common in children with ADHD relative to children without ADHD, independent of gender, socio-economic status, IQ, and learning disabilities (Biederman et al., 2004; Willcutt et al., 2005).

EF deficits appear to be particularly related to the inattention symptoms of ADHD (Martel, 2009; Willcutt, et. al, 2005). Whereas EF skills are associated with ADHD overall, once the severity of inattention symptoms are controlled for, hyperactivity/impulsivity tends to show little to no unique association with EF among elementary and kindergarten age children (Brocki, Eninger, Thorell, & Bohlin, 2010; Chhabildas, Pennington, & Willcutt, 2001; Willcutt et. al, 2005).

Poor EF has also been linked with social and academic maladjustment at school entry. Several studies suggest that children with EF skill deficits are less socially competent and have more difficulties with emotion regulation than children with stronger EF skills (Barkley, 2003;

Clark, Prior, & Kinsella, 2002; Huang-Pollock, Mikami, Pfiffner, & McBurnett, 2009; Miller & Hinshaw, 2010). EF has been found to be associated with aggression, social withdrawal, and other externalizing and internalizing behaviors in young children (Bierman et al., 2008; Lundy, 2007; Monette et al., 2011; Riggs, Blair, & Greenberg, 2003). Furthermore, when EF has been experimentally improved in interventions, it has been found to mediate intervention effects on teacher and observer rated aggression and social behaviors (Bierman et al., 2008; Riggs, Greenberg, Kusche, & Pentz, 2006). However, some studies have not found any associations between EF and social outcomes. For example, in their 2004 cross-sectional study, Biederman and colleagues found no differences between children with and without EF deficits in their social functioning as rated by parents. Such contradictory findings may be due in part to examining EF deficits as a dichotomous variable or using parent ratings to assess social functioning, rather than teacher or peer ratings, which tend to be more valid indices (e.g., Power et al., 1998).

EF measured in prekindergarten has also been found to predict children's later academic achievement in kindergarten controlling for prekindergarten achievement (Alloway, Gathercole, Kirkwood, & Elliott, 2009; Blair & Razza, 2007; Clark, Pritchard, & Woodward, 2010; Welsh, Nix, Blair, Bierman, & Nelson, 2010). Interventions that have shown improvements in EF have also shown that these improvements mediate young children's academic skills (Bierman et al., 2008). Within the population of children with ADHD, having EF deficits has also been associated with a decrease in academic achievement (Biederman et al., 2004; Mariani & Barkley, 1997).

Whereas links between ADHD and EF deficits have been studied frequently, researchers are beginning to focus more on how regulating emotions and reactions in distressing social

contexts may also increase the social adjustment problems experienced by young children with ADHD (Barkley, 2010; Crick & Dodge, 1994; Nigg & Casey, 2005).

ADHD, Rejection Reactivity, and Kindergarten Adjustment

From a conceptual standpoint, the capacity to regulate emotions depends both upon the level of emotional reactivity in response to evocative events, and the capacity of the regulatory systems to manage or diffuse that arousal. Deficiencies in regulating emotions is an important factor to consider in ADHD as it has been found to predict the persistence of ADHD into adulthood and has been commonly implicated as a feature of ADHD and associated social problems (Barkley, 2010; Barkley & Fischer, 2010). The joint consideration of cognition and emotion is especially important given that children with ADHD often have challenges in each of these domains, including heightened emotional reactivity and reduced cognitive control (Barkley, 2010; Johnson & Rosen, 2000; Nigg & Casey, 2005). Conceptually, the EF deficits associated with ADHD might decrease children's capacity to manage emotional arousal, particularly in the context of processing social information in stressful or ostracizing social situations. In addition, children with ADHD may experience more negative emotional arousal when faced with the challenges of social interaction. As children move into kindergarten, demands for regulation increase, as children must function within the larger peer group of the classroom, and social play becomes increasingly rule-based (Bierman, Torres, & Schofield, 2010). Studies of elementary-school children with ADHD suggest that they are less able to process social cues completely and accurately relative to their non-ADHD peers. Specifically, they tend to respond to social provocation with greater negative emotional intensity, attribute hostile intent when faced with ambiguous social experiences, and generate more aggressive responses to provocation in comparison to children without ADHD (King et al., 2009; Maedgen

& Carlson, 2000; van den Broek, 1997). In this study, this increased tendency to experience intense emotional arousal in challenging social situations, especially ones that can be perceived as ostracizing, will be referred to as *rejection reactivity*. This concept focuses on tapping into two concepts: 1) encoding, the first step of Crick and Dodge's social information processing model (e.g., the sensation and perception of feelings; 1994), and 2) the emotional arousal involved in rejection sensitivity, as regulation of such emotional intensity has been found to be a key deficit of children with ADHD (Barkley, 2010; Downey, Lebolt, Rincón, & Freitas, 1998). However, these factors have not yet been studied in young children with ADHD.

Rejection reactivity is conceptualized as intertwined and distinct from EF. That is, children with ADHD may have a tendency to experience greater rejection reactivity combined with a tendency toward impulsivity, as opposed to a tendency to use EF skills in upsetting social situations. Specifically, such impulsive and emotionally dysregulated encoding of social information increases the likelihood of pre-emptive assessments of social threat, rather than reflective assessments that utilize EF (Barkley, 2010; Crick & Dodge, 1994; Rosen et al., 2007). That is, in emotionally arousing situations, children with ADHD may be less motivated to, less capable of, and/or more averse to delaying their response, and instead respond quickly (Barkley, 2010; Sonuga-Barke, 2002). Thus, it is possible that when faced with emotionally arousing and socially threatening scenarios, rather than shift attention to positive cues in the social situation or access working memory regarding past positive social cues, children with poor social adjustment rely on self-defensive, pre-established schemas without thinking and considering other information (Crick & Dodge, 1994). Neuroimaging studies have also found that processing of cognitive versus emotional information is divided into two different areas within the anterior cingulate cortex such that the dorsal region processes cognitive information, and the rostral-

ventral region processes emotional information and detects emotional threat (Bush, Luu, & Posner, 2000). The combination of deficits in these areas of processing may increase emotion dysregulation and undermine positive social integration (Muris & Ollendick, 2005). That is, a lack of EF skills to manage or reduce rejection reactivity may mean children will have difficulty inhibiting negative emotions and shifting attention or recalling positive social cues to reduce rejection attributions. Such emotion dysregulation plays a foundational role in psychopathology and its associated problems (Cole & Hall, 2008; Martel, 2009; Muris & Ollendick, 2005).

Prior research suggests that the hyperactivity/impulsivity symptoms associated with ADHD and the ADHD-HI/C subtypes are more strongly associated with intense negative emotional reactions than are inattention symptoms and the ADHD-I subtype (Maedgen & Carlson, 2000; Martel, 2009). Furthermore, Nigg and Casey's (2005) focus on an affect-related pathway for ADHD and Barkley's (2010) emphasis on deficient emotional self-regulation are considered to specifically link symptoms of hyperactivity/impulsivity with aggressive behavior, whereas their focus on cognitive control is considered to apply to symptoms of inattention. Specifically, early hyperactivity/impulsivity may increase risk for eliciting negative interpersonal responses from parents and peers, as they react negatively to intrusive or annoying behavior. These negative reactions from parents and peers, in turn, may be distressing to hyperactive/impulsive children, who may become sensitized and over-reactive as a function of rejection exposure (Canu & Carlson, 2007). In turn, increased reactivity to rejection has been found to predict worse aggressive behavior, social behavior, peer rejection, and academic functioning over time (Ayduk, Gyurak, & Luerssen, 2008; Downey et al., 1998). Furthermore, children who are reactive to rejection are less likely to engage with peers, possibly for fear of being rejected, and thus, may be more likely to withdraw from social situations (Silvers,

Gabrieli, Gross, Remy, & Ochsner, 2012). However, rejection reactivity's influence on the social and academic function of children with ADHD has not been studied and thus, it is unclear whether rejection reactivity will also show associations with school adjustment for this population.

As noted earlier, it may be very important to consider the impact of rejection reactivity on behavior in conjunction with the level of children's concurrent regulatory cognitive processes in order to determine the degree to which each of these processes accounts for associations between ADHD symptoms (e.g., hyperactivity/impulsivity and inattention) and kindergarten adjustment problems (e.g., aggression, social withdrawal, and academic achievement; Nigg & Casey, 2005). This comparative research may provide useful information to guide preventive intervention design, identifying which processes should be targeted in interventions for children with ADHD. It is also important to study these emotional and cognitive processes at an early age before negative expectations and attributions for being ostracized become engrained and reinforced by peer rebuke (Crick & Dodge, 1994). As a result, preventive intervention might effectively change social processing and enhance regulatory functioning. For example, a prevention program in kindergarten that practices social problem solving in emotionally arousing situations may be able to change social schemas especially those misused in emotionally provoking scenarios.

Thus, this study examined associations of the severity of hyperactivity-impulsivity and inattention with kindergarten adjustment (aggression, social withdrawal, and academic achievement) and how these associations vary as a function of EF and rejection reactivity.

Study Hypotheses

Understanding how EF and rejection reactivity play a role in the development of the social-cognitive challenges associated with ADHD during the formative early childhood years can contribute to the development of a better etiological model of ADHD. Furthermore, it can contribute to understanding how interventions targeting EF and emotion dysregulation can be enhanced and evaluated across academic and behavioral outcomes. For example, examining how EF and rejection reactivity each affect ADHD outcomes can have implications for when to apply an intervention that focuses on improving EF versus one that focuses on emotion dysregulation in social interactions (e.g., reducing the initial emotional response and practicing changing thoughts around ostracism during emotionally aroused states). This study will test a model that posits that EF skills and rejection reactivity serve as mediators linking ADHD symptoms of hyperactivity/impulsivity and inattention with kindergarten aggression, social withdrawal, and academic achievement. This study will specifically address the following key questions in a sample of kindergarten children selected with high levels of ADHD symptoms using a cross sectional design:

1. How are hyperactivity/impulsivity and inattention differentially related to concurrent aggression, social withdrawal, and academic achievement?
2. How are EF and rejection reactivity associated with concurrent hyperactivity/impulsivity and inattention?
3. Does EF mediate the association between hyperactivity/impulsivity and inattention with concurrent aggression, social withdrawal, and academic achievement?
4. Does rejection reactivity mediate the association between hyperactivity/impulsivity and inattention with concurrent aggression, social withdrawal, and academic achievement?

The following hypotheses are made in response to these questions:

Hypothesis 1. Unique associations are expected between hyperactivity/impulsivity and increased aggression; and between inattention and increased social withdrawal and poor academic achievement.

Hypothesis 2. Unique associations are expected between hyperactivity/impulsivity and increased rejection reactivity; and between inattention and poor EF.

Hypothesis 3. Poor EF is expected to mediate the association between inattention and increased social withdrawal and poor academic achievement. While children with EF deficits show elevated aggression in some studies, this may well be due to concurrent inattention. Given that hyperactivity/impulsivity, rather than inattention, is predominately associated with aggression (e.g., Gagnon et al., 1995; Willcutt et al., 2012), we hypothesize that EF deficits will not be associated with aggression if inattention is controlled for in the analysis.

Hypothesis 4. Heightened rejection reactivity is expected to mediate the association between hyperactivity/impulsivity and increased aggression. While rejection reactivity has been linked with social behaviors, it is not hypothesized to serve as a link between hyperactivity/impulsivity and social withdrawal as social withdrawal is typically more often associated with inattention rather than hyperactivity/impulsivity (e.g., Willcutt et al., 2012). Furthermore, this study focuses on the intensity of the emotional reaction to rejection, which may more often elicit aggression, rather than anticipatory expectations for rejection that may be associated with social withdrawal. Based on the hypothesis that children with ADHD often show elevated levels of emotion dysregulation and may find it difficult to modulate their feelings when faced with rejection, this study focuses on the intensity of the child's emotional reaction (Barkley, 2010; Johnson & Rosen, 2000). While associations are not expected between rejection

reactivity and social withdrawal, as well as academic achievement, they will be explored as they have not yet been researched in a sample of kindergarteners with ADHD.

Figure 1 summarizes the expected associations and pathways that will be assessed in order to test the hypotheses proposed in this study. Implications for treatment and early identification of children based on these dimensions will be discussed.

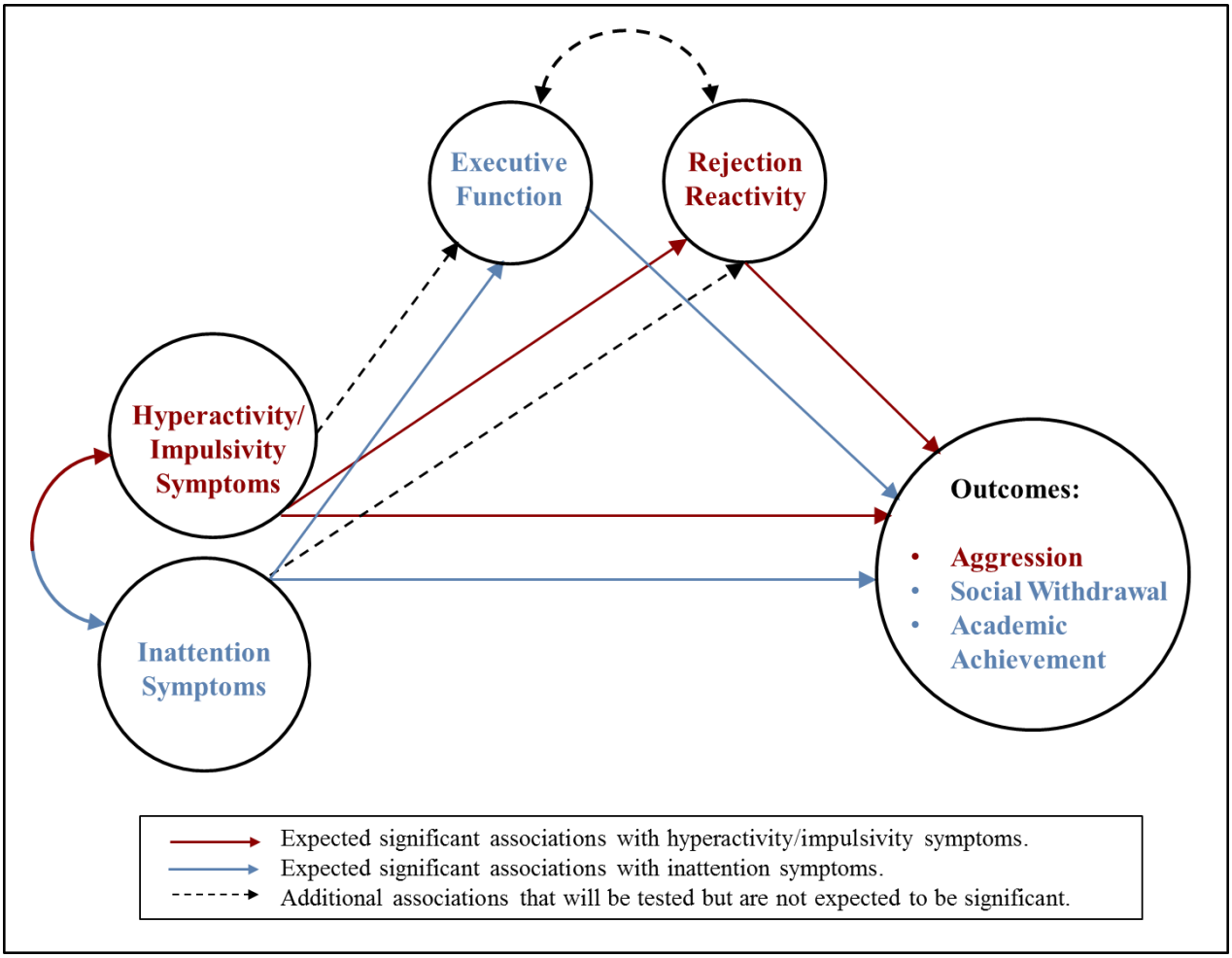


Figure 1. Hypothesized Model of EF and Rejection Reactivity Mediating the Associations between School Adjustment and ADHD Symptoms in Kindergarteners

Participants

One hundred-thirty-three children with clinical or sub-clinical elevations of ADHD symptoms were recruited for an intervention study. This study uses children's baseline and screening measures, which were assessed within one month of each other, prior to the start of the intervention. Children were recruited during their kindergarten year from 46 classrooms from four school districts serving rural and small urban areas in central Pennsylvania. In the final sample of children with ADHD, 65% were male, 74% were white, 11% were African American, 4% were Latino/Hispanic, 1% was Asian, and 11% were multiracial. The average age of the children at the time teachers completed their ratings of the children was 5 years and 2 ½ months old with a standard deviation 5 months. At the time of assessment, 7% of all children were taking stimulant or non-stimulant psychoactive medication. All data was collected from children's baseline or screening assessments, which were administered in the fall of their kindergarten year.

Screening and Sample Selection Procedures

Brochures describing the study were sent home with all kindergarten children in the participating classrooms. In total, 870 parents received brochures and 722 were returned (88%). Of those, 77 parents declined to participate (11%) and an additional 12 children moved before having an opportunity to interview the teachers. Thus, 633 children were retained in the study and were rated by their classroom teachers on the Conner's ADHD Rating Scale-Short Form-Revised (Conners) and the DuPaul ADHD Rating Scale (ADHD-RS). Children passed through this the first gate of the screening process if teachers rated them as having three or more inattentive symptoms, three or more hyperactivity/impulsivity symptoms, or four or more total symptoms. In the next gate of the process, parents completed the Diagnostic Interview Schedule for Children (DISC-IV), Conners and the Behavioral Assessment Scale for Children (BASC-2).

To pass this gate, children had to receive a T-score greater than 60 on the cognitive problems/inattention, hyperactivity, ADHD Index, or DSM-IV Total Index of the Conners; or the Hyperactivity or Attention Problems of the BASC-2 based on the parent ratings. Thirty children were screened out of the study for having a sensorimotor disability, frank neurological disorder, or psychosis as reported by their parents, or being unable to complete the assessments due to low levels of English proficiency. Children with comorbid disorders (i.e. separation anxiety, generalized anxiety, major depression, as well as oppositional defiant and conduct disorders) were not excluded. Based on findings that ADHD symptoms are still emerging at this age and that ADHD commonly co-occurs with oppositional defiant disorder, children were also included in the original study if they meet subclinical levels of ADHD symptoms or oppositional disorder (Burns & Walsh, 2000; Sonuga-Barke, Auerbach, Campbell, Daley, & Thompson, 2005). This was determined by having a T-score greater than or equal to 58 on a parent or a teacher measure of the Conner's or the BASC-2 or if they met DISC-IV criteria based on the number of symptoms parents and/or teachers endorsed. Based on these criteria, 28% of the children included in this study were considered to have subclinical levels of ADHD.

The above measures used to diagnose and include or exclude children in the study are established measures known for their excellent psychometric properties and relevance to ADHD. The Conners and BASC-2 are age-normed behavioral rating forms. The Conners Parent and Teacher Rating forms have been demonstrated to have a test re-test reliability between .72 and .92 over a six to eight week period (Conners, 2001). The internal reliability for children between the ages of 3 and 5 years old ranges from .73 to .96 across all indices (Conners, 2001). Parent BASC-2 has an internal reliability of .83 or higher on all relevant indices and the test re-test reliability exceeds .72 (Reynolds & Kamphaus, 2004). The teacher version of the DuPaul ADHD

Rating Scale, a DSM-IV checklist of ADHD symptomology, and the DISC-IV were also used. The teacher version of the DuPaul ADHD Rating Scale has .94 levels of internal consistency (α = .94) and test-retest reliability (*r* = .90; DuPaul, Power, McGoey**,** Ikeda, & Anastopoulos, 1998). The validity of the parent DISC-IV has been previously reported with a test re-retest reliability of .79 in a clinical sample and .60 in a community sample with ADHD (Shaffer, Fisher, Lucas, Dulcan, & Schwab-Stone, 2000). Furthermore, validity has been demonstrated with previous versions of the DISC with a sensitivity ranging from .73 to 1 and kappa = .72 (Fisher et al., 1993; Schwab-Stone et al., 1996). All these measures are commonly used in evidence-based assessments of childhood ADHD (Pelham, Fabiano, & Massetti, 2005).

Measures

ADHD symptoms. Hyperactivity/impulsivity symptom counts were based on the total number of hyperactivity/impulsivity symptoms endorsed by the teacher on the DuPaul ADHD Rating Scale as well as any additional different symptoms endorsed by the parent on the DISC-IV. Similarly, inattention symptom counts were based on the total number of inattention symptoms endorsed by the teacher on the DuPaul ADHD Rating Scale as well as any additional different symptoms endorsed by the parent on the DISC-IV.

Executive function. Three cognitive performance tasks were used to assess EF. All measures were significantly correlated. Children were administered the Backward Word Span task, where they were asked to listen to the interviewer say a list of words, and then repeat the list in reverse order. At the outset the list was limited to two words. For each subsequent item, one word was added to the list until the list consisted of five words. During the practice, children were allotted two attempts to master the task and if they were unable to repeat the words in reverse order the assessment was not administered. The assessment ended once a child failed one

item. Children's score represented the highest number of words they were able to repeat correctly. The Backward Digit Span, a numeric variant of the backward word span, has been shown to effectively measure working memory in children between the ages of three and six years old (Carlson, 2005; Davis & Pratt, 1996). Tests of forward word recall have been found to have strong test-retest reliabilities (r =.80) and to correlate highly with other measures of memory (Alloway, Gathercole, Willis, & Adams, 2004).

Children were also administered the Heads-Toes-Knees-Shoulders (HTKS), which is designed to tap into working memory, inhibitory control, and attention set-shifting (Ponitz, McClelland, Matthews, & Morrison, 2009). In this task, children were first asked to copy the examiner, touching their head and touching their toes. Then, they were asked to play a silly game and touch their toes when the examiner said "touch your head" and vice versa. After four practice trials with feedback, there were 10 scored trials. In a second training sequence, children touched their knees when the examiner said to touch their shoulders and vice versa. In a second set of 10 scored trials, children responded to each type of paired behavioral command, in varied order. Children earned two points for a correct response, zero points for an incorrect response, and one point if they made any motion toward the incorrect response but then self-corrected. The outcome variable used was the total number of correct points, with a maximum of 40 points possible. The HTKS task has been demonstrated to have good validity and reliability with kindergarteners (Ponitz et al., 2009).

Lastly, the Pencil Tapping task taps into children's working memory and inhibitory control. It requires children to tap a peg once when the interviewer taps twice and vice versa (α = .94; Diamond & Taylor, 1996). In task, children have to inhibit a strong tendency to imitate the

examiner, remember the pegs the examiner tapped, and follow the rule. The total score was the number of correct trials (out of 16 trials).

Rejection reactivity. The tendency to react with increased negative emotion to rejection was assessed with a new experimental task called the Social Cognitive Interactive Task (SCIT; Powers & Bierman, 2011). This computer-game-based measure is specifically designed to engage young children in order to assess their social cognitions in emotionally challenging situations that were intended to stimulate realistic peer interactions. The task was modeled after Cyberball, a similar virtual ball tossing game use to stimulate social exclusion (Williams & Jarvis, 2006). In many studies with older individuals, Cyberball has been shown to successfully elicit feelings of ostracism and increased arousal in response to being left out of a game of tossing a ball with confederates after being included for the first few passes (Boyes, & French, 2009; Ruggieri, Bendixen, Gabriel, & Alsaker, 2013; Williams, Cheung, & Choi, 2000). In the SCIT, children have the added option to choose a shape and bright colors for their avatar. Theoretically, this option to customize their avatar is intended to increase the degree to which children feel they identify with the avatar. Like Cyberball, a child also has an opportunity to practice passing a ball with another avatar in order to increase the feeling of identifying with the avatar and being part of a game. When a third avatar joins the play, however, the child's avatar is left out, as the other two begin to play ball with each other. After the challenge, children's emotional reactions were assessed by asking them to 1) choose the valence of their feelings from the options of "happy," "sad," "mad," or "scared" and; 2) choose the intensity of their feelings as either "a little" or "a lot." Rejection reactivity was dichotomized based on these responses. Children were considered to be *reactive to rejection* if they said they felt "sad," "mad," or "scared" and they felt it "a lot." Children were considered to *not be reactive to rejection* if they

said they felt “sad,” “mad,” or “scared” and they felt it “a little”, or they reported feeling “happy” (regardless of whether they said they felt “happy” a little or a lot).

School adjustment. Aggression was assessed using teacher and parent ratings. Teachers rated children using the Authority Acceptance scale of the Teacher Observation of Child Adaptation-Revised (TOCA – R), which consists of 10 items rated on a 6-point Likert scale (almost never to almost always). The Authority Acceptance scale of the TOCA-R has a strong reliability ($\alpha = .88$) and teacher inter-rater reliability ($r = .68$; Werthamer-Larsson, Kellam, & Wheeler, 1991). Parents’ rating was based on the average of children’s standardized scores on the parent rated BASC-2 aggression subscale and the oppositional scale of the parent rated Conners.

Social withdrawal was assessed using teacher and parent ratings on a 6-point Likert scale (almost never to almost always). Each rating was based on five items, two from the TOCA-R social contact scale (i.e., “invites others to play” and “avoids playing with other children”) and three from the Revised Behavior Problem Checklist (i.e., “low energy, lethargic, or inactive;” "keeps to him/herself, tends to withdraw” and “acts younger than his or her age;" Quay, 1983; Werthamer-Larsson et al., 1991). The scale has strong reliability based on the sample used in this study ($\alpha = .77$).

Children’s academic achievement was measured directly with the standardized and nationally-normed Woodcock-Johnson (WJ) Tests of Achievement III Letter-Word Identification and Applied Problems subtests (Woodcock, McGrew, & Mather, 2001). Both these scales have had strong reliabilities of .80 or greater.

Control measures. Children's gender, age, race, and use of medication were assessed by parent report. The abbreviated battery of the Stanford-Binet, 5th Edition was used to estimate children's intelligence quotient (IQ), which is an important part of ADHD to control for (Roid, 2006). The average IQ score was 96.64 with a standard deviation of 14.60.

Data Analysis Plan

For the first stage of the analyses, Pearson correlations were computed to examine simple associations among the study variables. In the second stage of the analyses, a series of structural equation models was estimated to test the study hypotheses. To test hypothesis one, three structural equation models were used to estimate how hyperactivity/impulsivity and inattention were associated with each of the constructs representing school adjustment (i.e., aggression, social withdrawal, and academic achievement). To test hypothesis two, structural equation models were used to evaluate the paths from hyperactivity/impulsivity to EF and rejection reactivity, and inattention to EF and rejection reactivity. These analyses served as the first step in establishing that the data meet the necessary prerequisites to test for mediation. Finally, to test hypotheses three and four, three structural equation models were used to determine whether EF and/or rejection reactivity mediated the paths from hyperactivity/impulsivity and inattention to school adjustment (i.e., aggression, social withdrawal, and academic achievement).

Analyses were conducted with the AMOS program of SPSS. Full information maximum likelihood (FIML) was used in order to reduce the loss of overall power due to missing data from any single case (Schafer & Graham, 2002). Across all variables, 3% of the data was missing (four cases out of 133 had any missing data points).

Results

Descriptive Analyses

Descriptive statistics for all variables in this study are presented in Table 1.

Table 1.

Descriptive Statistics

Variables	Mean	SD	Min	Max
Hyperactivity/Impulsivity Symptoms	6.24	2.61	0	9.00
Inattention Symptoms	6.11	2.50	0	9.00
Backward Word Span	2.01	.72	1.00	4.00
HTKS	22.69	13.46	0	40.00
Pencil Tapping	13.20	4.46	0	16.00
% Reactive to Rejection (SCIT)	63%	.49	0	1.00
Aggression (TOCA-R)	2.73	.96	1.00	5.43
Aggression (Parent BASC-2)	54.53	12.56	13.00	86.00
Aggression (Parent Conners)	55.31	12.31	38.00	90.00
Social Withdrawal – Teacher Rating	2.63	.84	1.00	5.80
Social Withdrawal – Parent Rating	1.92	.66	1.00	4.00
WJ Letter Word	103.51	14.42	70	155
WJ Applied Problems	100.06	15.05	31	130

Next, Pearson correlations were computed to examine associations among the variables included in the study. As shown in Table 2, hyperactivity/impulsivity was positively associated with teacher-rated aggression and trended towards significance with rejection reactivity.

Inattention was inversely associated with the EF measures and academic achievement, and positively associated with teacher-rated aggression and withdrawal. The EF measures were positively associated with academic achievement and inversely associated with social withdrawal. Rejection reactivity was positively associated with teacher-rated aggression as measured by the TOCA-R.

Table 2

Correlations among Study Variables

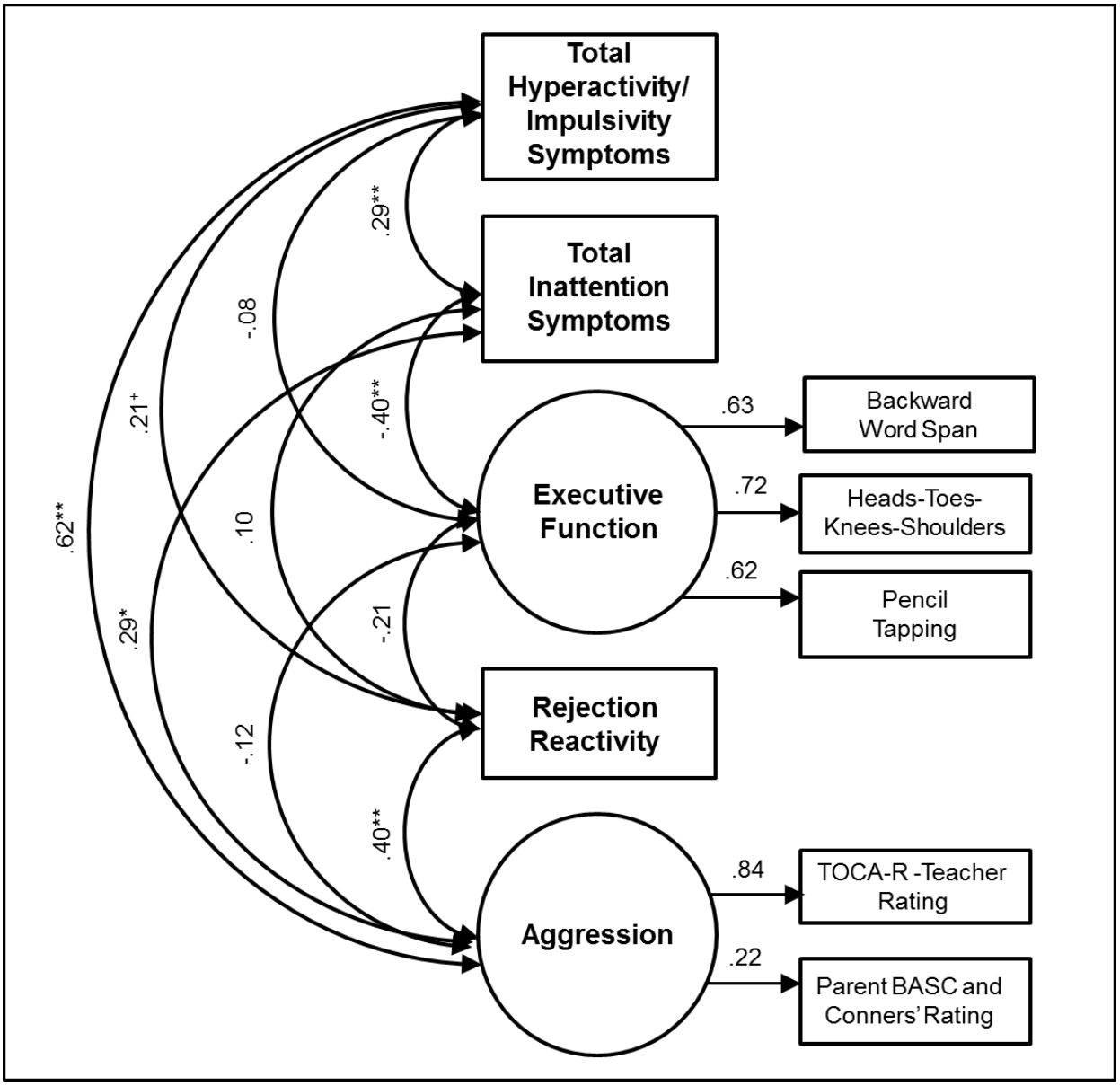
Variables	2	3	4	5	6	7	8	9	10	11	12
1. Hyperactivity/Impulsivity	.29**	-.03	-.05	-.11	.17+	.49**	.26**	-.05	-.09	.06	-.03
2. Inattention	--	-.22*	-.30**	-.30**	.08	.24**	.10	.29**	.12	-.32**	-.35**
3. Backward Word Span	--	--	.52**	.37**	-.08	-.14	.04	-.21*	-.16+	.21*	.46**
4. HTKS	--	--	--	.43**	-.18*	-.02	.09	-.25**	-.14	.27**	.50**
5. Pencil Tapping	--	--	--	--	-.07	-.14	-.05	-.30**	-.22*	.24**	.41**
6. Rejection Reactivity	--	--	--	--	--	.26**	.07	-.09	.03	.04	-.07
7. Aggression (T)	--	--	--	--	--	--	.28**	.26**	.18*	.01	-.08
8. Aggression (P)	--	--	--	--	--	--	--	-.03	.34**	-.12	-.03
9. Social Withdrawal (T)	--	--	--	--	--	--	--	--	.29**	-.10	-.26**
10. Social Withdrawal (P)	--	--	--	--	--	--	--	--	--	-.09	-.16+
11. WJ Letter Word	--	--	--	--	--	--	--	--	--	--	.49**
12. WJ Applied Problems	--	--	--	--	--	--	--	--	--	--	--

Note. T = Teacher; P = Parent. ** $p < .01$; * $p < .05$; + $p < .1$

Measurement Model

In the next stage of the data analyses, three measurement models were estimated for each outcome to assess the associations between the observed variables and the latent constructs. This measurement model is presented for aggression in Figure 2. The same model was repeated for

social withdrawal and academic achievement. All the models were judged to satisfactorily fit the data based on the pattern of fit indices. The fit indices used to determine model fit for all models in this study were χ^2, RMSEA (Browne & Cudeck, 1993; Steiger & Lind, 1980), CFI (also known as RNI, Bentler, 1990; McDonald & Marsh, 1990), and TLI (Tucker & Lewis, 1973; Bentler & Bonett, 1980). All models had a non-significant χ^2 (aggression $\chi^2 = 10.89$, df = 9; social withdrawal $\chi^2 = 6.46$, df = 10; & academic achievement $\chi^2 = 7.43$, df = 10, $p > .05$), indicating that the models did not significantly differ from what would be expected based on the data. A model is also generally considered to have good fit if CFI > .96, TLI > .95, and RMSEA < .05 (Bentler & Bonett, 1980; Browne & Cudeck; 1993, Hu & Bentler, 1999). The aggression model had CFI = .96, TLI = .94, and RMSEA = 0 and thus, were considered to have acceptable fit based on these criteria. The social withdrawal model and academic achievement model had CFI = 1, TLI > 1.03, and RMSEA = 0 and thus, were considered to have good fit based on these criteria. All observed measures were judged to be acceptable indicators of their respective latent constructs. Table 3 lists the factor loadings for each indicator in each main model tested. Although two factor loadings were small (.42 and .22), all of the other loadings were greater than .54. While factor loadings of .42 and .22 are low and not ideal, this may be due to having teacher and parent rating indicators for the same construct since discrepancies between teacher and parent ratings are common (De Los Reyes, 2011). However, it is preferable to have ratings from two different observers in order to have a multi-method measured construct with theoretically increased validity. The lower loading for the parent rating of aggression in comparison to the other school adjustment measures may also be due to the use of a different measure. All indicators were significantly related to their latent constructs ($p < .05$).



** $p < .01$; * $p < .05$; $^{+}$ $p < .1$

Figure 2. Measurement Model for Aggression

Table 3.

Model Factor Loadings

	Aggression Model		Social Withdrawal Model		Academic Achievement Model	
	EF	Agg.	EF	SW	EF	AA
Backward Word Span	.63		.60		.63	
HTKS	.72		.71		.74	
Pencil Tapping	.62		.67		.61	
Aggression (T)		.84		--		--
Aggression (P)		.22		--		--
Social Withdrawal (T)		--		.69		--
Social Withdrawal (P)		--		.42		--
WJ Letter Word		--		--		.54
WJ Applied Problems		--		--		.92

Note. Agg. = Aggression; SW = Social Withdrawal; AA = Academic Achievement; T = Teacher; P = Parent.

Structural Equation Models

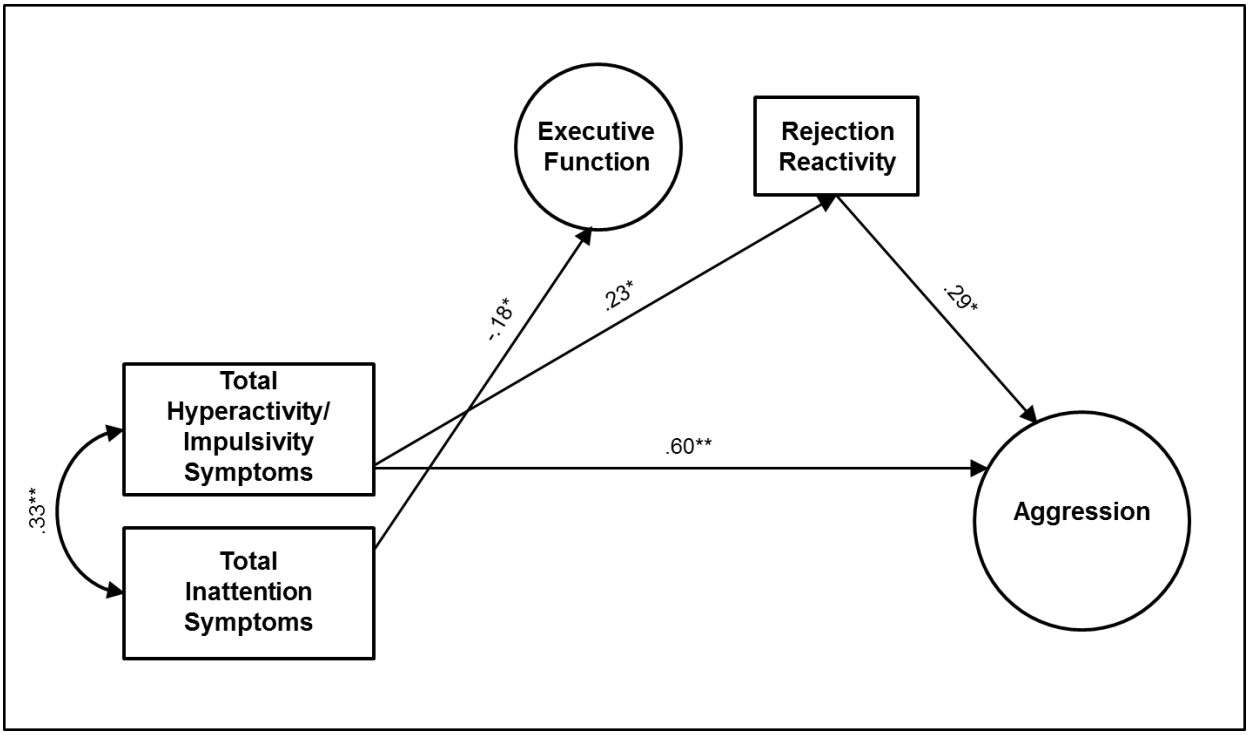
In the third stage of the data analyses, a series of structural equation models were estimated to examine the associations among ADHD symptoms, the hypothesized mediators (EF and rejection reactivity) and the school adjustment outcomes (aggression, social withdrawal, and academic achievement). Separate models were estimated and the purposed hypotheses were

tested sequentially for each outcome. The final models with their standardized path coefficients are presented in Figures 3 – 5. Gender, age and IQ were controlled for in all structural equation models.

Aggression model. For the aggression model, first a structural equation model was tested in which only the paths from the ADHD symptom to aggression were estimated while all the other paths were constrained to be zero. Hyperactivity/impulsivity was associated with greater aggression with a standardized path coefficient of .61 ($p < .01$), while inattention was not associated with aggression. Next, to assess hypothesis two and determine the associations between ADHD symptoms and the hypothesized mediators, a model was estimated in which only these paths were estimated while all the other paths were constrained to be zero. In this model, hyperactivity/impulsivity was associated with higher rejection reactivity ($B = .27$, $p < .05$) and inattention was associated with poor EF ($B = -.17$, $p < .05$). EF and rejection reactivity were not significantly correlated in this model while hyperactivity/impulsivity and inattention were ($r = .31$, $p < .01$). Lastly, to examine the effects of the hypothesized mediators on aggression while controlling for ADHD symptoms, a structural equation model with only these paths was estimated. Rejection reactivity was significantly associated with aggression ($B = .22$, $p < .05$), while EF was not. This saturated model for aggression was judged to have good fit ($\chi^2 = 13.05$, df = 17, $p > .05$; CFI = 1; TLI = 1.07; and RMSEA = 0).

For the final structural equation model for aggression, which is presented in Figure 3, all the non-significant direct paths (hyperactivity/impulsivity to EF, inattention to aggression, and EF to aggression) were removed. This final model for aggression was judged to have good fit as $\chi^2 = 12.73$ (df = 19, $p > .05$), CFI = 1, TLI = 1.20, and RMSEA = 0. As the χ^2 difference between this more parsimonious structural equation model and the saturated structural equation model

was nonsignificant (χ^2 = -0.32, df = 2, p > .05), the more parsimonious structural equation model was preferred. Using only the significant mediator and the method described by Tofighi and MacKinnon (2011), a 95% confidence interval for the mediated effect was calculated to be 0.02 to .132. Thus, rejection reactivity mediated the association between hyperactivity/impulsivity and aggression.



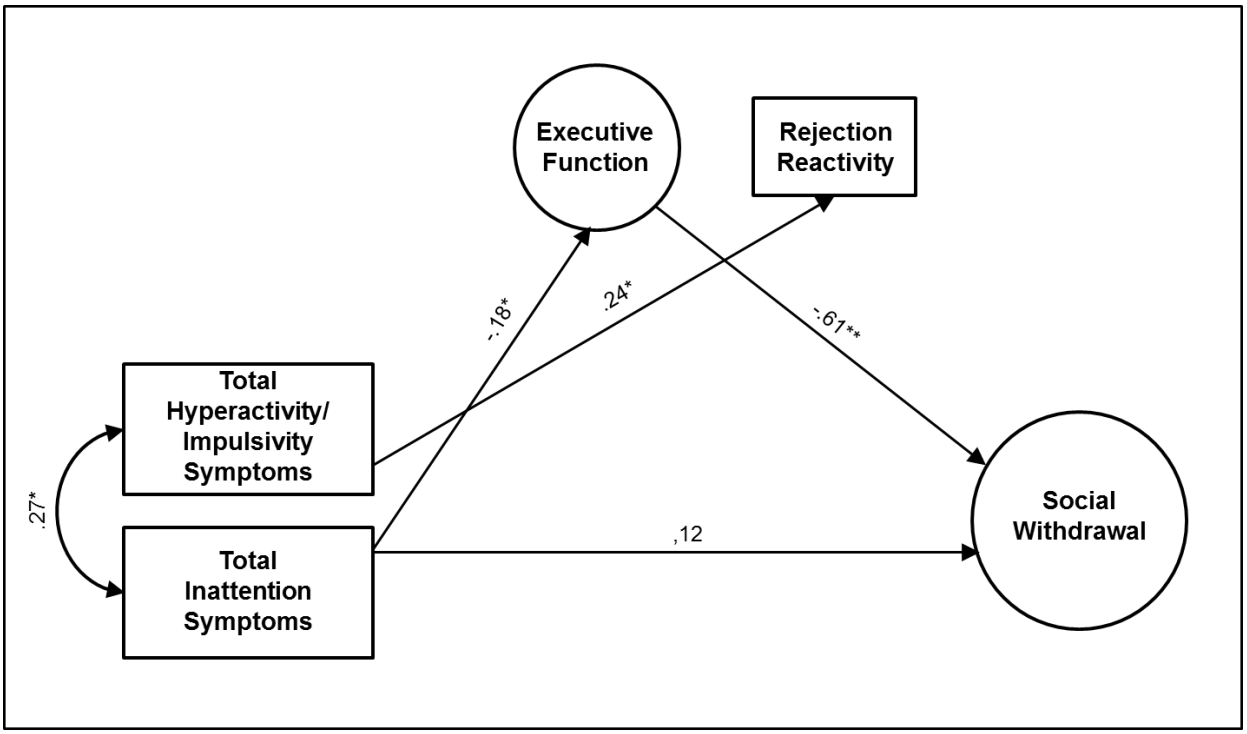
** p < .01; * p < .05

Figure 3. Structural Equation Model Predicting Aggression

Social withdrawal model. For the social withdrawal model, similar to the aggression model, a structural equation model was tested first in which only the paths from ADHD symptoms to social withdrawal were estimated while all the other paths were constrained to be zero. Inattention was associated with greater social withdrawal with a standardized path coefficient of .38 (p < .01), while hyperactivity/impulsivity was marginally negatively associated with social withdrawal (B = -.19, p < .1). Furthermore, as mentioned earlier, inattention was

associated with poor EF (B = -.17, p < .05). Next, to examine the effects of the hypothesized mediators on social withdrawal while controlling for ADHD symptoms, a structural equation model with only these paths was estimated. EF was significantly associated with social withdrawal (B = -.54, p < .05), while rejection reactivity was not. This saturated model for social withdrawal was judged to have good fit (χ^2 = 14.21, df = 17, p > .05), CFI = 1,TLI = 1.05, and RMSEA = 0).

For the final structural equation model for social withdrawal, which is presented in Figure 4, all the non-significant direct paths (hyperactivity/impulsivity to EF, hyperactivity/impulsivity to social withdrawal, and rejection reactivity to social withdrawal) were removed. This final model for social withdrawal was judged to have good fit as χ^2 = 16.64 (df = 19, p > .05), CFI = 1, TLI = 1.04, and RMSEA = 0. As the χ^2 difference between this more parsimonious structural equation model and the saturated structural equation model was nonsignificant (χ^2 = 2.43, df = 2, p > .05), the more parsimonious structural equation model was preferred. Interestingly, in this model, the association between inattention and social withdrawal became only marginally significant. Using only the significant mediator and the method described by Tofighi and MacKinnon (2011), a 95% confidence interval for the mediated effect was calculated to be 0 to .059 and a 90% confidence interval for the mediated effect was calculated to be .003 to .052. Thus, EF marginally fully mediates the association between inattention and social withdrawal.

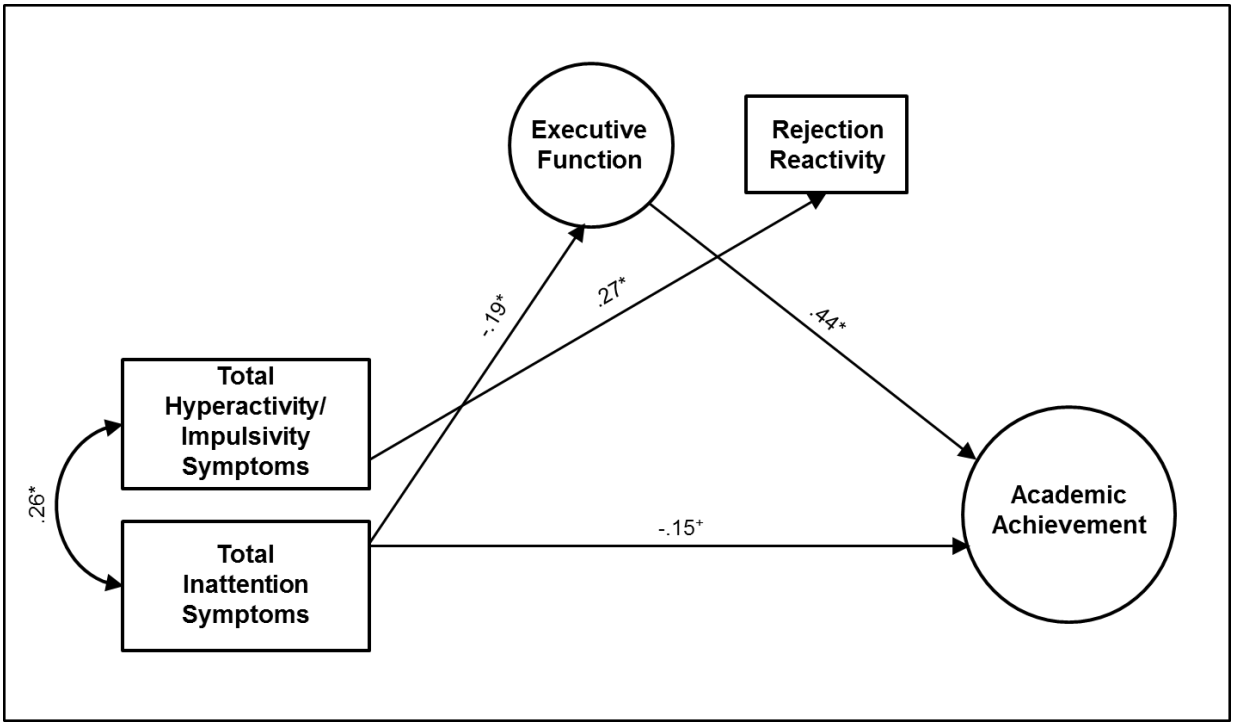


** $p < .01$; * $p < .05$

Figure 4. Structural Equation Model Predicting Social Withdrawal

Academic achievement model. For the academic achievement model, similar to the other models, a structural equation model was tested first in which only the paths from ADHD symptoms to academic achievement were estimated while all the other paths were constrained to be zero. Inattention was associated with poor academic achievement with a standardized path coefficient of -.031 ($p < .01$), while hyperactivity/impulsivity was not associated with academic achievement. Furthermore, as mentioned earlier, inattention was associated with poor EF (B = -.17, $p < .05$). Next, to examine the effects of the hypothesized mediators on academic achievement while controlling for ADHD symptoms, a structural equation model with only these paths was estimated. EF was significantly associated with academic achievement (B = .48, $p <$ .01), while rejection reactivity was not. This saturated model for academic achievement was judged to have good fit (χ^2 = 13.47, df = 17, $p > .05$; CFI = 1; TLI = 1.04; and RMSEA = 0).

For the final structural equation model for academic achievement, which is presented in Figure 5, all the non-significant direct paths were removed (hyperactivity/impulsivity to EF, hyperactivity/impulsivity to academic achievement, and rejection reactivity to academic achievement). This final model for academic achievement was judged to have good fit as χ^2 = 15.05 (df = 19, $p > .05$), CFI = 1, TLI = 1.04, and RMSEA = 0. As the χ^2 difference between this more parsimonious structural equation model and the saturated structural equation model was nonsignificant (χ^2 = 1.58, df = 2, $p > .05$), the more parsimonious structural equation model was preferred. Interestingly, in this model, the association between inattention and academic achievement becomes only marginally significant. Using only the significant mediator and the method described by Tofighi and MacKinnon (2011), a 95% confidence interval for the mediated effect was calculated to be -.760 to -.017 and a 90% confidence interval for the mediated effect was calculated to be -.667 to -.045. Overall, this suggests that EF significantly fully mediates the association between inattention and academic achievement.



* $p < .05$, $^{+}$ $p < .1$

Figure 5. Structural Equation Model Predicting Academic Achievement

Discussion

Theorists have suggested that deficits in cognitive regulatory control (EF skills) and elevated emotional reactivity may each be associated with the adjustment problems of children with ADHD (Nigg & Casey, 2005). Past research suggests the problems associated with ADHD vary based on symptoms' dimensions. Hyperactivity/impulsivity tends to be associated with greater aggression while inattention tends to be associated with increased social withdrawal and worse academics (e.g., Gagnon et al., 1995; Hodgens et al., 2000; Lahey et al., 1994; Maedgen & Carlson, 2000; Willcutt et al., 2012; Wolraich et al., 1996). This study builds upon past research by replicating these associations in a sample of kindergarteners and examining both EF and rejection reactivity as intermediary links accounting for these associations. Specifically, hyperactivity/impulsivity was associated with greater aggression and heightened rejection

reactivity. In structural equation models, rejection reactivity mediated the association between hyperactivity/impulsivity and aggression. In contrast, inattention was uniquely associated with increased social withdrawal, worse academic achievement, and poor EF. In structural equation models, EF fully mediated the association between inattention and academic achievement and marginally mediated the association between inattention and social withdrawal. Children's gender, age, and IQ were controlled for in all analyses.

Aggression

This study adds to the literature clarifying that while children with ADHD are often more aggressive than their peers, aggression is associated with the hyperactive/impulsive dimension of ADHD and not the inattention dimension (e.g. Gagnon et al., 1995; Hodgens et al., 2000; Maedgen & Carlson, 2000; Willcutt et al., 2012). In order to understand this association, this study examined the role of a novel construct, rejection reactivity. This is the first study to demonstrate that rejection reactivity is associated with aggression and hyperactivity/impulsivity, and marginally mediates the association between hyperactivity/impulsivity and aggression.

Many children with ADHD have problems with aggression, peer rejection, and negative emotional reactivity. This study takes a novel approach by examining the overlap of these two latter areas by providing insight into how these children's rejection reactivity may contribute to these problems. It is hypothesized that children with ADHD evoke peer rejection in response to their impulsive, annoying behaviors. This heightened exposure to rejection may lead to increased distress and an increased tendency to react aggressively in defense of rejection that feels unwarranted. Past research has demonstrated that from school entry, children who exhibit elevated hyperactive/impulsive and aggressive behaviors are at increased risk for problematic peer relations, including low levels of peer acceptance and elevated rates of peer rejection (Ladd,

Hart, Wadsworth, & Goiter, 1988). Impulsive and intrusive behaviors become increasingly problematic during the early elementary years as such behaviors violate the increasingly rule-governed social conventions and norms of reciprocity in elementary-school-aged peer relations (Bierman, 2004). Thus, hyperactive/impulsive children have greater difficulty with entering and sustaining positive peer interactions as they get older. If they commonly interpret such peer rebuff as an indication of hostile intent, these children may experience more intense emotional responses over time. As children with ADHD have a more difficult time managing their emotions, a negative interpretation of peer responses may compound the likelihood that they will react with anger and aggression (Barkley, 2010; Dodge & Somberg, 1987). Prior research suggests that hyperactivity/impulsivity is associated with several biases in social information processing that increase the likelihood of an angry response (Uekermann et al., 2010). For example, hyperactivity and aggression have each been linked with a positive self-illusory bias in which children blame external sources for being rejected (Hoza, Pelham, Dobbs, Owens, & Pillow, 2002; Owens & Hoza, 2003). In addition, hyperactivity/impulsivity is associated with pre-emptive social decision-making, in which interpretations of social problems are made prematurely, without adequate consideration of the full set of social cues (Crick & Dodge, 1994; Rosen et al., 2007). As a result, these children may have more intense, dysregulated emotional responses to peer rebuff, and over time, pre-emptively respond aggressively more frequently in order to defend themselves from what they perceive as unwarranted rejection.

While such rejection reactivity may emerge in response to defending oneself from the peer rejection experienced by children with ADHD, it is also possible that vulnerability to rejection reactivity stems, in part, from early temperament and attachment experiences. Hyperactivity has been linked with higher levels of temperamental irritability and negative

affectivity, which may increase the child's affective reaction to responses that are perceived as negative or hostile (including peer rejection) and thereby, contribute to aggressive behavior (Sonuga-Barke et al., 2005). Research suggests that children who are temperamentally irritable with elevated levels of negative emotionality are at increased risk for difficulties in early parent-child interactions (Clarke, Ungerer, Chahoud, Johnson, & Stiefel, 2002). In turn, parents who fail to respond with sensitivity and support to their irritable infant raise the risk for insecure attachment (Niederhofer, 2009). Conceptually, insecure attachment and experiences of parental rejection may increase child vulnerability to rejection reactivity, by biasing the child's internal working model with a fear of interpersonal rejection (Canu & Carlson, 2007; Downey et al., 1998; Kim & Yoo, 2013; Morrell & Murray, 2003). That is, feeling insecure in the parent-child relationship may lead a child to be more emotionally distressed by peer behaviors that indicate a lack of support.

The present study supports these possible theories as rejection reactivity significantly mediated the association between hyperactivity/impulsivity and aggression However, further research is necessary to clarify whether rejection reactivity emerges in children with ADHD and effects aggression through these hypothesized pathways or another pathway. Furthermore, research is necessary to examine whether rejection reactivity may play a different role in children without ADHD as these associations may be different in other children (e.g. Howarth, Guyer, & Perez-Edgar, 2013).

In this study, EF was not significantly associated with aggression; none of the EF measures used in this study correlated with either teacher or parent ratings of aggression. Conceptually, theorists have suggested that EF skills should help children manage emotions and behavior; thereby, helping them to comply with rules and inhibit aggression (Blair, 2002).

However, several studies have failed to find links between the kinds of EF tasks used in this study and aggressive behavior (Bierman et al., 2008; Brophy, Taylor & Hughes, 2002). For example, studying "hard to manage" 4-year olds, Brophy et al., (2002) found no associations between working memory or set-shifting skills and aggressive behaviors, although aggressive children showed more perseveration errors on the EF tasks. These findings may be due to the type of EF tasks being used in these studies. Recently, researchers have differentiated between EF tasks that focus on cognitive performance in affectively neutral circumstances, such as the Peg Tapping and Dimensional Change Card Sort tasks ("cool EF"), and EF tasks that require the modulation of emotion and behavior, such as delay tasks ("hot EF"; Zelazo, Carlson, & Kesek, 2008). Cool and hot EF tasks have been found to factor separately in some studies and may have different neural roots (Blair & Razza, 2007; Nigg, 2006). Management of impulsivity has been more closely linked with hot EF task performance than with the kind of cool EF tasks included in this study (White et al., 1994). This study included cool EF tasks in order to focus on assessing the cognitive control pathway to ADHD proposed by Nigg and Casey (2005), as opposed to a pathway that assessed emotion and behavioral regulation. Had hot EF or behavioral inhibition measures of EF been used, associations with aggression may have emerged.

Social Withdrawal

While hyperactivity/impulsivity was associated with externalizing problems, inattention was associated with internalizing problems. In order to understand this association between inattention and social withdrawal, EF and rejection reactivity were examined as potential intermediary constructs. EF was significantly associated with both inattention and social withdrawal. Although the statistical significance of the association was only marginal, EF skills

mediated the association between inattention and social withdrawal. Rejection reactivity was not associated with social withdrawal.

Thus, it is thought that inattention rated by teachers and parents often reflects deficits in EF skills (e.g., working memory, inhibitory control, and attention set-shifting) that keep children with ADHD from learning important skills for starting and joining in social interactions. Their lack of social competence may account for their social withdrawal. Strong EF skills may initially build upon a strong ability to focus one's attention, as attention develops early in the first year of life (Garon et al., 2008). On the other hand, a lack of strong EF skills may make it more difficult for inattentive children to maintain social relations (Lundy, 2007). For example, deficits in working memory may make it more difficult for children to recall templates of appropriate social behavior, while deficits in inhibitory control may make it more difficult for children to delay an inappropriate reaction that could interfere with social play (Barkley, 2001; Bull & Scerif, 2001; Diamond, 2005; Miyake et al., 2000; Monette et al., 2011). Furthermore, deficits in attention set shifting can make it more difficult to focus on problem solving and regulating emotions in distracting social environments (Chang & Burns, 2005; Derryberry & Rothbart, 1997; Posner & Peterson, 1990). Prior research has documented that deficits in EF are linked with poor prosocial play skills, language delays, and low levels of positive classroom participation (Bierman, Torres, Domitrovich, Welsh, & Gest, 2009).

Overtime, as the lack of these skills socially isolate children with poor EF, these children may miss out on the social learning that occurs in the context of positive peer and teacher interactions, thereby reducing their social integration and success at school (Coolahan, Fantuzzo, Mendez & McDermott, 2000; Konold & Pianta, 2005). In this sample of kindergarten children, the mediational role of EF in the association between inattention and social withdrawal was only

marginally significant. It may be that problems with social engagement are only beginning to emerge in association with a lack or delay of learned social skills. As children become older and have to take part in more complex play, their poor EF and associated social deficits may lead to reduced opportunities to practice social skills and a negative self-perception of their social competence (Owens & Hoza, 2003; Parten, 1932). Thus, through this negative cascade, poor EF may fully account for the association between inattention and social withdrawal over time. A similar phenomenon occurs for children with learning disabilities, who also often have EF deficits, as they show elevated rates of solitary play and unoccupied time, as well as briefer and less complex social interactions when they interact with peers, relative to normative rates in elementary school (Gottlieb, Gottlieb, Berkell & Levy, 1986; Mattison & Mayes, 2012; & Smith, 1993). At the beginning of kindergarten, inattention may also have a more direct association with social withdrawal as a lack of attention may keep children from being able to engage, focus and learn socially. Other studies have implicated other factors in this association, such as sluggish cognitive tempo (e.g., low alertness and slow processing), which can contribute to a reduced ability to attend to minor social cues and remember conversations, and in turn, to problems with social engagement (Carlson & Mann, 2002; Mikami, Huang-Pollock, Pfiffner, McBurnett, & Hangai, 2007). Thus, it is possible that EF may play a larger role in the association between inattention and social withdrawal at a later age, whereas other factors, such as sluggish cognitive tempo or inattention directly, may play a more consequential role at this age.

While rejection reactivity was also examined as a potential mediator of the association between social withdrawal and inattention, rejection reactivity was not significantly associated with social withdrawal or inattention. Theoretically, rejection reactivity could be associated with increased rejection, thereby reduce children's opportunities to practice social skills. In this

manner, rejection reactivity might increase children's social withdrawal over time. But it is possible that at this early age this potential negative cascade has not taken place yet. Another possibility is that since rejection reactivity was significantly associated with hyperactivity/impulsivity, which is associated with a positive illusory self-perception in children with ADHD, children reactive to rejection may not be inclined to withdraw socially when they feel rejected, but instead to react with anger and retaliation (Owens & Hoza, 2003; Sarno, 2001). Further research is necessary to clarify the role of rejection reactivity in motivating approach-oriented versus avoidance-oriented social behaviors.

Academic Achievement

EF fully mediated the association between inattention and poor academics. Academically, EF skills contribute to storing and recalling content; inhibiting distracting, off-task behavior and prepotent responses; and shifting and managing attention to different tasks and emotional cues during difficult tasks (Bull & Scerif, 2001; Barkley, 2001; Derryberry & Rothbart, 1997; Monette et al., 2011; Posner & Peterson, 1990). The fact that EF fully accounts for the association between inattention and academic achievement highlights the central role of EF skills in regulating attention to engage in learning and problem solving, and helping accomplish academic goals from an early age. As hypothesized, this study did not find an association between rejection reactivity and academic achievement. While it was theoretically possible for rejection reactivity to have spillover effects on academic learning, kindergarten may be too early of an age for there to be a negative cascading effect of rejection reactivity onto academic performance.

Limitations and Future Directions

There are several limitations of this study to consider. The cross sectional design of this study limits the ability to make inferences about the predictive power of ADHD symptoms, EF, and rejection reactivity. Therefore, possible causal and temporal explanations of associations amongst constructs are heavily theory based. Future longitudinal research can help clarify the role of EF and rejection reactivity in children with ADHD.

A challenge with studying relatively new constructs is a lack of well-developed and extensive measures to assess a new construct. As shown in this study, rejection reactivity plays an important role in the school adjustment of children with ADHD. However, this construct was measured by a single-item dichotomized indicator. Future research would benefit from using a more extensive measure with more indicators to tap into rejection reactivity. Further research is also necessary to better understand this affect related side of ADHD and to develop better measures to asses it.

An additional challenge common to studies using different observers' ratings of behavior (e.g., Achenbach, McConaughy, & Howell, 1987) is that the teacher and parent ratings used in this study had a low correlation, and thus, the parent ratings had low factor loadings on the constructs composed of both parent and teacher ratings. Both parent and teacher ratings were used as having more informants is considered to add incremental validity (Johnston & Murray, 2003). Despite the low factor loadings for the parent ratings on the behavioral constructs (.22 for aggression and.42 for social withdrawal), the teacher loadings were high (.73 for aggression and .77 for social withdrawal). As teacher ratings are considered to be more accurate and useful than parent reports for children with ADHD and since the structural equation models in this study had good fit, the lack of high factor loadings for the parent ratings is not judged to be a major

limitation of the validity of measuring the latent constructs of aggression and social withdrawal (Power et al., 1998).

Lastly, a larger sample would have been ideal for the size of the structural equation models used in this study. Despite the small sample size for finding effects in models with as many parameters as those used in this study, it is noteworthy that marginal and significant mediational effects were found. Schreiber, Nora, Stage, Barlow and King (2006) have reported that while sample size needs may vary for each study and the distribution of the data within the study, the general rule of thumb has been to have at the very least 10 cases for every free parameter estimated. In this study's model there are 12 measures underlying seven constructs (hyperactivity/impulsivity, inattention, EF, rejection reactivity, aggression, social withdrawal, and academic achievement) with error terms for each measure and construct being analyzed, necessitating a sample size of 350. An alternate suggestion for sample size has been to have at least 200 participants but this is still more than this study's sample of 133 children (Garver & Mentzer, 1999; Hoelter, 1983). Thus, it is possible that with a larger sample size, these marginal trends for mediation would have been found to be significant. With a larger sample, the role of interactions between EF and rejection reactivity in the school adjustment problems of children with ADHD could also be examined. As more research is conducted on the cognitive and affective pathways of ADHD, more attention should be allocated to understanding the interwoven associations and conjoint effects of these two pathways within larger samples.

Despite these limitations, this study can illuminate how constructs related to ADHD are conceptualized and how they relate to each other. Further studies, preferably with larger sample sizes assessed over time, are necessary to verify the proposed possible associations and to better

understand the etiology of ADHD and its associated features (e.g., rejection reactivity, EF, and school adjustment problems).

Clinical Implications

This study emphasizes the importance of both cognitive and affect related processing in children with ADHD. Furthermore, this study exemplifies how there are different correlates to target for the different priority problems different children with ADHD may have. Children whose primary problem is with hyperactivity/impulsivity may need interventions that target their tendency to have more intense emotional responses to rejection and to behave more aggressively. For example, their rejection reactivity may be reduced through interventions that teach them to manage and reduce their initial emotional response and change their thoughts and expectations around ostracism during emotionally aroused states. In addition, in order to target the parental and peer rejection that may fuel rejection reactivity and the associated aggression, these children may benefit from classroom interventions intended to prevent peer rejection and promote emotion regulation in the context of classroom peer relationships. They may also benefit from a family systems approach that addresses aversive parenting, such as parent-child interaction therapy, which can address emotional reactivity, relational problems, and disruptive behaviors (Labauve, 2003; Ladnier & Massanari, 2000; Zisser & Eyberg, 2010). On the other hand, children who primarily have inattention problems may need interventions that help them develop their cognitive capacities, provide them with skills to engage socially, and assist them with academics. Social-emotional learning programs that target EF and emotion regulation, such as the Promoting Alternative Thinking Strategies (PATHS) Curriculum (Kusche & Greenberg, 1994), provide an integrated treatment that may be able to address both the cognitive and affective pathways. For example, PATHS has been shown to improve EF and children's

academic and social competence (Bierman et al. 2009; Riggs et al., 2006). Within children with ADHD, computer training programs have also been shown to improve EF skills (Klingberg et al., 2005).

This study also demonstrates that EF and rejection reactivity need to be targeted at an early age. While EF were only marginal mediators of the social adjustment of children with ADHD, it is possible that these associations become significant at a later age since at the beginning of kindergarten, the negative consequences of poor EF have yet to become engrained in social relationships. Over time, as children experience more rejection and are unable to muster the EF skills to engage in social situations, rejection reactivity and social schemas may become engrained and eventually lead to a negative cascade of having less friends and thereby, less opportunities to learn socially (Crick & Dodge, 1994). Social functioning becomes increasingly important as children progress through kindergarten on to grade school, where they have to learn to function within the larger social setting of the classroom and with increasingly complex rules of social play (Bierman et al., 2010). In addition to potentially increasingly falling behind academically as a result of the poor EF associated with inattention, the intermediary cognitive and affective process may overtime widen the gap between the school adjustment problems of children with ADHD and those without ADHD. Thus, this study suggests that there are intermediary problems that begin to emerge for children with ADHD as early as the beginning of kindergarten that can be targeted in order to possibly reduce having greater academic and social problems later in school. Furthermore, this study suggests that it may be helpful to consider EF skills and rejection reactivity from an early age, in addition to symptoms of ADHD, as part of screening and determining who may benefit from what interventions. Further research can clarify the longitudinal impacts of EF and rejection reactivity.

Conclusions

In summary, this study demonstrates the importance of considering both cognitive and affective processes in children with ADHD. Hyperactive/impulsive children's emotional reactivity to rejection plays a key role in the aggressive behaviors that commonly spill over into problems with peers, school, and overall functioning. EF skills go across domains and appear to play an important role in being less withdrawn socially and performing better academically. As the association of inattention with social withdrawal and academic achievement becomes insignificant once EF is accounted for, it is especially critical for children with ADHD to develop strong EF skills to help regulate their attention. Hence, it may be important to develop more tailored interventions for children with ADHD in order to reduce rejection reactivity for especially hyperactive, impulsive and aggressive children, and increase EF skills for especially inattentive, socially withdrawn, and academically low performing children. Future research can benefit from more models that examine these two pathways together longitudinally in children with ADHD.

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