POSITIVE ILLUSORY BIAS IN THE PHYSICAL DOMAIN AND COGNITIVE FUNCTIONING AMONG CHILDREN WITH ADHD SYMPTOMS

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ABSTRACT

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Current literature suggests school-aged children with Attention-Deficit/Hyperactivity Disorder (ADHD) overestimate their competence in comparison to adult-report or objective performance outcomes, often referred to as positive illusory bias (PIB). PIB research has primarily focused on children's perceived competence within the academic, social, and behavioral domains with surprisingly limited research in the physical domain. In addition, relatively few studies have examined PIB in relation to cognitive dysfunction and whether higher order cognition may underlie both motor deficits and PIB in children with ADHD. Accordingly, the aim of this study was two-fold: (a) to assess whether children with ADHD overestimate their competence in the physical domain, and (b) to investigate whether PIB is more pronounced with greater cognitive dysfunction. Using a cross-sectional design, participants (N = 28, M_{age} = 9.6 ± 1.3 years) were assessed on self-report measures of competence, interference and working memory tasks, and motor skill ability. Findings showed child report of competence for the athletic domain to be higher than, but not significantly different from, parent report, $t(27) = 1.52$, $p < .05$. However, hierarchical regression analyses showed flanker incongruent reaction time ($F(1, 23) = 5.34$, $p < .05$) to explain 18% of PIB variance beyond covariates. Based on this finding, future work is recommended that examines the intersection of cognitive dysfunction, motor performance, and ADHD in children.

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KEY TO SYMBOLS AND ABBREVIATIONS

ADHD	= attention deficit hyperactivity disorder
EF	= executive function
GMQ	= gross motor quotient
HI	= hyperactive/impulsive
IA	= inattentive
ms	= milliseconds (e.g., 1000ms = 1 second)
PIB	= positive illusory bias
PRS	= parent rating scale
RT	= reaction time
RA	= response accuracy
SPPC	= self-perception profile for children
TGMD	= test of gross motor development

CHAPTER ONE

INTRODUCTION

As one of the most prevalent childhood neurobehavioral disorders, approximately 11% of school-aged children suffer from Attention-Deficit/Hyperactivity Disorder (ADHD; Centers for Disease Control and Prevention [CDC], 2016). ADHD is characterized by symptoms such as developmentally inappropriate impairment of attention and/or hyperactive/impulsive behavior in multiple settings (American Psychiatric Association, 2013). Around seven years of age, the key features of inattention and/or hyperactivity/impulsivity are present and foster impairments across at least two settings, most often home and school (Owens & Hoza, 2003). Such impairments include social and academic difficulties, family distress and dysfunction, and challenges in various other settings such as sports (Owens & Hoza, 2003). Pelham, Foster, and Robb (2007) identified that difficulties often persist over the adolescent and adult years, making chronic management of the disorder an essential and recognizable major public health issue estimated to cost US$36 to US$52.4 billion annually.

Children with ADHD display significant impairments in multiple achievement domains including academic performance (Hinshaw, 1992; LeFever et al., 2002), social interaction (Hoza et al., 2005; Pelham & Milich, 1984), behavioral conduct (Hinshaw, 1987) and motor control (Harvey & Reid, 1997; 2003; Zelaznik et al., 2012). Despite these significant functional deficits, many children with ADHD tend to underreport the presence of problems (Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007). In fact, research suggests they exaggerate their own competence such that their self-perceptions commonly do not correspond with objective teacher and parent ratings of their performance (Hoza et al., 2004; Hoza, Owens, Pelham, & Pillow., 2002; Owens et al., 2007). Researchers have termed this phenomenon as positive illusory bias

(PIB; Hoza et al., 2002; Owens & Hoza, 2003). According to Hoza et al. (2002), PIB is operationally defined as a "disparity between self-report of competence and actual competence such that self-reported competence is substantially higher than actual competence" (pg. 271).

Extant research has identified the existence of similar positive illusions in the broad population. For example, when adults are asked to compare themselves to an average target, their self-evaluations are often more positive than possible (Taylor & Armor, 1996). This is termed the 'better than average effect' (Alicke & Govorun, 2005). This effect is considered a mild positive bias that is adaptive and serves a wide variety of cognitive, affective, and social functions. Robins and Beer (2001) conducted a longitudinal study assessing whether positive illusions are adaptive or maladaptive. Their work had several goals. First, they focused on parallel questions about the correlates and consequences of positive illusions. Secondly, to longitudinally test claims about the benefits and shortcomings of positive illusions, Robins and Beer (2001) examined subjective well-being and self-esteem over 4 years of college. Those who entered college with positive illusions about academic ability reported higher levels of well-being and self-esteem. However, growth curve analyses found participants with overly positive illusions to have a downward trajectory of well-being and self-esteem compared to those with accurate self-perceptions. Intriguingly, those with positive illusions about academic performance did not receive better grades, often failing to meet their own high expectations. These findings suggest positive illusions have both adaptive and maladaptive consequences. Accordingly, children with ADHD who have exaggerated positive bias may be susceptible to maladaptive consequences over the long term.

Past literature on PIB has focused on the academic, social, and behavioral domains, where children with ADHD have shown significant deficits that predispose them to experience repeated failures and negative feedback (Owens & Hoza, 2003). Children with ADHD typically show poor academic achievement (Hinshaw, 1992), and have been found to demonstrate less persistence on school-related tasks than their non-impaired peers (Cantwell & Satterfield, 1978). Symptoms salient in ADHD such as inattention or hyperactivity often result in poor grades, unfinished assignments, and inaccurate academic work (Owens & Hoza, 2003). Impulsivity and hyperactivity leads to frequent fidgeting and unnecessary movement within a classroom, often serving to disrupt and create friction between teachers and peers (Greshman, MacMillan, Bocian, Ward, & Forness, 1998).

Friction created within the classroom setting extends to daily social interactions. Children with ADHD have clinically significant and impaired social problems that are often perceived by adults and peers as bothersome and annoying (Landau & Milich, 1988; Whalen & Henker, 1985). According to Pelham and Bender (1984), they often experience low rates of acceptance and high rates of social rejection. Thus, their social interactions are characterized by negative social feedback from parents, peers, and teachers (Whalen, Henker, & Dotemoto, 1981).

Behavioral conduct is the most salient of deficits among children with ADHD, including significant difficulties with inhibiting prepotent responses, stopping an ongoing response, and interference control (Barkley, 1997). Manifestations of these deficits include non-compliance with adult commands (Danforth et al, 2006) and aggression (Loney & Milich, 1982). According to Shaffer (1994), these impairments leave children with ADHD at increased risk for school dropout.

PIB has been identified within academic, social, and behavioral domains utilizing several research paradigms. Early research compared ratings of competence on self-perceptions measures with absolute self-perception scores (mean score in the absence of a criterion for comparison). The main focus of extant literature on PIB was to identify differences in rating of competence between children with ADHD and typically developing (TD) children. Thus, computing absolute self-perception scores provided researchers with a value to compare between groups when other criteria for comparison (e.g., teacher and parent report) were not available. Intriguingly, this method used to examine the self-perceptions of children with ADHD has generated mixed results. Hoza et al. (1993) conducted one of the first studies to compare self-perceptions of boys with and without ADHD utilizing the Self-Perception Profile for Children (SPPC; Harter, 1985). The SPPC was utilized to assess children's self-perceptions among six different domains including: scholastic competence, social acceptance, behavioral conduct, athletic competence, physical appearance, and global self-worth. Boys with ADHD did not have significantly different self-perceptions compared to boys without ADHD across each of the domains excluding one. Interestingly, athletic competence was the one domain where boys with ADHD were found to have more positive self-perceptions than boys without ADHD (Hoza et al., 1993), and the authors interpreted this as evidence of self-enhancement on the part of boys with ADHD. Children with ADHD have also been found to report significantly lower self-perceptions compared to TD children (Horn et al., 1989). However, these findings have been highly criticized for utilizing a different self-assessment method (i.e., Piers-Harris Self Concept Scale), and failing to assess salient domains such as academics and behavior. Studies examining absolute self-perceptions provide the weakest support for PIB with a lack of basis for comparison. In sum, they highlight unique patterns in children's self-perceptions providing preliminary evidence to suggest children with ADHD are less congruent with actual performance compared to TD children.

In order to further assess the PIB phenomenon, early studies also examined pre-task prediction and post-performance evaluations identifying how children with ADHD are overly optimistic in post-task performance evaluations (Hoza et al., 2000, 2001). Hoza et al. (2000) utilized a success-failure manipulation task within the social domain instructing boys with and without ADHD to get a child confederate to come to a camp. In order to manipulate performance, each child participated in a successful and unsuccessful social interaction. In both success and failure conditions, coders blind to group status evaluated boys with ADHD as less socially competent than boys without ADHD. Nonetheless, boys with ADHD evaluated their own performance as significantly better than did control boys, and this was most evident following a failed social interaction experience. Hoza et al. (2001) expanded upon the previous study by focusing on the academic domain, utilizing a "find-a-word puzzle" task in success and failure conditions to examine children's self-evaluations of performance. Compared to TD boys, boys with ADHD solved fewer test puzzles, had less persistence with the task, and were rated by coders as less effortful. Despite these issues, post-task evaluations of boys with ADHD were not significantly different from controls, suggesting the self-evaluation ratings of children with ADHD did not match with their actual performance (Hoza et al., 2001). More specifically, boys with ADHD provided overly optimistic reports of their own competence.

An important question these methodologies did not assess was the magnitude of PIB when compared to actual performance. More recent studies have examined the discrepancies between the competence of children as rated by teachers or standardized achievement scores and children's self-perceived competence (Owens et al., 2007). Hoza et al. (2002) examined boys with and without ADHD on their self-reports of competence through the Self-Perception Profile for Children (SPPC; Harter, 1985) against a teacher report (i.e., Teacher Report of Child's Actual

Behavior; Harter, 1985). Compared to the teacher reports, boys with ADHD overestimated their academic, social, and behavioral abilities substantially more than control boys (Hoza et al., 2002). Subsequent research demonstrated that PIB was present among boys and girls with ADHD, regardless of the informant ratings used as the criterion (e.g., teachers, mothers, or fathers; Hoza et al., 2004). These studies also showed that children with ADHD demonstrated the most exaggerated sense of competence in the domain of greatest deficit.

PIB research has primarily focused on the academic, social, and behavioral domains. There has been relatively limited research for the motor domain. Children with ADHD show motor overflow (e.g., mirror movements in finger tapping task) (Denckla, & Rudel, 1978; Denckla, Rudel, Chapman, & Krieger, 1985), impaired timing of motor responses (Rubia, Taylor & Sergeant, 1999; Yan & Thomas, 2002), and comorbid motor disorders (Harvey, 1997; Zelaznik et al., 2012). Despite these deficits in motor functioning there is a surprising lack of research investigating of PIB within the physical domain.

Previous research suggests assessment of the physical domain may be a fruitful area of research. Hoza et al. (1993) found that athletics was the sole domain where significant differences in self-perceptions were evident between boys with and without ADHD. More specifically, boys with ADHD were found to have more positive self-perceptions than boys without ADHD (Hoza et al., 1993). Examination of the physical domain is also important because motor ability is readily observed by others, making it difficult to mask incompetence. This is especially salient for children with ADHD considering they are known to have motor timing challenges and comorbid motor disorders (Harvey, 1997; Zelaznik et al., 2012). The motor deficiencies may be exposed while engaging in physical activity and would be expected to impact physical self-perceptions.

A possible explanation for PIB in children with ADHD is cognitive dysfunction. Neuroimaging studies suggest four main neural regions associated with ADHD including: prefrontal cortices, basal ganglia, cerebellum, and the corpus callosum (Hoza et al., 2005; Owens et al., 2007). These neural regions are related to executive function (EF), an umbrella term used to describe higher or meta-cognitive function (Chang, Liu, Yu, & Lee, 2012; Diamond, 2012). EF involves self-regulation and monitoring processes that are responsible for purposeful and goal-directed behaviors such as having to concentrate or pay attention (Diamond, 2012; Zelaznik et al., 2012). There are three core components of EF including: inhibition (behavioral inhibition, selective attention, and cognitive inhibition), working memory (retaining and working with information), and cognitive flexibility (set-shifting). From these, higher order EFs are assembled such as reasoning, problem solving, and planning, essential functions for cognitive, social, and psychological development along with mental and physical health (Diamond, 2012; Lui & Tannock, 2007;).

Neuropsychological research suggests that children with ADHD have cognitive dysfunction, making it difficult to self-monitor and regulate behavior and leading to overestimation of ability (Owens et al., 2007). Ownsworth, McFarland, and Young (2002) investigated factors underlying deficits in self-awareness and self-regulation. The primary objectives were to: a) review empirical research that utilized neurologically-based models and psychologically-based models when investigating deficits in awareness; and b) examine the contributions of both neuropsychological and psychological factors underlying deficits in self-awareness and self-regulation (Ownsworth et al., 2002). They found that individuals with an impaired capacity for volition (power of using one's will) and high level of self-deception may fail to provide accurate information about their disorder difficulties (Ownsworth et al., 2002).

Impaired EFs interfering with the development of anticipatory awareness, self-management, and readiness may explain why children with ADHD have been found to provide exaggerated self-perceptions of competence.

One consistent gap within the literature is to what extent these impaired EFs also lead to interference in development of anticipatory awareness, self-management, and readiness within the physical domain. Thus, the purpose of this study is two-fold. First, we assess whether children with ADHD overestimate their competence in the physical domain. Overestimation of competence within the academic, social, and behavioral domains has been well documented within the PIB literature. However, the physical domain has yet to be examined. The physical domain is an important domain to assess because in Hoza et al.'s (1993) study, which was one of the first to investigate self-perceptions among children with ADHD, the athletic domain was sole domain of which there was a significant difference between children with and without ADHD. Our first hypothesis is that children with ADHD overestimate their competence in the physical domain. Second, assuming this overestimation exists, our goal is to understand if PIB was more pronounced with greater cognitive dysfunction. Our second hypothesis is that the magnitude of PIB is associated with the degree of EF deficit, with higher PIB associated with poorer performance on EF measures.

CHAPTER TWO

LITERATURE REVIEW

To provide a framework for examining ADHD and children's self-perceptions in the physical domain, it is necessary to review the existing literature on ADHD, EF, PIB, and motor functioning. First, the prevalence of ADHD, its proposed subtypes, and its relationship to EF will be discussed. Second, the literature on EF and its link to PIB will be discussed. Third, the origins of PIB will be reviewed with respect to the evolving methodologies used to examine self-perceptions in children with ADHD. Finally, the link between ADHD and motor functioning will be discussed to provide justification for the investigation of PIB in the physical domain.

Attention Deficit Hyperactivity Disorder

ADHD is one of the most prevalent neurobehavioral disorders, affecting approximately 6.4 million children in the US (CDC, 2016). Prevalence rates range from 2 to 11% depending on the diagnostic assessment tool employed (Argold, Erkanli, Egger, and Costello, 2000; Brown et al., 2001; Cormier, 2008; Dulcan, 1997; Faraone, Segeant, Gillberg, and Biederman, 2003). The prevalence of this disorder is associated with high costs for child services in primary care settings. As the most common mental health disorder among children, the economic impact of ADHD is estimated to cost roughly $14, 576 annually per individual with the disorder (Pelham, et al., 2007). Due to the chronic nature of the disorder, ADHD-type symptoms are often evident at an early age and may be displayed across a lifespan. In fact, for a majority of children diagnosed with ADHD, limitations in daily functioning continue through adolescence and into adulthood (Barkley, Fischer, Smallish, and Fletcher, 2004; Barkley, Guevremont, Anastopoulos, and Fletcher, 1991). Thus, the chronic management of the disorder has become a major public health issue estimated to cost US$36 to US$52.4 billion annually (Pelham et al., 2007).

Children with ADHD symptoms tend to have difficulty paying attention, modulating activity level, and controlling impulses compared to TD peers (Pelham et al., 2007). The onset of this disorder is evident in childhood and characterized by several subtypes including inattention (IA), hyperactivity/impulsivity (HI), and combined (C) subtypes. One of the primary deficits evident in children with ADHD is inability to sustain attention, particularly for structured, repetitive, and uninteresting tasks (CDC, 2016). There are a variety of attention deficits including: selective attention, limited attentional capacity, and distractibility (Froehlich et al., 2007). HI behavior is activity that is excessively intense and inappropriate (Barkley, 1997). Children with this subtype are often characterized as "always on the go," talking excessively during class, and often fidgeting and squirming (Cantwell & Satterfield, 1978). Research suggests both hyperactivity and impulsivity are part of a more fundamental deficit in behavioral regulation (Hinshaw, 1992). Those characterized with both IA and HI subtypes are considered to have a C subtype; the most common subtype found among those with ADHD (CDC, 2016). Symptoms associated with these subtypes lead to limitations among various different domains including: scholastic achievement, peer relationships, and behavior problems (Barkley, 1990; Froehlich et al., 2007). Intriguingly, regardless of symptomology between ADHD subtypes, there appears to be a shared central deficit related to cognitive dysfunction (Barkley, 1997). In particular, there appear to be failures of inhibitory control (Barkley, 1997; Logan, Schachar, and Tannock, 1997; Schachar & Logan, 1990) and working memory (Burgess, et al., 2010), key features of EF.

Executive Function

EF is an umbrella term used to describe higher or meta-cognitive processes (Chang, Liu, Yu, & Lee, 2012; Diamond, 2012). These cognitive processes allow for selection, initiation, coordination, implementation, and planning of behavior (Botvinick, Braver, Barch, Carter, & Cohen, 2001). EF involves self-regulation and monitoring processes that are responsible for purposeful and goal-directed behaviors such as having to concentrate or pay attention (Diamond, 2012). According to Barkley (2012), there exist a number of related terms that refer to the same top-down processes used when guiding behavior for specific tasks (Diamond, 2012). The terms cognitive control and executive control refer to mental processing specific to the prefrontal cortex. Miller and Cohen (2001) have found EF performance and prefrontal cortex activity are highly correlated. EF has three core components known as inhibitory control, working memory, and cognitive flexibility (Diamond, 2012).

Inhibitory control, one of the core EFs, is the ability to act on the basis of choice rather than impulse (Diamond, 2012). The capacity to inhibit enables selective attention, focus for a desired task, and being able to suppress irrelevant stimuli. Diamond (2012) suggests an aspect of inhibitory control is one's ability to control their behavior, self-control. For example, self-control may be necessary when wanting to suppress blurting out an answer that first comes to mind. When responding to a question, it may be advantageous to think thoughtfully and provide a more polished response (Diamond, 2012). Lack of self-control can often lead to errors of impulsivity, which are errors that are made when an individual lacks the ability to wait.

Working memory refers to a part of the brain system that provides temporary storage and manipulation of information (Baddeley, 1992). Simultaneous storage and processing of information are necessary to engage in complex cognitive tasks such as learning and reasoning (Baddeley, 1992). Although concurrent storing and processing of information is a salient feature of working memory, the prime function is the allocation and coordination of resources. This coordination requires inhibitory control for selective attention to pertinent information for retrieval and processing. Both working memory and inhibitory control support each other and rarely do they operate independently (Diamond, 2012). An important aspect of inhibitory control is the ability to inhibit prepotent responses. Effective inhibition requires holding a goal in mind to attend to pertinent information and ignore irrelevant information (Nigg, 2000). In addition, these core executive processes help enable people to relate multiple ideas together in new creative ways by resisting focus on unnecessary information (Diamond, 2012; Smith & Jonides, 1999).

Cognitive Flexibility builds on inhibitory control and working memory and often is evident later in development (Davidson, Amso, Anderson, & Diamond, 2006). The ability to change perspectives and adjust to new and varying demands is the essence of cognitive flexibility (Diamond, 2012). For example, the Wisconsin Card Sorting Task (Milner, 1963; Stuss et al., 2000) is one of the oldest task-switching and set-shifting tasks used to test prefrontal cortex function. Cards are sorted by shape, color, and number and the task requires participants to correctly figure out the sorting structure based on feedback and switched sorting rules from the experimenter. Important aspects of completing the task successfully include inhibition of previous perspectives and loading into working memory a different perspective (Diamond, 2012). The relationship with inhibitory control and working memory remain evident when discussing cognitive flexibility. For example, the ability to inhibit can be important when having to ignore distracting stimuli when having to switch between different tasks. Working memory would be utilized when having to activate different perspectives based on new or varying demands inherent in a given task (Davidson et al., 2006; Diamond, 2012). In other words, this would enable a person to think flexibility in solving a given problem. The ability to change thought processes based on varying demands is of high importance when it comes toEF .

The three core components of EF are intertwined. However, it is important to note the in-depth relationship inhibitory control and working memory share. Inhibitory control and working memory co-occur and generally need one another in order for a system to operate adaptively. In light of the close relationship between these processes, it is prudent to examine both inhibitory control and working memory when examining EF in children with ADHD. Inhibitory control and working memory are the fundamental building blocks of EF. Therefore, the core processes of inhibitory control and working memory will be investigated in the present study.

Positive Illusory Bias

PIB is defined as a perception of the self that is overly positive and departs from an objective grasp of reality with reference to competence in a given domain. PIB is characterized by an unrealistic positive self-view that it is imagined and not based in reality (Hoza et al., 1993; Hoza et al., 2004; Taylor & Brown, 1988). The inherent conundrum in defining PIB is the philosophical debate concerning what reality is or how it should be measured. Fortunately, different methodologies carried out in social psychology have developed operational definitions for measuring positive illusions of the self. Evidence for illusions has been shown in experimental work where feedback is manipulated (e.g., succeeding or failing on a task) and then measured based on the participant's recall of the feedback (Taylor & Brown, 1988). This paradigm provides evidence for how people may distort feedback in self-serving ways.

PIB may be operationally defined as the disparity between child and parent reports of child competence such that children report themselves substantially greater competence than their parents report of the child (Hoza et al., 2002). Over the last two decades, there have been two primary methods for measuring competence of self-perception measures including: absolute rating scale scores (mean scores), and discrepancy scores.

Absolute Self-Perception Scores. Early research compared ratings of competence on self-perception measures among children with and without ADHD by computing a mean score from the rating scale in the absence of a criterion measure. Hoza et al (1993) conducted one of the first studies that compared the self-perceptions of boys with and without ADHD. It is important to keep in mind that this investigation held an underlying assumption that children with ADHD are less competent due to the manifestation of the disorder. However, actual competence is not directly measured which influence the researchers to examine self-perceptions by comparing boys with and without ADHD. In order to assess children's self-perceptions, Hoza et al (1993) utilized the Self-Perception Profile for Children (SPPC; Harter 1985) which measures competence across six achievement domains: scholastic competence, social acceptance, behavioral conduct, physical appearance, athletic competence, and global self-worth. The purpose of Hoza et al's (1993) study was to examine the importance of cognitive-motivational variables in boys with ADHD by way of comparison with TD boys. In doing so, the goal was to examine self-perception and attribution variables among boys with and without ADHD (Hoza et al., 1993). Prior to controlling for internalizing behavior problems (e.g., depression), the only subscale for which there were significant differences between the groups was behavioral conduct. However, after controlling for internalizing symptoms, the differences evident among the groups for behavioral conduct were no longer present. Suggesting internalizing symptoms of boys with ADHD accounted for the difference. Intriguingly, after internalizing symptoms were covaried out, there were differences for the athletic competence subscale such that boys with ADHD provided more positive self-evaluations than boys without ADHD (Hoza et al., 1993). These findings suggested that further investigation into the differences among children with and without ADHD would require greater attention and that the athletic domain was in some manner unique.

Other researchers found that children with ADHD report significantly lower self-perceptions compared to TD children (Horn et al., 1989; Ialongo et al., 1994), which does not support the existence of PIB in children with ADHD. In light of these findings, it is crucial to highlight the differences in methodology. Horn et al (1989) and Ialongo et al (1994) both utilized the Piers-Harris Self Concept Scale (Piers, 1969) as opposed to the SPPC. The Piers-Harris Self Concept Scale utilizes a dichotomous assessment of self-perceptions, which lacks the sensitivity of a dimensional assessment approach found in the SPPC. Secondly, Hoza et al's (1993) findings were evident after internalizing symptoms were controlled. Horn et al (1989) did not control for internalizing symptoms, which may account for inconsistencies among findings. In all, studies that have utilized absolute self-perceptions of children with ADHD have shown mixed findings. It is important to note that absolute self-perception scores provide the weakest support for PIB. This is likely because actual competence is not considered relative to self-perceptions. Actual competence is incorporated into discrepancy analysis, which is a more contemporary approach to assessing PIB.

Discrepancy Analysis. To overcome flaws specific to absolute self-perception score analyses, contemporary studies have begun to utilize discrepancy analyses. With this approach, criterion scores (e.g., parent report) are subtracted from the child's self-report of competence. This provides a difference score representing the gap or bias between the child's perspective and a criterion representing actual competence. It is important to note that there has been a range of individuals used to provide the criterion score, including the mother, father, and teacher.

One of the first studies to examine PIB through use of discrepancy analysis was conducted by Hoza et al. (2002). In this study, teacher reports were used as the criterion measure against which children's reports were compared. Hoza et al. (2002) found that relative to teacher report, boys with ADHD tended to overestimate their ability in academics, social abilities, and behavioral conduct compared to TD children. More recently, Hoza et al. (2004) examined whether PIB was present in boys and girls with ADHD and whether this was the case regardless of the criterion rater. Hoza et al. (2004) found that PIB was in fact present in boys and girls with ADHD regardless of criterion rater (i.e., mother, father, teacher).

Discrepancy analysis is not without limitations. For example, competence ratings among children with ADHD may be viewed as exaggerated because of negative bias in criterion ratings. Evaluations by a parent or teacher may be more negative because of the difficulties children with ADHD pose to the evaluator. Lower ratings by the evaluators will make children's comparative ratings appear inflated. Hoza et al. (2004) specifically examined this notion and found that PIB was evident in children with ADHD but not evident among children without ADHD. These findings suggest PIB does not appear to be an artifact of rater bias on the part of the criterion rating (Owens et al., 2007).

An additional concern is that criterion raters may not be in a good position to judge competence in a particular domain. For example, classroom teachers may not be as accurate in judging physical competence as the parent, as the parent is more likely to view the child in sport and other physical activity settings. However, research has been conducted comparing children's self-perceptions to objective criteria (i.e., achievement scores) to establish whether perceptions resemble competence.

Theoretical Explanations for PIB

The phenomenon of PIB in the self-perceptions of children diagnosed with ADHD has been well documented; however, the underlying mechanisms remain relatively unclear. To better articulate the functions and causes of PIB, several hypothesized explanations for PIB have been proposed such as: cognitive immaturity hypothesis (Milich, 1994), self-protective hypothesis (Ohan & Johnston, 2002), and neuropsychological deficits hypothesis (Owens & Hoza, 2003). These proposed hypotheses share overlap in the various constructs used to explain the functionality of PIB, meaning they may not be mutually exclusive. The main utility of these theoretical frameworks is how PIB has conceptualized and how this conceptualization has helped advance research with respect to identifying the underlying mechanisms of PIB (Owens et al., 2007).

Cognitive Immaturity. Literature widely suggests that young children typically overestimate their skills in various domains, and supposedly this exaggeration may serve an adaptive function (Bjorklund & Green, 1992). The assumption is that children experience many instances of failure due to their lack of experience and thus having an optimistic belief in their ability may be adaptive nature for persisting in challenging tasks (Owens et al, 2007). Ironically, the overestimation of ability and supposed adaptiveness of cognitive immaturity is analogous to PIB. Children with ADHD have been found to overestimate their abilities similar to young children who do so because they lack the maturity to properly gauge their competence. However, one major distinction that is evident within the cognitive immaturity bias that has not been accounted for in PIB is the longevity of these overly bias perceptions. For example, Milich (1994) identified that cognitive immaturity is a phase that a majority of children will grow out of once they have had more experiences that help them better gauge their competence. In other words, these children are expected to grow out of their bias in cognitions. No examination has investigated the longevity of PIB perceptions and whether children with ADHD have the ability to grow out these biases in cognition. Moreover, no study has directly investigated the cognitive immaturity hypothesis in children with ADHD (Owens et al, 2007).

Self-Protective Hypothesis. Proponents of the self-protective hypothesis argue that when children with ADHD are faced with a challenging task, they tend to inflate reports of competence in an attempt to hide feelings of incompetence (Diener & Milich, 1997). These children often present themselves in the best possible light, which may be a coping mechanism to protect their self-esteem. The origin of this interpretation is consistent with Dweck and Leggett's (1988) work examining two major patterns of cognition-affect-behavior: the maladaptive *helpless* orientation (e.g., avoidance of challenging tasks and decrease in performance when faced with an obstacle) and the more adaptive *mastery* orientation (e.g., seeking of challenging tasks and resilient motivation following failure; Diener & Dweck, 1980; Nicholls, 1978; 1984). Stemming from these orientations are two more generalized conceptualizations of goals: learning and performance goals. Dweck and Leggett (1988) found that children with *learning* goals intended to improve their ability in contrast to those with *performance* goals who were more concerned with proving their ability to others. Interestingly, a greater concern for performance goals produces a vulnerability to the helpless orientation whereas learning goals support a mastery orientation (Dweck & Leggett, 1988). Thus, an assumption may be made that exaggerated self-perceptions reported by children with ADHD may suggest they are operating under performance goals to avoid appearing incompetent (Diener & Milich, 1997). Several studies provide empirical support for the self-protective hypothesis.

One of the first studies to directly test the self-protective hypothesis examined boys with and without ADHD in the social domain (Diener & Milich, 1997). The objective was to examine the effects of positive social feedback on dyadic interactions of TD boys and boys with ADHD. There were a total of 60 unfamiliar dyads in two unstructured cooperative tasks. After an initial interaction, both members of the dyad separately completed surveys that assessed their partner's performance in the social interaction. Following this initial interaction, there was a positive feedback condition and a no feedback condition. In the positive feedback condition, the child with ADHD was told his partner enjoyed the interaction. In the control condition, children did not receive any feedback. The children then interacted for a second time, completing the same surveys following their interaction. An important assumption behind manipulating feedback deals with how the child will respond to positive feedback based on their goal orientation. For example, if children with ADHD inflate their self-perceptions in order to influence people to believe they can accomplish a task successfully (e.g., performance goal), then it can be hypothesized that their ratings of performance may become more realistic following positive feedback. In other words, there would be less of a reason to exaggerate one's self-competence since they would be considered to have achieved their goal (Diener & Milich, 1997). Findings showed that following the first interaction, but prior to feedback, boys with ADHD reported that their partners liked them more than their partners actually did. However, after the second interaction, boys with ADHD who received positive feedback showed a significant decrease in their self-perceptions while comparison boys showed an increase. It appeared that boys no longer felt the need to enhance their reports of self-competence once positive feedback was given. Thus, these findings support the self-protective hypothesis that children with ADHD provide inflated reports of their self-competence to prevent feelings of inadequacy (Diener & Milich, 1997).

Another study conducted by Ohan and Johnston (2002) expanded upon Diener and Milich's (1997) methodology by testing the self-protective hypothesis in two different domains: social and academic. As stated previously, boys with ADHD tend to hold performance goals in the social domain, often leading them to inflate their perceptions of self-competence in order to thwart feelings of incompetence (Diener & Milich, 1997). Similar to the social domain, boys with ADHD have been found to hold performance goals within the academic domain. Dunn and Shapiro (1999) conducted a study examining positive feedback after boys with ADHD completed a maze task with a confederate (i.e., teacher). This interaction served two purposes: 1) check performance on the maze that represented the academic domain; 2) interaction with confederate which represented the social domain/interaction. Ohan and Johnston (2002) found that boys with ADHD lowered their self-perceptions following positive feedback, consistent with Diener and Milich's (1997) finding. In addition, results revealed boys without ADHD did not lower their self-perceptions specific to their social performance. Unexpectedly, the results revealed a different story specific to the academic domain. For example, both groups of boys appeared to increase their self-perceptions once they received positive feedback. In other words, the results help provide additional support for the self-protective hypothesis in the social domain, but have not yet been replicated within the academic domain (Ohan & Johnston, 2002).

Neuropsychological Hypothesis. Neuropsychological research suggests that children with ADHD have cognitive dysfunction, making it difficult to self-monitor and regulate behavior and leading to overestimation of ability (Owens et al., 2007). According to Nigg (2006), there are four neural regions associated with ADHD: basal ganglia, cerebellum, corpus callosum, and prefrontal cortices. There exists evidence that children with ADHD have abnormal brain activation and functioning patterns during challenging tasks utilizing these four structures

(Seidman, 2006). These four regions are also related to EF and neuropsychological research suggests children with ADHD suffer from cognitive dysfunction (Murphy, Barkley, & Bush, 2001; Swanson, Castellanos, Murias, LaHoste, & Kennedy, 1998).

Similarities between patients with neurological disorders and those diagnosed with ADHD led to hypotheses that ADHD is a brain disorder that affects the prefrontal cortex (PFC; Mattes, 1980). Mattes' work focused exclusively on animals and human neurological patients with frontal lobe lesions to identify if they were associated with impulsivity, and hyperactivity (Mattes, 1980). It was through successful stimulant medications and animal models that early support for the PFC model of ADHD developed (Seidman, 2006). Neuroimaging studies helped provide support for this model. Seidman, Valera, and Makris (2005) helped replicate studies that have identified brain structural alterations in ADHD in childhood. One of the main alterations includes significantly smaller volumes in the dorsolateral PFC (Seidman et al., 2005). ADHD has increasingly been understood as a developmental brain disorder that impacts regions related to the PFC, moreover, neuropsychological theories have emphasized dysfunctions of the PFC; especially cognitive dysfunctions (Barkley, 1997; Seidman, 2006).

Neuropsychological functioning of elementary school-aged children diagnosed with ADHD has often been compared with TD children where general group differences exist (Frazier, Demaree, & Youngstrom, 2004). Overall, cognitive dysfunctions in children diagnosed with ADHD have received substantial support. Effect sizes are modest, usually ranging from 0.4 to 0.7 using Cohen's *d* (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Children with ADHD exhibit below average on EFssuch as response inhibition and working memory (Barkley, Grodzinsky, & DuPaul, 1992; Grodzinsky & Diamond, 1992; Pennington & Ozonoff, 1996).

According to Fuster (1995), inhibition and working memory contribute to greater control, timing, and complexity for motor actions that are goal directed. These components of EFare essential for the development of varied and complex movements that may be used for motor responses directed toward a goal (Barkley, 1997). Beyond the relationship of executive function and ADHD, another important deficit of associated with the disorder is poor motor functioning. A majority of intervention studies where motor functioning and ADHD are examined share a focus on the influence of medication on movement-related skills (Connors & Delamater, 1980; Conrad, Dworkin, Shai, & Tobiessen, 1971). Children with ADHD often show neurological soft signs, poor sensorimotor coordination, and attention difficulties (McMahon & Greenberg, 1977). In addition, children with ADHD have been characterized as poorly coordinated and clumsy (Ottenbacher, 1979; Szatmari, et al 1989).

Motor Functioning and ADHD

Motor functioning literature is comprised of two main categories: motor process and movement performance (Harvey & Reid, 2003). Motor process studies focus on underlying factors that are believed to affect observable movement (e.g., perceptual-motor, psychomotor, and sensorimotor processes; Harvey & Reid, 2003). Highlighted variables in motor process studies on children with ADHD include sensorimotor, motor control, and fine motor variables. Sensorimotor studies highlight sensory performance outputs such as tasks of visual motor performance (Cakirpaloglu & Radil, 1992; Conners & Delamater, 1980; Korkman & Pesonen, 1994; Pitcher, Piek, & Hay, 2003; Tseng, Henderson, Chow, &Yao, 2004) and finger tapping (Gordon & Kantor, 1979; Zelaznik, et al., 2012). Motor functioning studies emphasize the links between motor overflow (Denckla et al., 1985; Denckla & Rudel, 1978), motor soft signs (Yan & Thomas, 2002), and impaired motor timing (McMahon & Greenberg, 1977). Fine motor control studies have suggested children with ADHD struggle with fine motor control tasks like writing or completing coordinated finger movements compared to their typically developing peers (Hefley & Gorman, 1986; Pereira, Eliasson, & Forssberg).

Movement performance studies vary slightly from the motor processes literature. The variables of interest in movement performance studies include observable behaviors (Harvey & Reid, 2003). Different method contexts have been utilized to measure observable behaviors such as retrospective and skill performance studies. Retrospective studies often utilize parent and teacher reports or observations of movement skills in children with ADHD (Ottenbacher, 1979). Although observations from parents and teachers may be informative, limitations include decay of memory and in some cases misconceptions (Offer, Kaiz, Howard, & Bennett, 2000). A main assumption for retrospective studies is that parents and teachers harbor motor development knowledge (Harvey & Reid, 2003). Doyle, Wallen, and Whitmong (1995) conducted a study examining motor skills in Australian children with ADHD. They found that parents rating of children's motor skills were generally underrated compared to children's actual performance on the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP; Bruininks, 1978). Thus, although informative, retrospective studies may not provide a comprehensive scope of movement behavior (Harvey & Reid, 2003).

Skill performance studies have been linked to children diagnosed with ADHD from the ages of 5-18 (Harvey & Reid, 2003). A majority of these studies assess movement skills of children with ADHD compared to control groups (Harvey & Reid, 2003). These types of studies are often referred to as intergroup studies. Intergroup studies have examined relationships between children with and without ADHD utilizing various motor skill assessments. For example, Beyer (1999) compared movement skills of boys with ADHD to boys with LD utilizing the BOTMP. Findings revealed that children diagnosed with ADHD performed significantly worse than their peers with LD specific on visual-motor coordination, upper-limb speed and coordination. Piek, Pitcher, and Hay (1999) assessed movement skills of children with and without ADHD utilizing the Movement ABC or MABC (Henderson & Sugden, 1992) and found that in comparison to age-matched peers, balance scores were significantly lower for those with ADHD. Harvey & Reid (1997) utilized the Test of Gross Motor Developemtn-2 or TGMD-2 (Ulrich, 1985) GMD-2 to assess fundamental movement skills in children with and without ADHD. They found that children with ADHD performed both locomotor and object control skills below the 35^{th} percentile in comparison to age-matched peers (Harvey & Reid, 1997).

Summary

This review highlighted the existing literature on ADHD, EF , PIB, and motor functioning. ADHD is one of the most prevalent neurobehavioral disorders evident in school-aged children who display significant impairments across multiple achievement domains (e.g., academic competence, social competence, behavioral conduct, and motor functioning). Primary deficits of the disorder are related to EF (Barkley, 1997). In particular, there appear to be failures of inhibitory control (Barkley, 1997; Logan, Schachar, and Tannock, 1997; Schachar & Logan, 1990) and working memory (Burgess, et al., 2010), key deficits of what is referred to as cognitive dysfunction. To date, few empirical investigations have examined the relationship between cognitive dysfunction and PIB. One theoretical explanation for PIB is that cognitive dysfunction may predispose children with ADHD to poorly self-monitor and regulate behaviors, leading to overestimation of abilities. In addition to cognitive dysfunction, children with ADHD are known to have comorbid motor disorders that may be exposed while engaging in physical activity and that would be expected to impact physical self-perceptions. PIB research has primarily focused on children's perceived competence within the academic, social, and behavioral domains. However, the physical domain has limited empirical support. Accordingly, the aim of this study was two-fold: (a) to assess whether children with ADHD overestimate their competence in the physical domain, and (b) to investigate whether PIB is more pronounced with greater cognitive dysfunction.

CHAPTER THREE

METHODS

Participants and Recruitment

Participants were 28 children (20 boys, 8 girls; M_{age} = 9.61 ± 1.34 years) recruited from the Greater Lansing Michigan area. A recruitment email to a parent listserv and flyers posted in community outreach centers encouraged those interested to email or call the laboratory. Contacts via email or phone were followed up by a phone interview with parents (those who called were automatically eligible to complete the phone interview at that time if they chose to do so). For each phone call interview, a participant information form was completed by a researcher to determine eligibility. To be included in the study, children were required to meet four main inclusion criteria: 8 to 12 years of age, ADHD diagnosis or ADHD-type symptoms, ability to engage in physical activity, and normal or corrected-to normal vision.

Children younger than 8 years of age were excluded because the Self-Perception Profile for Children (SPPC) questionnaire requires at minimum a third grade reading level. Those older than 12 years of age were excluded to ensure the age range in the current study mirrored previous literature (Hoza et al., 1993,, 2001, 2002). Parents were required to affirm their child possessed either an ADHD diagnosis or had suspected ADHD-type symptoms. Parents were first asked whether their child had been diagnosed with ADHD. If a diagnosis was not affirmed, parents were asked whether their child possessed at least one of the following ADHD-type symptoms: easily distracted, trouble sitting still, talks excessively, difficulty focusing, or interrupts often. If affirmed, the remainder of the phone call interview was conducted. Those who were unable to provide affirmation of ADHD diagnosis or ADHD-type symptoms were excluded from the study.

Parents who affirmed their child possessed an ADHD diagnosis or ADHD-type symptoms were asked whether their child was physically capable of performing exercise according to a Child Physical Activity Readiness Questionnaire (CPAR-Q, Thomas, Reading, & Shepard, 1992) and Health History Questionnaire. Parents were asked a list of health questions specific to the CPAR-Q that utilized a 'yes' or 'no' response format. If parents responded affirmatively to a specific item, explanatory questions were asked to identify whether their child could still complete the study safely (e.g., inhalers, allergy medicine). If measures could not be taken to ensure safety, the child was excluded from the study. Following the CPAR-Q, additional health history questions were asked to identify whether children had any comorbid developmental disorders (e.g., Autism, mental retardation) or a disorder involving seizures. Children with comorbid developmental disorders or a disorder involving seizures were excluded from the investigation. Those eligible were scheduled to make a single visit to the laboratory.

Research Design and Procedure

A cross-sectional design had participants make a single visit to the laboratory on a day they had not previously participated in physical education or other structured physical activities. During the visit, the parent and participant were provided further explanation of the purpose of the study and potential associated risks. The opportunity to ask questions was permitted prior to obtaining written consent from parents and informed written assent from the participant. Following completion of informed consent/assent, the parent was placed in an adjoining room to avoid potential influences they may have on their child's responses or performance. In tandem with a single experimenter each, child participants and parents completed study measures in the order listed below.

Child Measures

Self-Perception Profile for Children. The Self-Perception Profile for Children (SPPC; Hater, 1985; 2012) was used to measure participants' perceived competence. Designed for children 8 to 13 years of age, the SPPC is a 36-item questionnaire with six subscales including: Athletic Competence, Physical Appearance, Scholastic Competence, Social Competence, Behavioral Conduct, and Global Self-Worth (Harter, 1985; 2012). Each subscale is measured using six, 4-point structured alternative items. This structured alternative format was designed to counterbalance the tendency to report socially desirable responses (Harter, 1985; 2012). The standardized instructions from the Self-Perception Profile for Children: Manual and Questionnaires (Harter, 2012) were followed. First, the child was asked to decide which of two statements best describes themselves (e.g., *Some kids wish they could be a lot better at sports* BUT *Other kids feel they are good enough at sports*). Subsequently, the child decided if the statement was *Really True* or *Sort of True* for them. Each item is scored from 1 to 4, with higher scores indicating greater perceived competence. All six subscales were assessed with athletic competence as the main subscale of interest. Previous research has shown scores from this measure to exhibit acceptable internal consistency reliability and validity for children in grades 3 through 8 (Harter, 1985; 2012). Internal consistency reliability of scores in the current study ranged from $\alpha = .68$ to .87. All subscales demonstrated good internal consistency reliability except for Physical Appearance, which showed only marginal internal consistency ($\alpha = .68$). Internal consistency values by subscale are found in Table 1.

Table 1. Internal Consistency Reliability for SPPC Subscales

Subscale	Alpha
Athletic Competence	.85
Physical Appearance	.68
Scholastic Competence	.87
Social Competence	.76
Behavioral Conduct	.87
Global Self Worth	.83

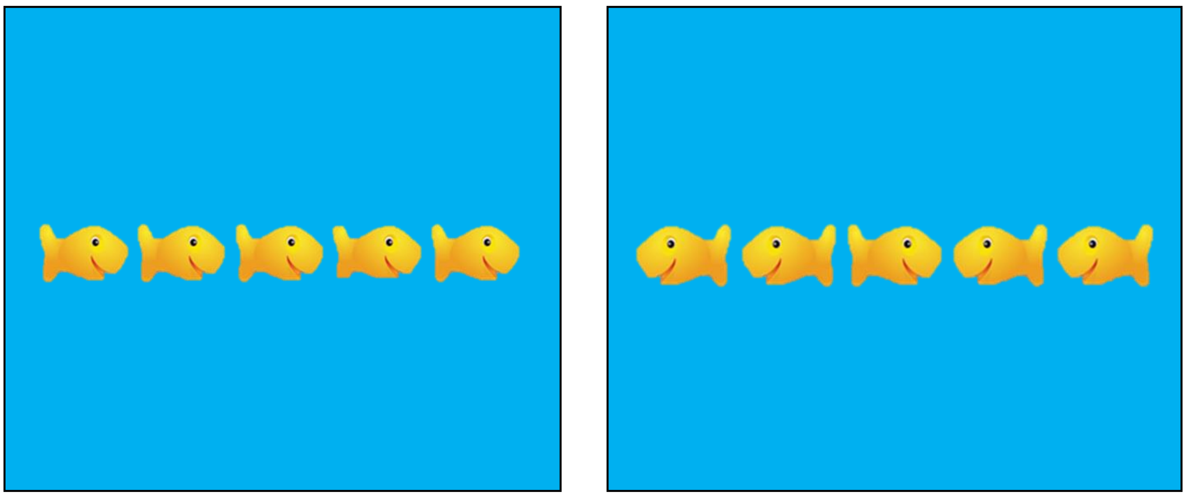
Executive Function Battery. Executive function (EF) is an umbrella term used to describe the processes of self-monitoring or self-regulation that are responsible for purposeful and goal-directed behaviors (Diamond, 2012). The purpose of the cognitive battery was to assess two EF components: inhibition and working memory. Inhibition was assessed through the Child Modified Flanker task, and working memory through *n*-back tasks (1-back and 2-back).

Child Modified Flanker

Participants completed a modified version of the Eriksen flanker task (Eriksen & Eriksen, 1974) in which they responded as quickly and accurately as possible to a centrally presented target fish among either *congruent* or *incongruent* flanking fish (see Figure 1; Hillman et al., 2006; Pontifex & Hillman, 2007). The central fish falls within an array of five total fish. The central fish either faces the same direction as all other flanking fish (congruent) or faces in the opposite direction of all other flanking fish (incongruent). Participants were asked to concentrate on the direction the center fish was facing, and respond as quickly and accurately as possible. If the fish was facing to the right, then participants were asked to respond by pressing the right (red) button on the response pad. If the center fish was facing the left direction, then participants were asked to respond by pressing the left (blue) button. Incongruent stimuli often contribute to more errors and longer response times than congruent stimuli (Pontifex et al., 2011). Two blocks of 100 trials were presented with equally probable congruency and directionality for each compatibility condition. The stimuli were 3 cm tall yellow fish presented focally for 200 ms on a blue background with a fixed inter-stimulus interval of 1700 ms (Pontifex et al., 2011).

Figure 1. Illustration of the (A) Congruent and (B) Incongruent Fish Stimuli used in the Modified Flanker Task

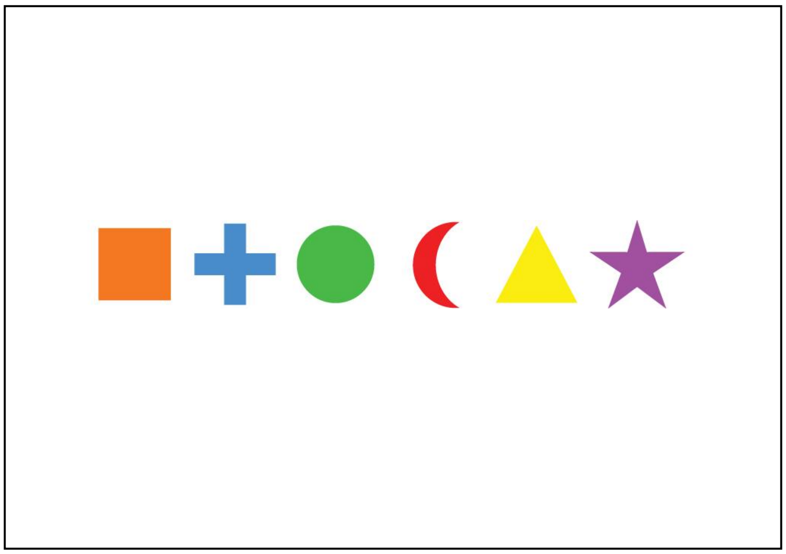
A) B)



N-Back Task

A modified serial n-back task was administered that involved 2 consecutive phases including: 1-back and 2-back. Each phase required the participants to discriminate between 6 distinct shapes as stimuli (see figure 2). Each shape had a distinct color: yellow triangles, green circles, orange squares, purple stars, blue crosses, and red crescents. In the 1-back condition participants were instructed to respond as quickly and as accurately as possible with the right button press if the current shape was the same as in the previous trial. In the 2-back condition, participants were instructed to respond as quickly and as accurately as possible with the right button press if the current shape was the same as the 2 trials previous. If the current shape was different from the previous trial in the 1-back, or from 2 trials previous in the 2-back condition, participants were instructed to perform a left button press. One block of 72 (48 non-target & 24 target) trials were completed for each n-back condition, randomized across task conditions with equally probable presentation of the stimulus (12 trails for each shape). All stimuli were approximately 3 cm tall and presented one at a time on a black background on a computer screen for 250 ms with a fixed 3000 ms inter-stimulus interval. The behavioral performance indices of interest for the Flanker and *N*-Back tasks included reaction time (RT; i.e., time in ms from the presentation of the stimulus to the response) and response accuracy (i.e., number of correct and error responses).

Figure 2. Illustration of the *N*-Back Task



Test of Gross Motor Development-2. The Test of Gross Motor Development (TGMD – 2; Ulrich, 2000) is a standardized assessment developed to measure fundamental motor skills. The test is subdivided in two parts: locomotor (run, gallop, hop, leap, horizontal jump, and slide) and object control skills (striking a stationary ball, stationary dribble, catching, kicking, overhand throw and underhand roll). To complete the test, participants, parents, and an additional experimenter relocated to a gymnasium. Parents were asked to sit outside of the gymnasium to avoid potential influence they may have on their child's performance. The experimenter's main responsibilities were to assist the expert coder in judging the participant's performance or help demonstrate the skills (this experimenter previously worked with the participant on the survey and cognitive battery). All participants completed each of the skills in the same order to avoid ordering effects.

Prior to assessment on any skill, participants observed an experimenter demonstrate each skill and were provided the opportunity to practice. Following observation and practice, 2 test trials were scored by the expert coder and one of the experimenters for each skill (Ulrich, 2000). A score of 0 (absent) or 1 (present) was coded for each performance criterion observed on each of the 2 trials. After completing the procedure for each of the two trials, the examiner totaled the score of the two trials to obtain a raw skill score. Raw scores were summed for each subtest (locomotor and object control). Subtest scores were later converted to standard scores, percentiles, and age equivalents. Lastly, the raw scores collected for each participant for all the 12 movement skills were added to produce a total score converted into the Gross Motor Quotient (GMQ; Ulrich, 2000). Tables 2 and 3 show the interrater reliability statistics for the total locomotor subtests, object control subtests, each skill, and each component of each skill. For the skill components, a kappa statistic was used to assess interrater agreement. The following heuristic was used to identify the strength of the kappa coefficient: <0.20 - slight, between 0.21 and 0.40 - fair, between 0.41 and 0.60 - moderate, and 0.61 and above - substantial agreement (Landis & Koch, 1977). Percentage agreement was also performed for each skill component. Repeatability was assessed using an Intraclass Correlation (ICC) and can be found in Table 4. ICC scores for the locomotor and object control subtests are in line with those of previous research (Barnett, 2012, 2013; Valentini, 2012). TGMD-2 scores were included for exploratory purposes to assess their association with parent ratings of physical competence.

Table 2. Interrater Reliability for Locomotor Skills

Performance Criteria		Trial 1		Trial 2	
		κ	% Agr.	κ	% Agr.
Run	1. Arms move in opposition to legs, elbows bent	0.84	96.4	0.56	82.1
	2. Brief period where both feet are off the ground	-0.04	92.9	0.46	92.9
	3. Narrow foot placement landing on heel or toe (i.e., not flat footed)	0.31	64.3	0.38	67.9
	4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)	0.53	85.7	0.58	85.7
Gallop	1. Arms bent and lifted to waist level at takeoff	0.53	78.6	0.76	89.3
	2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot	0.73	89.3	0.61	82.1
	3. Brief period when both feet are off the floor	0.29	85.7	1.00	75.0
	4. Maintains a rhythmic pattern for four consecutive gallops	0.51	89.3	0.71	92.9
Hop	1. Nonsupport leg swings forward in pendular fashion to produce force	0.41	71.4	0.50	75.0
	2. Foot of nonsupport leg remains behind body	0.39	75.0	0.52	82.1
	3. Arms flexed and swing forward to produce force	0.50	78.6	0.48	75.0
	4. Takes off and lands three consecutive times on preferred foot	-0.37	92.9	-0.37	92.9
	5. Takes off and lands three consecutive times on nonpreferred foot	1.00	100	0.84	96.4
Leap	1. Take off on one foot and land on the opposite foot	0.71	93.3	1.00	100
	2. A period where both feet are off the ground longer than running	0.84	96.7	1.00	100
	3. Forward reach with the arm opposite the lead foot	0.41	73.3	0.43	-
Horizontal Jump	1. Preparatory movement includes flexion of both knees with arms extended behind body	0.91	93.3	0.65	100
	2. Arms extend forcefully forward and upward reaching full extension above the head	0.41	96.4	0.58	100
	3. Take off and land on both feet simultaneously	0.52	71.4	0.34	-
	4. Arms are thrust downward during landing	0.19	-	0.34	-
Slide	1. Body turned sideways so shoulders are aligned with the line on the floor	0.80	89.3	0.70	89.3
	2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot	0.34	89.3	0.70	89.3
	3. A minimum of four continuous step-slide cycles to the right	1.00	92.9	1.00	92.9
	4. A minimum of four continuous step-slide cycles to the left	-0.37	93.9	-0.37	92.9

Table 3. Interrater Reliability for Object Control Skills

Performance Criteria		Trial 1		Trial 2	
		κ	% Agr.	κ	% Agr.
Striking a stationary ball	1. Dominant hand grips bat above nondominant hand	0.78	96.7	0.78	96.7
	2. Nonpreferred side of body faces the imaginary tosser with feet parallel	0.61	90.0	0.61	90.0
	3. Hip and shoulder rotation during swing	0.46	80.0	0.52	86.7
	4. Transfer body weight to front door	0.71	86.7	0.65	83.3
	5. Bat contacts ball	0.71	93.3	0.87	96.7
Stationary dribble	1. Contacts ball with one hand at about belt level	0.29	80.0	0.06	73.3
	2. Pushes ball with fingertips (not a slap)	0.28	80.0	0.51	83.3
	3. Ball contacts surface in front of or to the outside of foot on the preferred side	0.52	86.7	0.43	86.7
	4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it	1.00	96.7	0.47	93.3
Catch	1. Preparation phase where hands are in front of the body and elbows are flexed	-	80.0	-	80.0
	2. Arms extend while reaching for the ball as it arrives	-0.03	93.3	-	93.3
	3. Ball is caught by hands only	0.84	96.7	1.00	100
Kick	1. Rapid continuous approach to the ball	0.86	83.3	0.62	83.3
	2. An elongated stride or leap immediately prior to ball contact	0.77	83.3	0.51	86.7
	3. Nonkicking foot placed even with or slightly in back of the ball	0.43	86.7	-0.05	86.7
	4. Kicks ball with instep of preferred foot (shoe-laces) or toe	1.00	96.7	1.00	96.7
Overhand throw	1. Windup is initiated with downward movement of hand/arm	-0.05	90.0	0.47	93.3
	2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall	0.70	86.7	0.76	90.0
	3. Weight is transferred by stepping with the foot opposite the throwing hand	0.64	83.3	0.67	86.7
	4. Follow-through beyond ball release diagonally across the body toward the nonpreffered side	0.27	63.3	0.50	76.7
Underhand roll	1. Preferred hand wings down and back, reaching behind the trunk while chest faces cones	1.00	96.7	1.00	96.7
	2. Strides forward with foot opposite the preferred hand toward the cones	0.65	83.3	0.66	83.3
	3. Bend knees to lower body	0.65	83.3	0.73	86.7
	4. Releases ball close to the floor so ball does not bounce more than 4 inches high	0.54	76.7	0.38	70.0

Table 4. ICC Reliability

Performance Criteria	ICC (LCI-UCI)
1. Run	0.84 (0.66-0.93)
2. Gallop	0.90 (0.79-0.95)
3. Hop	0.79 (0.55-0.90)
4. Leap	0.85 (0.66-0.93)
5. Horizontal Jump	0.87 (0.71-0.94)
6. Slide	0.80 (0.57-0.91)
Total Locomotor Skills	0.86 (0.67-0.93)
7. Striking a Stationary Ball	0.90 (0.79-0.95)
8. Stationary Dribble	0.63 (0.19-0.83)
9. Catch	0.46 (-0.17-0.75)
10. Kick	0.83 (0.64-0.92)
11. Overhand Throw	0.89 (0.76-0.95)
12. Underhand Roll	0.86 (0.70-0.94)
Total Object Control Skills	0.89 (0.75-0.95)

Parent Measures

Demographic and General Health Information Questionnaire. Demographic information was collected including gender, ethnicity, SES (i.e., whether the child received free-or-reduced lunch), relationship to child, and highest level of education.

ADHD Rating Scale IV – Parent Version. The ADHD Rating Scale-IV was used to obtain parent ratings focused on the frequency of each ADHD symptom tied to DSM-IV criteria as expressed in the home setting (DuPaul, Power, Anastopoulos, & Reid, 1998). This measure consisted of 18-items each rated on a 4-point scale ranging from 0 (*never or rarely*) to 3 (*very often*). Parents were instructed to select a single response for each item that best described their child's behavior displayed over the past 6 months. In addition, parents were instructed to respond based on their child's behavior off medication (if their child was on medication). Inattention (IA) symptoms included all the odd-numbered items and Hyperactive-Impulsivity (HI) symptoms included all the even-numbered items. To obtain IA and HI subscale scores, responses of 0 or 1 were dummy coded as a 0 (no endorsed symptoms) and responses of 2 or 3 were dummy coded as a 1 (endorsed symptoms). Symptom endorsements for the odd-numbered items were summed to obtain IA subscale scores and for the even-numbered items to obtain HI subscale scores. The total symptom count score was obtained through summation of all symptom endorsements. Scores on the ADHD Rating Scale-IV have been found to be internally consistent and correlate highly with parent and teacher ratings (Du Paul Power, McGoey, Ikeda, and Anastopoulus, 1997). Internal consistency reliability of scores in the current study was $\alpha = .83$ for both the IA and HI subscales.

Parent Rating Scale of Child's Actual Behavior. A modified version of the Parent Rating Scale of Child's Actual Behavior (PRS; Harter 1985, 2012) was used as a measure of participants' actual competence. The original PRS is a 15-item questionnaire with five three-item subscales that are meant to parallel the five specific self-perception subscales of the SPPC, including: Athletic Competence, Physical Appearance, Scholastic Competence, Social Competence, and Behavioral Conduct. For each subscale, the parent respondent rated their child's behavior. An additional 12 items were added and contextualized to address performance of fundamental skills specific to the Test of Gross Motor Development-2 (TGMD-2). Thus, each item addressed performance on 1 skill. A structured alternative format similar to the child version was utilized with nearly identical questions. For example, the parent was first asked to decide what their child is most like from two descriptions – *This child does really well at all kinds of sports* BUT *This child isn't very good when it comes to sports*. Once they identified which description best described their child they were instructed to identify whether this was *Sort of True* or *Really True* of their child (Harter, 1985; 2012). Based on empirical results utilizing the PRS (Harter, 1985), this questionnaire is reliable and valid. All subscales met acceptable internal consistency values except the Physical Appearance subscale, which demonstrated weak internal consistency (α = .53). Internal consistency values can be found in Table 5.

Table 5. Internal Consistency Reliability for PRS Subscales

Subscale	Alpha
Athletic Competence	.79
Physical Appearance	.53
Scholastic Competence	.82
Social Competence	.79
Behavioral Conduct	.83

Data Analysis

Data screening and descriptive analyses (e.g., assessment of missing values, univariate and multivariate outliers, normality) were conducted according to recommendations outlined by Tabachnick and Fidell (2013). The total number of participants for analysis was 28 children. Two additional children consented to participate but were not eligible based on the inclusion criteria. An important consideration when studying competence perceptions via child and parent self-reports is the computation of difference scores. Difference scores reflecting PIB were calculated by subtracting the criterion score (i.e., parent report of child competence) from the child's self-report of competence. To examine performance on the TGMD-2, Independent t-tests and ANCOVA's were computed to identify potential differences among the sample. To examine if there was a significant association between the PRS and TGMD-2 performance, bivariate correlations were computed. Lastly, hierarchical multiple regression analyses (Cohen & Cohen, 1983) were conducted to predict the difference (PIB) score. In step 1 we ran the covariates (age and gender), step 2 the total ADHD symptom count, and step 3 the cognitive variable. Separate models were tested for each cognitive assessment. All analyses were conducted using SPSS for Windows version 22; an α level of .05 was used throughout to designate statistical significance.

CHAPTER FOUR

RESULTS

Participant Characteristics

Participant demographics and clinical characteristics are provided in Table 6. Children were classified into two categories based on diagnostic status identified during the recruitment interview phone call. Children whose parents confirmed a diagnosis of ADHD were classified as 'Diagnosed' and children of parents who confirmed ADHD-type symptoms were classified as 'Not Diagnosed'. No significant differences between groups were observed for demographic variables such as Age, Gender, Parent Education, or Free-or-Reduced Lunch t's $(26) \leq 0.67$, p's ≥ 0.16. No significant differences between groups were observed for symptom ratings for IA, HI, and Total t's $(26) \leq 1.49$, p's ≥ 0.15. Thus, all analyses utilized the total sample of both Diagnosed and Not Diagnosed participants.

Table 6. Demographic Information and Clinical Characteristics of Study Participants (*N* = 28)

Gender	71% Male		
Parent Rater	93% Mother		
Parent Education	57% AD; 29% CG; 14% SG		
Ethnicity	89% Non-Hispanic		
Race	82% Caucasian		
Free-or-Reduced Lunch	7%		
ADHD Diagnostic Status	Total	Diagnosed	Not Diagnosed
N	28 (8 female)	23 (6 female)	5 (2 female)
Age	9.60 (1.34)	9.70 (1.40)	9.40 (0.89)
Total Symptom Count	12.00 (4.28)	12.17 (4.61)	11.20 (2.39)
IA Symptom Count	6.93 (2.18)	7.32 (2.12)	5.20 (1.64)
HI Symptom Count	5.52 (2.64)	5.41 (2.75)	6.00 (2.24)

**Notes. AD = Advanced Degree, CG = College Degree, SC = Some College*

Descriptive Statistics and Correlations

Means, standard deviations, and bivariate correlations for all study variables appear in Table 7. Of the demographic variables, age was positively related to flanker congruent median

RT (r = .42, p < .05), *N*-back 1 target RA (r = .45, p < .05), and locomotor standard score (r = .52, p < .01), and negatively related to flanker congruent median RT (r = -.50, p < .01), flanker incongruent median RT (r = -.39, p < .05). Status was positively related to *N*-back 1 nontarget median RT (r = .49, p < .05). Whether the child had a mother or father as the criterion rater was negatively correlated with flanker congruent RA (r = -.40, p < .05), flanker incongruent RA (r = -.38, p < .05), and *N*-back 1 target RA (r = -.44, p < .05). Lastly, the child's race was positively correlated with flanker incongruent RA (r = .42, p < .05).

Regarding the correlation between primary study variables, the athletic PIB difference score (e.g., subtraction of parent report of competence from child report) was negatively correlated with flanker incongruent median RT (r = -.43, p < .05). Flanker congruent median RT was positively related to flanker incongruent median RT (r = .95, p < .01), *N*-back 1 target RT (r = .84, p < .01), *N*-back 1 nontarget RT (r = .74, p < .01). Flanker congruent RA was positively related to flanker incongruent RA (r = .87, p < .01), *N*-back 1 target RT (r = .83, p < .01), and *N*-back nontarget RA (r = .69, p < .01). Flanker incongruent median RT was positively related to *N*-back 1 target median RT (r = .86, p < .01), *N*-back 1 nontarget median RT (r = .78, p < .01). Flanker incongruent RA was positively related to *N*-back 1 target RA (r = .76, p < .01), *N*-back 1 nontarget RA (r = .63, p < .01).

N-back 1 target median RT was positively related to *N*-back 1 nontarget median RT (r = .87, p < .01). *N*-back 1 target median RT was positively related to *N*-back 1 nontarget median RT (r = .73, p < .01), and object control standard score (r = .50, p < .05).

Table 7. Descriptive Summary of Correlation of Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Athletic PIB	-													
2.Age	.08	-												
3.Gender	.00	.07	-											
4.Symptom Count	.18	.01	-.30	-										
5.F Congruent RT	-.34	-.50**	-.13	-.02	-									
6.F Congruent RA	-.08	.42*	-.08	-.31	-.10	-								
7.F Incongruent RT	-.43*	-.39*	-.14	-.00	.95**	.06	-							
8.F Incongruent RA	-.17	.36	-.04	-.29	.04	.87**	.19	-						
11.B1 Target RT	-.22	-.33	-.02	.08	.84**	-.01	.86**	.10	-					
12.B1 Target RA	-.16	.45*	.01	-.13	-.06	.83**	.04	.76**	.14	-				
13.B1 Nontarget RT	-.26	-.30	-.05	.14	.74**	.10	.78**	.21	.87**	.18	-			
14.B1 Nontarget RA	.07	.28	.05	-.24	-.19	.69**	-.16	.63**	-.11	.73**	-.15	-		
17.Locomotor Std. Score	.52	.52**	.10	-.01	-.31	.34	-.20	.23	-.10	.37	-.11	.22	-	
18.Object Control Std. Score	-.33	.30	-.23	.00	-.12	.36	.01	.35	-.05	.50*	-.02	.27	.59**	-
M	.23	9.61	1.29	12.00	424.09	82.62	460.01	73.19	588.14	85.84	579.10	69.33	5.64	7.11
SD	.79	1.34	.46	4.28	82.66	13.68	96.50	14.15	209.30	11.16	203.44	17.44	3.25	2.77

Notes. F – Flanker; RT – Reaction Time; RA – Response Accuracy; B1 – N-Back 1

$^{*}p < .05$

$^{**}p < .01$

Preliminary Analysis

Self-Report Measures of Child Competence. Means and standard deviations for all subscales of the SPPC and PRS (physical appearance excluded – failed to meet reliability standards) may be found in Table 8. The mean scores reported are also considered absolute self-perception scores, which are devoid of parent rating influence. The means represent the average of the raw scores reported by children on the SPPC. Previous literature has utilized absolute self-perception scores (Hoza et al., 1993) in order to compare between children with and without ADHD. For the current study, absolute self-perceptions scores were computed in order to compare between past studies. Absolute perceptions scores evident in this study are similar to that evident in previous literature (Hoza et al., 2002; Owens & Hoza, 2003). Absolute self-perception scores were not computed for parents considering this approach has yet to be utilized.

The more contemporary method of determining PIB is to calculate difference scores that reflect the discrepancy between child report competence and actual competence. Difference scores were calculated by subtracting the criterion score (i.e., parent report of child competence) from the child's self-report of competence. Difference scores can be found in Table 6. It is important to note that the athletic subscale was the domain of interest. Thus, all following analyses are discussed with specific reference to the athletic subscale.

To identify if there was a significant difference between children report of competence compared to parent reports, dependent (related) t-tests were computed. Analysis revealed no significant difference between child self-report and parent report of child competence $t(27) = 1.52$, $p > .05$.

Table 8. Self-Report Measure Means and Standard Deviations

	SPPC	PRS	Difference
Athletic Competence	2.93 (0.85)	2.70 (0.70)	0.23 (0.79)
Scholastic Competence	2.59 (0.83)	2.50 (0.90)	0.13 (0.86)
Social Acceptance	2.91 (0.71)	2.90 (0.73)	0.01 (0.97)
Behavioral Conduct	2.91 (0.75)	2.73 (0.73)	0.18 (1.01)
Global Self-Worth	3.30 (0.70)	-	-

**Notes. SPPC - Self-Perception Profile for Children; PRS – Parent Rating of Child's Actual Behavior*

Test of Gross Motor Development – 2. Preliminary data analyses were conducted to determine whether there were significant differences between status (Diagnosed and Not Diagnosed) on five dependent measures specific to the TGMD-2. No significant differences were found between status and the five dependent measures: locomotor raw scores [$t(26) = -.69$, $p > .05$]; locomotor standard scores [$t(26) = -.42$, $p > .05$]; object-control raw scores [$t(26) = .26$, $p > .05$]; object-control standard scores [$t(26) = -.08$, $p > .05$]; and gross motor quotient (GMQ) [$t(26) = -.29$, $p > .05$]. Thus, all analyses utilized the total sample of both Diagnosed and Not Diagnosed participants.

Individual independent t-tests were also computed for gender and the five dependent measures. No significant differences were evident among gender and four of the five dependent measures: locomotor raw scores [$t(26) = -.62$, $p > .05$]; locomotor standard scores [$t(26) = -.49$, $p > .05$]; object-control standard scores [$t(26) = 1.20$, $p > .05$]; and GMQ [$t(26) = .31$, $p > .05$]. Significant differences were evident between gender and object-control raw scores, $t(26) = 3.15$, $p < .05$) such that boys had overall higher scores ($M = 39.60$) than girls ($M = 32.25$).

Univariate ANCOVA's (gender was entered as a covariate) were computed to identify whether performance on the five dependent measures differed significantly based on the age of the participant. No significant differences were evident between age and two of the five dependent measures: object-control raw score [$F(4,22) = 2.06$, $p > .05$]; and object-control standard scores [$F(4,22) = 1.40$, $p > .05$]. Significant differences in age for three of the five dependent measures were evident: locomotor raw scores [$F(4,22) = 4.41$, $p < .05$]; locomotor standard scores [$F(4,22) = 3.85$, $p < .05$]; and GMQ [$F(4,22) = 3.2$, $p < .05$]. Tables 9 and 10 provide additional information for the age related variables and TGMD-2 dependent variables.

TGMD-2 variables of interest were compared with the parent rating scale of children's actual behavior (PRS) to examine relationships between a subjective (survey) and objective (TGMD-2) assessment of children's movement competence. Means, standard deviations, and bivariate correlations can be found in Table 11. Regarding the correlation between TGMD-2 dependent variables, the PRS athletic subscale score (e.g., means of parent report specific to athletic subscale) was positively correlated with locomotor standard score ($r = .38$, $p < .05$), object control raw score ($r = .57$, $p < .01$), object control standard score ($r = .61$, $p < .01$), and gross motor quotient ($r = .54$, $p < .01$). Locomotor raw score was positively correlated with locomotor standard score ($r = .98$, $p < .01$), object control raw score ($r = .49$, $p < .01$), object control standard score ($r = .60$, $p < .01$), and gross motor quotient ($r = .90$, $p < .01$). Locomotor standard score was positively correlated with object control raw score ($r = .48$, $p < .01$), object control standard score ($r = .59$, $p < .01$), and gross motor quotient ($r = .91$, $p < .01$). Object control raw score was positively correlated with object control standard score ($r = .92$, $p < .01$), and gross motor quotient ($r = .76$, $p < .01$). Object control standard score was positively correlated with gross motor quotient ($r = .87$, $p < .01$).

Table 9. Age Comparisons on Locomotor Skills

	8 (*n* = 9)		9 (*n* = 3)		10 (*n* = 8)		11 (*n* = 6)		12 (*n* = 2)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Run (8)	5.25 (2-8)	2.19	6.00 (6)	0	6.00 (2-8)	2.20	7.00 (5-8)	1.26	7.00 (6-8)	1.41
Gallop (8)	5.00 (2-8)	1.73	4.00 (3-5)	1.00	6.00 (5-8)	.93	5.17 (1-8)	2.48	6.50 (6-7)	.71
Hop (10)	6.00 (3-8)	1.32	4.67 (3-7)	2.08	7.38 (4-10)	2.33	8.00 (6-10)	1.79	10.00 (10)	0
Leap (6)	3.75 (2-6)	1.67	4.00 (2-6)	2.00	5.00 (2-6)	1.51	4.83 (3-6)	1.33	6.00 (6)	0
Jump (8)	4.00 (2-8)	2.18	5.00 (4-6)	1.41	3.13 (1-5)	1.25	6.00 (2-8)	2.19	7.00 (6)	2.00
Slide (8)	7.00 (5-8)	1.00	7.00 (6-8)	1.00	6.00 (2-8)	2.20	7.83 (7-8)	.41	8.00 (8)	0
LM SS	4.44 (2-10)	2.30	3.00 (2-4)	1.00	5.25 (2-10)	2.66	7.67 (3-13)	4.08	10.50 (10-11)	.71
LM RS	30 (23-43)	5.79	29 (26-32)	3.00	33.38 (24-44)	6.26	38.83 (29-47)	7.05	44.50 (43-46)	.71

Notes. LM – Locomotor; SS – Standard Score; RS – Raw Score; Age comparisons use ANCOVA with gender as the covariate; the numerals in the bracket next to each skill indicate the maximum skill criterion per skill; (range of scores)

Table 10. Age Comparisons on Object Control Skills

	8 (*n* = 9)		9 (*n* = 3)		10 (*n* = 8)		11 (*n* = 6)		12 (*n* = 2)	
	M	SD	M	SD	M	SD	M	SD	M	SD
Bat (10)	7.33 (4-10)	2.18	6.67 (6)	0	6.00 (2-8)	2.20	7.00 (5-8)	1.26	7.00 (6-8)	1.41
Dribble (8)	6.33 (2-8)	2.55	4.00 (3-5)	1.00	6.00 (5-8)	.93	5.17 (1-8)	2.48	6.50 (6-7)	.71
Catch (6)	5.33 (1-6)	1.66	4.67 (3-7)	2.08	7.38 (4-10)	2.33	8.00 (6-10)	1.79	10.00 (10)	0
Kick (8)	5.89 (4-8)	1.45	4.00 (2-6)	2.00	5.00 (2-6)	1.51	4.83 (3-6)	1.33	6.00 (6)	0
Throw (8)	6.22 (2-8)	2.43	5.00 (4-6)	1.41	3.13 (1-5)	1.25	6.00 (2-8)	2.19	7.00 (6)	2.00
Roll (8)	5.33 (3-8)	2.00	7.00 (6-8)	1.00	6.00 (2-8)	2.20	7.83 (7-8)	.41	8.00 (8)	0
OC SS	6.89 (3-13)	3.30	3.00 (2-4)	1.00	5.25 (2-10)	2.66	7.67 (3-13)	4.08	10.50(10-11)	.71
OC RS	36.78 (26-48)	7.48	29 (26-32)	3.00	33.38 (24-44)	6.26	38.83 (29-47)	7.05	44.50 (43-46)	.71

Notes. OC – Object Control; SS – Standard Score; RS – Raw Score; Age comparisons use ANCOVA with gender as the covariate; the numerals in the bracket next to each skill indicate the maximum skill criterion per skill; (range of scores)

Table 11. Correlation of TGMD-2 Variables with PRS

	1	2	3	4	5	6
1. PRS Athletic Competence	-					
2. LM Raw Score	.35	-				
3. LM Standard Score	.38*	.98**	-			
4. OC Raw Score	.57**	.49**	.48**	-		
5. OC Standard Score	.61**	.60**	.59**	.92**	-	
6. GMQ	.54**	.90**	.91**	.76**	.87**	-

Notes. PRS – Parent Rating Scale; LM – Locomotor; OC – Object Control; GMQ – Gross Motor Quotient

Primary Analysis

Hierarchical Regression Analyses. Hierarchical regression analyses were run to examine whether cognitive performance could predict PIB. In step 1 we ran covariates (age and gender), step 2 the ADHD symptoms (e.g., total symptom count), and step 3 the respective cognitive variable. Separate models were tested for each cognitive assessment.

Flanker. With athletic PIB set as the dependent variable, the final step in the hierarchical analysis showed a significant *p*-value change for flanker incongruent median RT ($\beta = -.47$, $p = .03$). The negative association found between flanker incongruent median RT and PIB shows that children with more PIB had faster reaction times. Hierarchical regression tables specific to flanker include tables 12 through 15. No significant *p*-value change was observed for the accuracy markers.

Table 12. Hierarchical Regression Model for Flanker Congruent Median Reaction Time Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.23	1.19	.00	-.75	1.32	.00	2.13	2.10	.00
Age	.05	.12	.08	.04	.12	.08	-.08	.13	-.13
Gender	-.01	.34	-.00	.10	.36	.06	.03	.35	.02
Symptom Total				.04	.04	.19	.04	.04	.19
Flanker Congruent Median Reaction Time							-.00	.00	-.41
R^2		.01			.04			.16	
F for change in R^2		.08			.85			3.37	

Table 13. Hierarchical Regression Model for Flanker Incongruent Median Reaction Time Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.23	1.19	.00	-.75	1.32	.00	2.15	1.75	.00
Age	.05	.12	.08	.04	.12	.08	-.06	.12	-.10
Gender	-.01	.34	-.00	.10	.36	.06	-.01	.33	-.00
Symptom Total				.04	.04	.19	.03	.04	.18
Flanker Incongruent Median RT							-.00	.00	-.47*
R^2		.01			.04			.22	
F for change in R^2		.08			.85			5.34*	

Note. *$p < .05$

Table 14. Hierarchical Regression Model for Flanker Congruent Response Accuracy Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.23	1.19	.00	-.75	1.32	.00	-.48	1.62	.00
Age	.05	.12	.08	.04	.12	.08	.06	.14	.11
Gender	-.01	.34	-.00	.10	.36	.06	.07	.38	.04
Symptom Total				.04	.04	.19	.03	.04	.17
Flanker Congruent RA							-.00	.01	-.08
R^2		.01			.04			.04	
F for change in R2		.08			.85			.09	

Table 15. Hierarchical Regression Model for Flanker Incongruent Response Accuracy Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.23	1.19	.00	-.75	1.32	.00	-.19	1.51	.00
Age	.05	.12	.08	.04	.12	.08	.08	.13	.14
Gender	-.01	.34	-.00	.10	.36	.06	.04	.37	.03
Symptom Total				.04	.04	.19	.02	.04	.13
Flanker Incongruent RA							-.01	.01	-.18
R^2		.01			.04			.07	
F for change in R2		.08			.85			.61	

***N*-Back 1.** No significant *p*-value changes were found between athletic PIB and *N*-back 1 reaction time on accuracy variables. Hierarchal regression tables specific to *n*-back 1 include tables 16 through 19.

Table 16. Hierarchical Regression Model for *N*-Back 1 Target Median Reaction Time Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.92	1.41	.00	-1.28	1.50	.00	-.40	1.78	.00
Age	.10	.13	.16	.09	.14	.14	.04	.15	.07
Gender	.07	.36	.04	.15	.38	.09	.15	.38	.09
Symptom Total				.03	.04	.17	.04	.04	.20
N-Back 1 Target Median Reaction Time							-.00	.00	-.21
R^2		.03			.06			.09	
F for change in R2		.32			.61			.86	

Table 17. Hierarchical Regression Model for *N*-Back 1Nontarget Median Reaction Time Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.92	1.41	.00	-1.28	1.50	.00	-.23	1.73	.00
Age	.10	.13	.16	.09	.14	.14	.04	.14	.06
Gender	.07	.36	.04	.15	.38	.09	.15	.38	.09
Symptom Total				.03	.04	.17	.04	.04	.22
N-Back 1Nontarget Median Reaction Time							-.00	.00	-.27
R^2		.03			.06			.12	
F for change in R2		.32			.61			1.40	

Table 18. Hierarchical Regression Model for N-Back 1Target Response Accuracy Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.92	1.41	.00	-1.28	1.50	.00	-1.08	1.51	.00
Age	.10	.13	.16	.09	.14	.14	.17	.15	.27
Gender	.07	.36	.04	.15	.38	.09	.14	.38	.08
Symptom Total				.03	.04	.17	.02	.04	.12
N-Back 1Target Response Accuracy							-.01	.01	-.26
R^2		.03			.06			.11	
F for change in R2		.32			.61			1.15	

Table 19. Hierarchical Regression Model for N-Back 1Nontarget Response Accuracy Predicting PIB

	Model 1			Model 2			Model 3		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Intercept	-.92	1.41	.00	-1.28	1.50	.00	-1.70	1.93	.00
Age	.10	.13	.16	.09	.14	.14	.07	.15	.12
Gender	.07	.36	.04	.15	.38	.09	.15	.39	.09
Symptom Total				.03	.04	.17	.04	.05	.20
N-Back 1Nontarget Response Accuracy							.01	.02	.08
R^2		.03			.06			.06	
F for change in R2		.32			.61			.13	

CHAPTER FIVE

DISCUSSION

The purpose of the current study was two-fold: 1) examine whether children with ADHD overestimate their competence in the physical domain; and 2) identify if PIB is more pronounced with greater cognitive dysfunction. Consistent with past research, children's mean subscale scores on the SPPC were higher than the parent's scores on the PRS across all domains (Horn, Wagner, and Ialongo, 1989; Hoza et al., 2002, 1993; Ialongo et al., 1994; Owens & Hoza et al., 2003). Specific to the athletic domain subscale, findings show children's report of competence exceeded their parent's report and revealed the highest discrepancy value compared to all other domains. In addition, the PIB discrepancy score attained with the current sample is in line with previous work (Evangelista et al., 2007; Hoza et al., 2002, 2004; Owens & Hoza, 2003). This offers some evidence that expected PIB was observed in the current sample. However, despite mean subscale score differences, no significant statistical differences were evident between child and parent reports of competence for the athletic subscale.

No study to date has examined PIB devoid of a typically developing group for comparison. In fact, regardless of the type of analysis used to quantify PIB, no study has investigated the relationship between child and parent report specifically. Thus, this is the first study to examine this relationship while also addressing the physical domain that has limited empirical investigation. Present findings suggest that further examination is necessary to explain the relationship between child and parent report of child competence.

Investigation for whether children with ADHD overestimate their competence in the physical domain helps address a major gap within PIB literature. In one of the landmark PIB studies, Hoza et al (1993) found that boys with ADHD provided more positive self-evaluations than boys without ADHD, specific to the athletic competence subscale. This was a notable finding considering no significant differences were found between boys with or without ADHD across all the other achievement domains (e.g., scholastic competence, social competence, behavioral control, physical appearance). These findings suggest there may be something unique about the physical domain in that children with ADHD may have a more difficulty assessing their competence compared to the other achievement domains. In other words, the salience of the physical domain may make it more difficult to mask incompetence compared to other achievement domains, and thus these children may be predisposed to further exaggerate their competence. Interestingly, PIB literature suggests the physical domain subscale scores from the child are often the most discrepant from parent or teacher report. In fact, research that has utilized discrepancy analysis to observe differences between child and parent report have often found that the most discrepancy can be found in the physical domain (Evangelista et al., 2007; Hoza et al., 2004).

In addition to addressing a major gap within PIB literature, the current study also utilized an objective approach to examine perceptions its relationship with performance. A vast majority of PIB studies observe the differences between child and parent report of competence without examining actual achievement scores (e.g., objective measures) as a criterion. Although child and parent report tend to reliably capture the constructs of interest, actual achievement scores may provide an important manipulation check for the parent report. In other words, parent report and actual achievement scores should be correlated if both measures are truly measuring the same constructs.

The current study examines whether children with ADHD overestimate their competence within the physical domain. This domain lends researchers the opportunity to utilize motor proficiency batteries to examine movement skill competence. The Test of Gross Motor Development-2 (TGMD-2) is a standardized assessment developed to measure fundamental motor skills. The test is subdivided in two parts: locomotor (run, gallop, hop, leap, horizontal jump, and slide) and object control skills (striking a stationary ball, stationary dribble, catching, kicking, overhand throw and underhand roll). Participants were scored based on the fluidity of their movements by two separate coders. Locomotor raw and standard scores, object control raw and standard scores, and gross motor quotient scores were computed for each child. Regarding the correlation between TGMD-2 dependent variables, the PRS athletic subscale score (e.g., means of parent report specific to athletic subscale) was positively correlated with locomotor standard score ($r = .38$, $p < .05$), object control raw score ($r = .57$, $p < .01$), object control standard score ($r = .61$, $p < .01$), and gross motor quotient ($r = .54$, $p < .01$). Thus, parent report appears to be a reasonable indicator of children's movement competence.

To further investigate the relationship between parent report and movement skill competence, the parent measure was adapted to incorporate questions that mapped directly with the TGMD-2 skills. This was done to determine whether parents could reliably assess their children's movement competence in reference to specific skills. Interestingly, there were no significant correlations between parent report and the adapted items that mapped directly on to the different skills. One explanation may be specific to the structure of the adapted items on the subscale. The items were highly binary in nature. In other words, parents were asked to report whether their child was good or bad at a particular skill as opposed to asking whether a child has the ability to meet specific criteria (as seen in the TGMD-2) to complete a skill correctly. It is also important to keep in mind that the TGMD-2 does not capture athletic competence directly. Instead, motor skill proficiency is presumed to be somewhat related to athletic competence.

Accordingly, the TGMD-2 was used as a rough manipulation check to establish whether parent ratings are at least to some degree grounded in actual competence.

Another novel aspect of the current study is the examination of cognitive dysfunction and PIB in children with ADHD. There exist many hypotheses that help explain the underlying mechanisms of PIB in children with ADHD including: cognitive immaturity hypothesis, self-protective hypothesis, and the neuropsychological hypothesis. Literature for PIB has focused on two former hypotheses with limited support for the latter. The secondary purpose of this study was to identify whether performance on inhibition and working memory tasks could predict PIB. Findings revealed that reaction time components of inhibitory control predicted PIB. More specifically, flanker incongruent median RT predicted PIB.

Findings reveal a negative relationship between inhibition and physical self-perceptions in children with ADHD. Higher reported competence on the athletic subscale was associated with faster reaction time. Faster RT is often predictive of poor RA, however, there was no significant relationship between faster RT and RA . Despite identifying that reaction time for an interference control task could predict PIB, working memory tasks did not predict PIB. Although working memory was not found to predict PIB scores, an explanation may exist. Low sample size may play a considerable role. Possibly with a greater sample size, working memory would predict PIB scores. With the current analysis, reaction time for working memory (nontarget) accounts for twice as much of the variance compared to total symptom count (step 2 of the hierarchical multiple regression). These findings suggest that with a larger sample size, reaction time on working memory tasks may be predictive of PIB. Working memory and inhibition are considered fundamental building blocks for EF, thus we would expect that cognitive dysfunction in these two areas would predict PIB scores.

Theoretical Implications

The current study helps inform understanding for the relationship between EF and PIB in children with ADHD. Prior to this study, the association between EF and PIB could not be determined due to lack of empirical support. Findings from this study show there does exist a relationship between a child's ability to inhibit and their physical self-perceptions when they possess ADHD symptoms. Specifically, findings suggest that RT specific to the flanker task shared a negative relationship with PIB scores. Meaning children who had faster RTs tended to have higher PIB scores. Although this negative relationship is evident, it is not entirely clear. For example, faster reaction times often correspond with poor response accuracy; however, this trend was not evident in the current study. No relationship was evident between working memory and PIB.

Considering the prominent role of cognitive dysfunction in the manifestation of ADHD, this study provides empirical support to an area worthy of research. Neuropsychological deficits are included as one of the few theoretical explanations for PIB. This theoretical approach is arguably one of the most testable theories considering the quantitative and objective nature of results. This study helps show that further empirical support is necessary to identify whether higher order cognition may underlie PIB evident in children diagnosed with ADHD.

The current study also helps inform understanding of PIB in relation to children with ADHD. The phenomenon of PIB in the self-perceptions of children diagnosed with ADHD has been well documented; however, the underlying mechanisms remain relatively unclear. To better articulate the functions and causes of PIB, several hypothesized explanations for PIB have been proposed such as: cognitive immaturity hypothesis (Milich, 1994), self-protective hypothesis (Ohan & Johnston, 2002), and neuropsychological deficits hypothesis (Owens & Hoza, 2003). In addition to utilizing theory, over the last two decades there have two main methods for measuring PIB including: absolute rating scale scores, and discrepancy scores.

The current study utilized the neuropsychological hypothesis is the theoretical framework and discrepancy analysis as the main measure of PIB. Use of these two methods provides support for how the current study informs understanding of PIB. First, this study provides an examination of PIB devoid of a TD group. Although there are many benefits to having a TD group, one limitation evident in PIB literature is a sole focus in reference to the group of concern, children diagnosed with ADHD. This study helped show that further investigation specific to those diagnosed with ADHD is needed to help advance PIB literature. The current study suggests that the theoretical framework was appropriate considering the relationship between inhibition and PIB scores. However, more detailed measurement methods may be employed to better capture this phenomenon. Discrepancy analysis has many advantages, however one flaw of the analysis evident in this study was the lack of specificity in quantifying PIB from one individual to the next.

Lastly, the current study helps inform understanding of motor functioning among children with ADHD. No study to date has examined the relationship between motor functioning and PIB in children with ADHD. The main purpose for assessing movement competence was to address whether parent report was a valid measure of children's actual competence. Utilizing an objective measure in tandem with parent report is seldom practiced within the PIB literature, thus the incorporation of an actual achievement measure speaks volumes to the breadth of the study. This said, the TGMD-2 does not capture athletic competence directly. This measure was used as a manipulation check to establish parent ratings, at least to some degree, are grounded in actual competence.

Examination of motor functioning also speaks to the relationship shared between EF and motor control. Although the relationship between EF and motor control was not the major focus of the current work, this study provides initial empirical evidence. To date, there exist no theoretical frameworks which examine EF and motor functioning exclusively. Yet descriptive studies may provide empirical support to help encourage researchers to address this important relationship.

Limitations and Future Directions

Despite providing empirical evidence for two considerable gaps in PIB literature (e.g., examination of PIB in the physical domain, and the relationship between PIB and cognitive ability), limitations exist. The primary limitation for the current study is the lack of power for analysis run. A total of 28 participants were deemed eligible for the study. Two additional children consented to participate but were not eligible based on the inclusion criteria. A priori analysis suggested that a minimum of 60 participants would be needed to achieve desired power. Thus, all analysis must be interpreted with caution due to the low number of participants that completed the study.

In addition to low power, the diagnostic threshold used to classify participants may slightly differ from that of other studies examining PIB. For example, two children were removed from the analysis because their parents did not report any symptoms of ADHD. To be included in analyses, participants were required to have a total symptom count of at least 1. Notably, this is a low threshold for determining ADHD symptomology and it may be argued that a subset of the population tested may not meet clinical diagnosis for ADHD. This said, the main purpose of the study was to examine how *symptoms* of ADHD may contribute to PIB. Thus, although clinical diagnoses may be important from a clinical/practitioner standpoint, the protocol in this study was followed to investigate symptoms of ADHD and PIB. In addition, due to the low number of participants, a low threshold was necessary to carry out analyses. It is important to interpret analysis with caution. The recruitment process was developed to include participants who showed symptoms of ADHD and overall this was an effective method. The main flaw was having fairly restrictive inclusionary criteria and thus having to exclude many participants.

Although the main approach for the current study was to recruit children with symptoms of ADHD, lack of clinically diagnosed children with ADHD could impact results. For example, PIB literature suggests that deficits associated with ADHD are part of the reason why PIB exists. Thus, if the sample in the current study did not exemplify the severity of ADHD symptoms similar to previous PIB studies, then this may explain why no significant differences between child and parent report of competence were observed. In addition to the measurement of PIB, the severity of ADHD symptoms could also impact EF and motor functioning. If the current sample is higher functioning than the typical sample of children with ADHD, then their ADHD symptoms may not manifest differently and thus they may show different deficits related to EF or motor control.

A limitation specific to the protocol of data collection is evident in the length of time for cognitive testing. Participants were asked to complete three tasks including: flanker, *N*-back 1, and *N*-back 2. All tasks had a practice trial followed by three trials that were included in data analysis. The duration of all these tasks took roughly 45 minutes to an hour and children often found it difficult to remain focused for the entirety of the session. Especially considering these children were medication naïve for a minimum of 24 hours prior to testing. Thus, many children failed to complete all blocks of cognitive testing due to fatigue. This lead to a low number of participants who were able to complete the *N*-back 2 and thus it was not used within the analysis.

In addition, performance on the *N*-back 2 was fairly poor. Children were expected to achieve a response accuracy score that exceeded 50% otherwise they would have to repeat the trial. This further contributed to fatigue and failure to complete the remainder of the cognitive testing.

Beyond the fatigue evident among some participants for the cognitive tasks, another limitation of the cognitive assessment was the cross-sectional nature. Cognition literature often utilizes a within-subjects design where participants are tested on the same cognitive tasks on multiple instances. This is done to confirm test-retest reliability of the cognitive assessment and to ensure that response accuracy and reaction time data are representative of a participant's typical performance. Although participants completed multiple trials for each cognitive assessment, the cross-sectional nature of the study may suggest that the cognitive data may not be representative of a participant's typical/averaged performance.

Beyond issues with the cognitive assessment, limitations are also evident for coding of movement skills. The typical approach to coding of the TGMD-2 skills includes: training with an 'expert coder', rating skills evident in the TGMD-2 against a 'gold standard' rating, and videotaping each movement skill so that coding can completed a later date by one or more raters. In the current study, parents were asked to wait outside the gymnasium while testing took place. Due to concerns of having children in a gymnasium where a parent was not directly present, live coding was utilized. Although reliability assessments show that live coding in the current study did not differ significantly from past literature, videotaped recording would have been the most prudent approach to assessing children's skill proficiency. Another area for future research is to examine children's perceived self-competence relative to specific movement skills. In the current study children were asked questions related more generally to athletic ability. The TGMD-2 does not capture athletic competence directly, yet motor skill proficiency is expected to be somewhat related. An investigation of movement competence perceptions specific to the skills within the TGMD-2 may offer valuable knowledge.

One of the main contributions of the current study was the use of an objective measure to identify actual competence within the physical domain. A majority of the self-perception literature has utilized parent or teacher report as the criterion measure for actual competence. Few studies have used an objective measure that can act as a manipulation check for whether parent or teacher report is accurate. In the current study, correlations suggested a significant association between parent report of athletic competence and the TGMD-2 motor skill assessment. More studies may benefit from utilizing this approach as it ensures that the criterion measure is a valid measure of actual competence.

Other avenues for future research should address limitations of the current study. This study was not designed to provide more empirical support for how children with ADHD and TD children compare in their physical self-perceptions. Thus, future work exploring PIB may benefit from exploring children with and without ADHD utilizing a similar methodology employed in the current study. Limited research has focused on the physical domain, however a majority of PIB literature discusses differences with a TD population. Utilizing a TD population would help expand the literature base of physical self-perceptions of children with and without ADHD.

No study to date has examined the relationship between EF and PIB among children with ADHD. Although this study addressed this gap in the literature, a cross-sectional approach was utilized as opposed to a within-subjects design. Repeated attempts over several training sessions may help address the lack of findings for a relationship between working memory and PIB. Working memory is a component of EF that has been shown to be impaired in children with ADHD. Thus, the lack of a finding between working memory and PIB scores was not expected.

A within-subjects design may help illuminate the relationship between working memory and PIB. An additional area worth exploring is whether PIB may be manipulated by utilizing positive feedback. Past research has found that children with overly positive evaluations of themselves in social situations decreased their exaggerated perceptions after receiving positive feedback. Future research focused on the physical domain may be able to investigate this relationship through examination of feedback provided throughout a movement competence assessment. As a general recommendation, future researchers should move toward longitudinal and experimental designs in order to advance knowledge on PIB in the physical domain.

Conclusion

The main implication of this research is that physical self-perceptions represent another important domain to examine in concert with academic, social, and behavioral domains when seeking to understand PIB in children with ADHD. Additionally, the current study provides preliminary evidence of a link between inhibition and PIB in the physical domain. Research in the physical domain lends itself to different methodological approaches, which may help elucidate the relationship between cognitive dysfunction and PIB. Although there were shortcomings of this project, this appears to be a potentially fruitful area of research. Future work examining the intersection of cognitive dysfunction, motor performance, and ADHD holds much potential to advance knowledge on children with ADHD as well as inform questions on the link of cognition with motor function.

APPENDICES

APPENDIX A

Contact E-Mail for MSU LISTSERV

Contact E-Mail for MSU LISTSERV

Subject: Seeking 8-12 year-old Children with ADHD Symptoms

Does your child get easily distracted, have trouble sitting still, talk excessively, have difficulty focusing, interrupt often, or have ADHD-type symptoms? If yes, your child may be eligible for a study examining the ways children with ADHD-type symptoms evaluate themselves. We seek children ages 8-12 with ADHD symptoms or an ADHD diagnosis.

Participating children make a single visit to the Social & Motivational Processes in Physical Activity Laboratory (SiMPL) located on the MSU campus, in the IM Sport Circle building (308 W. Circle Drive; East Lansing, MI 48824).

During the visit, one parent and the child complete consent/assent forms and a survey. Children additionally complete some computer and basic movement skill tasks. The total time requirement is less than 2 hours. There is no cost to participate, and $10 compensation is provided.

If you are interested, please contact me at the email or phone number below.

Many thanks for your consideration of this study!

Sincerely,

Olufemi Oluyedun
oluyedun@msu.edu
517-353-6497

APPENDIX B

Flyer

Figure 3. Flyer

APPENDIX C

Participant Information Form

Participation Information Form

This portion is completed by researcher during phone screening.

"The purpose of the following questions is to ensure that we provide your child with the highest level of care. Physical activity and fitness testing are safe for most children. To ensure safe participation for your child we would like to know some specific information about your child's health before we include them in this study. In some cases, we simply need to know more information (e.g., that you child has a puffer for asthma) while in other situations, we might tell you that we'd like your child to see a physician before participating in the study."

Child's name: ________________________

Your relationship with the child (e.g., mother, father): _________________________

Child's date of birth: ______________________

Current age of Child (circle one): 8 9 10 11 12

Child Sex: Female Male

"Has your child been diagnosed with ADHD?" Yes: ☐ No: ☐
(If 'Yes' skip the next question and proceed by asking for the parent/guardian name)

"Does your child get easily distracted, have trouble sitting, talks excessively, has difficulty focusing, interrupts often, and/or possesses ADHD-type symptoms? Yes: ☐ No: ☐

Your name: ______________________

Address: ____

Emergency contact details: ____

Mobile phone number: ______________________

Work phone number: ________________________

Email: __________________________

The following are a list of health questions. You may respond with a yes or no. Does your child have or has he or she ever experienced any of the following?

High or Low blood pressure	Yes: ☐	No: ☐
Elevated blood cholesterol	Yes: ☐	No: ☐
Diabetes	Yes: ☐	No: ☐
Chest pains brought on by physical exertion	Yes: ☐	No: ☐
Childhood epilepsy	Yes: ☐	No: ☐
Dizziness or fainting	Yes: ☐	No: ☐
A bone, joint or muscular problems with arthritis	Yes: ☐	No: ☐
Asthma or respiratory problems	Yes: ☐	No: ☐
Any sustained injuries and illness	Yes: ☐	No: ☐
Any allergies	Yes: ☐	No: ☐
Is your child taking any medication	Yes: ☐	No: ☐
Has your doctor ever advised your child to exercise	Yes: ☐	No: ☐
Is there any reason not mentioned above why any type or physical activity may not be suitable for your child	Yes: ☐	No: ☐

If answered 'YES' to any of the above questions, seek additional details and document here:

Now we are going to ask you a few general health information questions:

Does your child have a pervasive developmental disorder, for example Autism or Asperger Syndrome, mental retardation, or a disorder involving seizures?	Yes: ☐	No: ☐
Does your child have normal or corrected-to-normal vision?	Yes: ☐	No: ☐

Is there anything else we should know about your child that has not been addressed in the Health questions on this form?:

List any and all medication your child may be taking for Attention-Deficit Hyperactivity Disorder (ADHD):

APPENDIX D

Parent/Legal Guardian Consent Form

Parent/Legal Guardian Consent Form

Computer Task Performance, Movement Skill, and Self-Perceptions

Investigator Directing Research: Alan L. Smith, Ph.D., Professor and Chairperson, Department of Kinesiology, Michigan State University, 134 IM Sports Circle, East Lansing, MI 48824-1049, alsmith@msu.edu or 517-355-4731.

We invite you and your child to participate in a research study. Researchers are required to provide a consent form to inform you and your child about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you and your child to make an informed decision. You or your child should feel free to ask the researchers any questions.

Purpose of the Research: The purpose of this study is to examine how children with Attention-Deficit Hyperactivity Disorder (ADHD) symptoms evaluate themselves and how these evaluations are tied to performance on computer and movement tasks.

What Will You and Your Child Do: If you and your child agree to participate, everything will be completed in one visit with us in about 90 minutes. You will be asked to fill out this form, and your child will be asked to give assent. Also, you will fill out a set of questionnaires about your child. Your child will complete a questionnaire, computer tasks, and a series of movement skills.

- **Questionnaires** – You will be asked to complete questionnaires pertaining to your child. This should take about 45 minutes. Your child will complete a questionnaire that asks them "what they are like", which takes about 20 minutes.

- **Computer Tasks** – Your child will complete computer-based tasks that assess attention. These tasks will take about 25 minutes.

- **Movement Skills** – Your child will complete 12 standard movement skills. Your child will be given a chance to warm up and each skill will be demonstrated beforehand. Completing all movement skills takes about 30 minutes.

Privacy and Confidentiality: Any data you and your child provide are kept confidential, are numerically coded, and grouped with data from other participants. Once the study is complete and we destroy our list matching your name, your child's name, and your child's ID number, there will be no way to connect your child to their data. All records will be kept for at least 3 years after the close of the study in a locked, secure location and your child's confidentiality will be protected to the maximum extent of the law. However, when required by law, government representatives and the Michigan State University Human Research Protection Program may deem it necessary to look at and/or copy your child's information. All data obtained from this study will be used for research purposes only, not for the evaluation or diagnosis of any disorder.

You and Your Child's Rights to Participate, Say No, or Withdraw: Participation in this project is entirely voluntary. You or your child is free to withdraw from participation at any time for any reason. There is no penalty for withdrawing. Your child should feel free to inform the research staff if they are thinking about stopping or deciding to stop. Also, you or your child may choose to skip a question at any time if uncomfortable or you simply prefer not to answer it.

Costs and Compensation for Participation: Participation in this research study is free, though any costs associated with parking on campus will be your responsibility. You will receive a $10 gift certificate for participation, even if you or your child decides to withdraw early from the study. Your child will also receive some stickers and a small prize (value less than $1).

Potential Benefits: There is no direct benefit of participation to you or your child, though you may enjoy participating in the research. We hope to gain insight into how children's self-evaluations tie to movement and attention. This may benefit scientific progress and inform us how to make best use of physical activity opportunities for children.

Potential Risks: All procedures, techniques, equipment, and measures used in this study are routinely used in educational and research settings. No methods are used that are new, untested, or of questionable safety. Some participants may be uncomfortable with the computer tasks or particular survey questions. Neither you nor your child are required to complete tasks or items that make you feel uncomfortable, though you must complete our initial safety/screening questions to be involved in the study.

Contact Information: If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher, Dr. Alan L. Smith, Department of Kinesiology, Michigan State University, 134 IM Sports Circle, East Lansing, MI 48824. Dr. Smith can be reached at alsmith@msu.edu or 517-355-4731.

If you have questions or concerns about you or your child's role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or email: irb@msu.edu or regular mail at Olds Hall, 408 West Circle #207, MSU East Lansing, MI 48824.

Documentation of Informed Consent: Before you agree to participate, please ensure that you:

- Are aware of what you and your child will be asked to do.
- Give your consent voluntarily
- Know that you or your child can withdraw your consent at any time.

Your signature below means that you voluntarily agree for you and your child to participate in this research study.

Signature: ____ Date: _______________________

Name: ____

Please Print

Thank you for your consideration. You will be given a copy of this form to keep.

APPENDIX E

Child Assent Form

Child Oral Assent Form

Study Title: Computer Task Performance, Movement Skill, and Self-Perceptions

We invite you to participate in this project. Your parent or guardian has said that it is okay for you to do this project if you want to, but it is also ok if you do not want to do it. You should only do it if you want to. Here is what we will do if you participate.

- This project has a few parts. All of which you will complete today.
- In this project, you get to tell me how good you think you are at things like school, friendships, behavior, appearance, and athletics.
- After this, you'll complete two games on the computer.
- I'll give you instructions before each game.
- In between the games I will ask you if you need a break. If you need more breaks just ask. I want you to enjoy the project!
- After the computer games, you'll do some physical tasks, like running, skipping, and bouncing or kicking a ball.
- I won't tell anyone, even your parents, about what you say or do on these tasks.
- If you do not want to take part, that is okay. You only have to tell me you do not wish take part. Nothing bad will happen if you tell me you don't want to take part.
- When we're done today, you can select a prize from this box. You can also keep the sticker chart we use as we go through the tasks today.
- Do you have any questions?

I would like to read some questions to you, and for you to respond either yes or no.

- Do you understand what you will do if you participate?
- Do you understand that you can quit at any time and that nothing bad will happen?
- Do you know that you don't have to answer any questions you do not want to answer or do anything you do not want to do?
- Would you like to do this study? If yes, please sign your name below:

Signature: ____ Date: ______________________

Name: ____
Please Print

Thank you! You will be given a copy of this form to keep.

APPENDIX F

Demographic Questionnaire

Please answer the following questions to the best of your ability

General Information

1. Today's date? ___________

2. What is your child's date of birth? ________/_________/_________

3. What is your child's current age? ________ current grade? _________

4. What is your relationship to the child (e.g., mother, father)? ______________________

5. What is the highest grade or year of school **you <u>or</u> your spouse** completed?

☐Never attended school or only attended kindergarten
☐Grades 1 through 8 (Elementary)
☐Grades 9 through 11 (Some high school)
☐Grade 12 or GED (High school graduate)
☐College 1 year to 3 years (Some college or technical school)
☐College 4 years (College graduate)
☐Graduate School (Advanced Degree)

6. What is your child's gender? ☐Male ☐Female

7. Is your child of Hispanic Ethnicity? ☐Yes ☐No

8. How do you describe your child's race? (please check the one option that best describes them)

☐American Indian or Alaska Native
☐Asian
☐Black or African American
☐Native Hawaiian or Other Pacific Islander
☐White
☐Mixed (list groups): ____
☐Other (write in): ____

9. Does your child receive free-or-reduced priced lunch at school?

☐Yes ☐No

APPENDIX G

Parents Rating Scale of Child's Actual Behavior

Instructions:

For each child, please indicate what you feel to be his/her actual competence on each question, in your opinion. First decide what kind of child he or she is like--the one described on the left or right--then indicate whether this is 'sort of true' or 'really true' for that individual. Thus, for each item, check ***one*** of four boxes. If you have no basis to form an opinion, circle "Don't know".

Sample

Really True	Sort of True	This child would rather play outdoors in their spare time	**OR**	This child would rather watch T.V.	Sort of True for Me	Really True for Me

PRS

1.	Really True	Sort of True	This child is really good at his/her school work	**OR**	This child can't do the school work assigned	Sort of True	Really True
Don't know							

2.	Really True	Sort of True	This child finds it hard to make friends	**OR**	For this child, it's pretty easy	Sort of True	Really True
Don't know							

3.	Really True	Sort of True	This child does really well at all kinds of sports	**OR**	This child isn't very good when it comes to sports	Sort of True	Really True
Don't Know							

4.	Really True	Sort of True	This child is good looking	OR	This child is not very good looking	Sort of True	Really True
Don’t know							

5.	Really True	Sort of True	This child is usually well-behaved	OR	This child is often not well-behaved	Sort of True	Really True
Don’t know							

6.	Really True	Sort of True	This child often forgets what (s)he learns	OR	This child can remember things easily	Sort of True	Really True
Don’t know							

7.	Really True	Sort of True	This child has social skills to make friends	OR	This child doesn't have social skills to make friends	Sort of True	Really True
Don’t know							

8.	Really True	Sort of True	This child is better than others his/her age at sports	OR	This child can't play as well	Sort of True	Really True
Don’t know							

9.	Really True	Sort of True	This child has a nice physical appearance	**OR**	This child doesn't have such a nice physical appearance	Sort of True	Really True
Don't know							

10.	Really True	Sort of True	This child usually acts appropriately	**OR**	This child would be better if (s)he acted differently	Sort of True	Really True
Don't know							

11.	Really True	Sort of True	This child has trouble figuring out the answers in school	**OR**	This child almost always can figure out the answers	Sort of True	Really True
Don't know							

12.	Really True	Sort of True	This child knows how to become popular	**OR**	This child does not know how to become popular	Sort of True	Really True
Don't know							

13.	Really True	Sort of True	This child doesn't do well at new outdoor games	**OR**	This child is good at new games right away	Sort of True	Really True
Don't know							

<table>
<tr><td>14.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child isn't very good looking</td><td rowspan="2">OR</td><td rowspan="2">This child is pretty good looking</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

<table>
<tr><td>15.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child often gets in trouble because of things (s)he does</td><td rowspan="2">OR</td><td rowspan="2">This child usually doesn't do things that get him/her in trouble</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

For the remaining items, please use the picture chart to assist in responding. (*use TMGD-2 sticker chart in Appendix M*)

<table>
<tr><td>16.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child has good running form</td><td rowspan="2">OR</td><td rowspan="2">This child has poor running form</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

<table>
<tr><td>17.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child is a good galloper</td><td rowspan="2">OR</td><td rowspan="2">This child is a poor galloper</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

18.	Really True	Sort of True	This child is a good hopper both on their left and right feet	**OR**	This child is a poor hopper	Sort of True	Really True
Don’t know							

19.	Really True	Sort of True	This child is a good leaper	**OR**	This child is a poor leaper	Sort of True	Really True
Don’t know							

20.	Really True	Sort of True	This child is a good horizontal jumper	**OR**	This child is a poor horizontal jumper	Sort of True	Really True
Don’t know							

21.	Really True	Sort of True	This child is good at sliding	**OR**	This child is poor at sliding	Sort of True	Really True
Don’t know							

22.	Really True	Sort of True	This child is good at hitting a stationary ball with a bat	**OR**	This child is poor at hitting a stationary ball	Sort of True	Really True
Don't know							

23.	Really True	Sort of True	This child is good at dribbling a ball	**OR**	This child is poor at dribbling a ball	Sort of True	Really True
Don't know							

24.	Really True	Sort of True	This child is good at catching	**OR**	This child is poor at catching	Sort of True	Really True
Don't know							

25.	Really True	Sort of True	This child is good at kicking	**OR**	This child is poor at kicking	Sort of True	Really True
Don't know							

<table>
<tr><td>26.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child is good at overhand throwing</td><td rowspan="2">OR</td><td rowspan="2">This child is poor at overhand throwing</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

<table>
<tr><td>27.</td><td>Really True</td><td>Sort of True</td><td rowspan="2">This child is good at underhand rolling</td><td rowspan="2">OR</td><td rowspan="2">This child is poor at underhand rolling</td><td>Sort of True</td><td>Really True</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Don’t know</td></tr>
</table>

APPENDIX H

ADHD Rating Scale-IV: Home Version

ADHD RATING SCALE-IV: HOME VERSION			
Circle the number that *best describes* your child's school behavior over the past 6 months (or since the beginning of the school year).			
1. Fails to give close attention to details or makes careless mistakes in schoolwork.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
2. Fidgets with hands or feet or squirms in seat.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
3. Has difficulty sustaining attention in tasks or play activities.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
4. Leaves seat in classroom or in other situations in which remaining seated expected.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
5. Does not seem to listen when spoken to directly.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
6. Runs about or climbs excessively in situations in which it is inappropriate.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
7. Does not follow through on instructions and fails to finish work.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
8. Has difficulty playing or engaging in leisure activities quietly.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
9. Has difficulty organizing tasks and activities.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
10. Is "on the go" or acts as if "driven by a motor.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
11. Avoid tasks (e.g., schoolwork, homework) that require sustained mental effort.			

0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
12. Talks excessively.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
13. Loses things necessary for tasks or activities.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
14. Blurts out answers before questions have been completed.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
15. Is easily distracted.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
16. Has difficulty awaiting turn.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
17. Is forgetful in daily activities.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)
18. Interrupts or intrudes on others.			
0 (Never or rarely)	1 (Sometimes)	2 (Often)	3 (Very often)

APPENDIX I

Sticker Chart

Survey

1. Self-Perception Questionnaire ☐

STICKER

Computer Games

1. Fish ☐
2. Shapes ☐

STICKER

Gym Games

1. Running ☐
2. Galloping ☐
3. Hoping ☐
4. Leaping ☐
5. Horizontal Jumping ☐
6. Sliding ☐
7. Two-Hand Striking ☐
8. Stationary Bouncing ☐
9. Catching ☐
10. Kicking ☐
11. Overhand Throwing ☐
12. Underhand Rolling ☐

STICKER

APPENDIX J

Self-Perception Profile for Children

Instructions:

- The following statements deal with what kind of a person you are
- Please read both statements in each row
- Decide which of the two statements is most like you (left statement vs. right statement).
- Once you pick a side, mark whether this is “REALLY TRUE FOR ME” OR “SORT OF TRUE FOR ME” by marking the appropriate box with an X.
- Please choose only ONE answer.
- Remember: ***There are no right or wrong answers; simply choose the one that is best for you.***

Sample

Really True for Me	Sort of True for Me	Some kids would rather play outdoors in their spare time	BUT…	Other kids would rather watch T.V.	Sort of True for Me	Really True for Me

SPPC

1)

Really True for Me	Sort of True for Me	Some kids feel that they are very good at their school work	BUT…	Other kids worry about whether they can do the school work assigned to them	Sort of True for Me	Really True for Me

2)

Really True for Me	Sort of True for Me	Some kids find it hard to make friends	BUT…	Other kids find it pretty easy to make friends	Sort of True for Me	Really True for Me

3)

Really True for Me	Sort of True for Me	Some kids do very well at all kinds of sports	BUT…	Other kids don’t feel that they are very good when it comes to sports	Sort of True for Me	Really True for Me

4)

Really True for Me	Sort of True for Me	Some kids are happy with the way they look	BUT…	Other kids are *not* happy with the way they look	Sort of True for Me	Really True for Me

5)

Really True for Me	Sort of True for Me	Some kids often do not like the way they behave	BUT…	Other kids usually like the way they behave	Sort of True for Me	Really True for Me

6)

Really True for Me	Sort of True for Me	Some kids are often unhappy with themselves	BUT…	Other kids are pretty pleased with themselves	Sort of True for Me	Really True for Me

7)

Really True for Me	Sort of True for Me	Some kids feel like they are just as smart as other kids their age	BUT…	Other kids aren't so sure and wonder if they are as smart	Sort of True for Me	Really True for Me

8)

Really True for Me	Sort of True for Me	Some kids know how to make classmates like them	BUT…	Other kids don't know how to make classmates like them	Sort of True for Me	Really True for Me

9)

Really True for Me	Sort of True for Me	Some kids wish they could be a lot better at sports	BUT…	Other kids feel they are good enough at sports	Sort of True for Me	Really True for Me

10)

Really True for Me	Sort of True for Me	Some kids are happy with their height and weight	BUT…	Other kids wish their height and weight were different	Sort of True for Me	Really True for Me

11)

Really True for Me	Sort of True for Me	Some kids usually do the right thing	BUT…	Other kids often don't do the right thing	Sort of True for Me	Really True for Me

12)

Really True for Me	Sort of True for Me	Some kids don't like the way they are leading their life	BUT…	Other kids *do* like the way they are leading their life	Sort of True for Me	Really True for Me

13)

Really True for Me	Sort of True for Me	Some kids are pretty slow in finishing their school work	BUT…	Other kids can do their school work quickly	Sort of True for Me	Really True for Me

14)

Really True for Me	Sort of True for Me	Some kids don't have the social skills to make friends	BUT…	Other kids do have the social skills to make friends	Sort of True for Me	Really True for Me

15)

Really True for Me	Sort of True for Me	Some kids think they could do well at just about any new sports activity they haven't tried before	BUT…	Other kids are afraid they might not do well at sports they haven't ever tried	Sort of True for Me	Really True for Me

16)

Really True for Me	Sort of True for Me	Some kids wish their body was different	BUT…	Other kids like their body the way it is	Sort of True for Me	Really True for Me

17)

Really True for Me	Sort of True for Me	Some kids usually act the way they know they are supposed to	BUT…	Other kids often don't act the way they are supposed to	Sort of True for Me	Really True for Me

18)

Really True for Me	Sort of True for Me	Some kids are happy with themselves as a person	BUT…	Other kids are often not happy with themselves	Sort of True for Me	Really True for Me

19)

Really True for Me	Sort of True for Me	Some kids often forget what they learn	BUT…	Other kids can remember things easily	Sort of True for Me	Really True for Me

20)

Really True for Me	Sort of True for Me	Some kids understand how to get peers to accept them	BUT…	Other kids don't understand how to get peers to accept them	Sort of True for Me	Really True for Me

21)

Really True for Me	Sort of True for Me	Some kids feel that they are better than others their age at sports	BUT…	Other kids don't feel they can play as well	Sort of True for Me	Really True for Me

22)

Really True for Me	Sort of True for Me	Some kids wish their physical appearance (how they look) was different	BUT…	Other kids like their physical appearance the way it is	Sort of True for Me	Really True for Me

23)

Really True for Me	Sort of True for Me	Some kids usually get in trouble because of things they do	BUT…	Other kids usually don’t do things that get them in trouble	Sort of True for Me	Really True for Me

24)

Really True for Me	Sort of True for Me	Some kids like the kind of person they are	BUT…	Other kids often wish they were someone else	Sort of True for Me	Really True for Me

25)

Really True for Me	Sort of True for Me	Some kids do very well at their classwork	BUT…	Other kids don’t do very well at their classwork	Sort of True for Me	Really True for Me

26)

Really True for Me	Sort of True for Me	Some kids wish they knew how to make more friends	BUT…	Other kids know how to make as many friends as they want	Sort of True for Me	Really True for Me

27)

Really True for Me	Sort of True for Me	In games and sports some kids usually watch instead of play	BUT…	Other kids usually play rather than just watch	Sort of True for Me	Really True for Me

28)

Really True for Me	Sort of True for Me	Some kids wish something about their face or hair looked different	BUT…	Other kids like their face and hair the way they are	Sort of True for Me	Really True for Me

29)

Really True for Me	Sort of True for Me	Some kids do things they know they shouldn't do	BUT…	Other kids hardly ever do things they know they shouldn't do	Sort of True for Me	Really True for Me

30)

Really True for Me	Sort of True for Me	Some kids are very happy being the way they are	BUT…	Other kids wish they were different	Sort of True for Me	Really True for Me

31)

Really True for Me	Sort of True for Me	Some kids have trouble figuring out the answers in school	BUT…	Other kids almost always can figure out the answers	Sort of True for Me	Really True for Me

32)

Really True for Me	Sort of True for Me	Some kids know how to become popular	BUT…	Other kids do not know how to become popular	Sort of True for Me	Really True for Me

33)

Really True for Me	Sort of True for Me	Some kids don't do well at new outdoor games	BUT…	Other kids are good at new games right away	Sort of True for Me	Really True for Me

34)

Really True for Me	Sort of True for Me	Some kids think that they are good looking	BUT…	Other kids think that they are not very good looking	Sort of True for Me	Really True for Me

35)

Really True for Me	Sort of True for Me	Some kids behave themselves very well	BUT…	Other kids often find it hard to behave themselves	Sort of True for Me	Really True for Me

36)

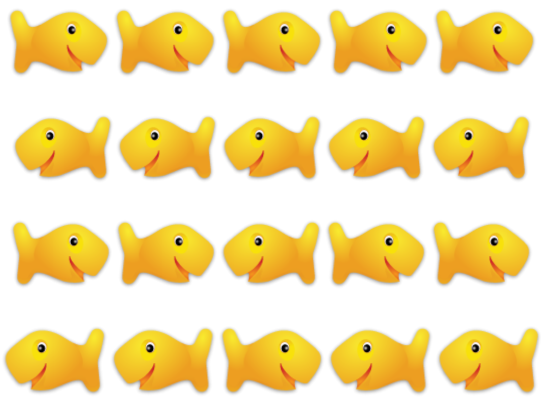
Really True for Me	Sort of True for Me	Some kids are not very happy with the way they do a lot of things	BUT…	Other kids think the way they do things is fine	Sort of True for Me	Really True for Me

APPENDIX K

Child Modified Flanker Task Instructions

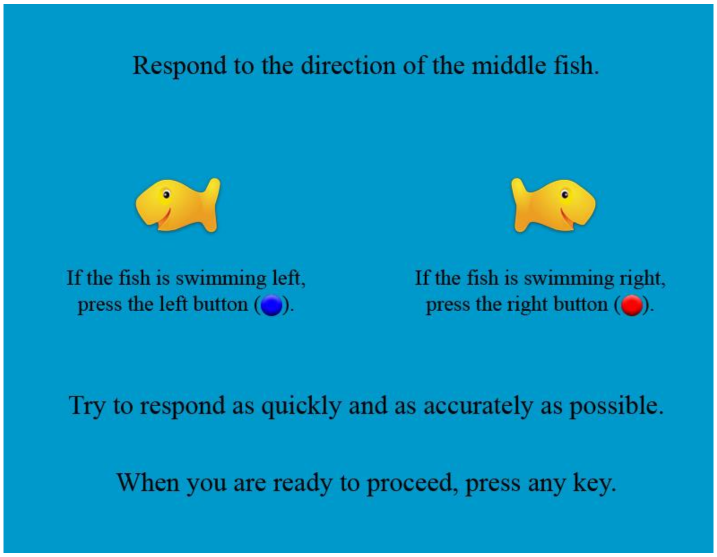
"You're going to play a computer game where your job will be to respond based on which direction the center fish is facing (swimming). You are going to see a set of five fish on the screen at a time. Sometimes all the fish will be swimming in one direction (show example cards). And sometimes the outer fish will be facing in the opposite direction (show example cards).

Figure 4. Flanker Fish



Regardless, you are responsible for concentrating on the center fish. If the center fish is facing in the right direction then you would respond by pressing the right (red) button on this response pad. If the center fish is facing the left direction then you would respond by pressing the left (blue) button. Try to respond as quickly as possible but also as accurately as possible. Also, please respond every time you see fish on the screen!

Figure 5. Flanker Instruction Page



APPENDIX L

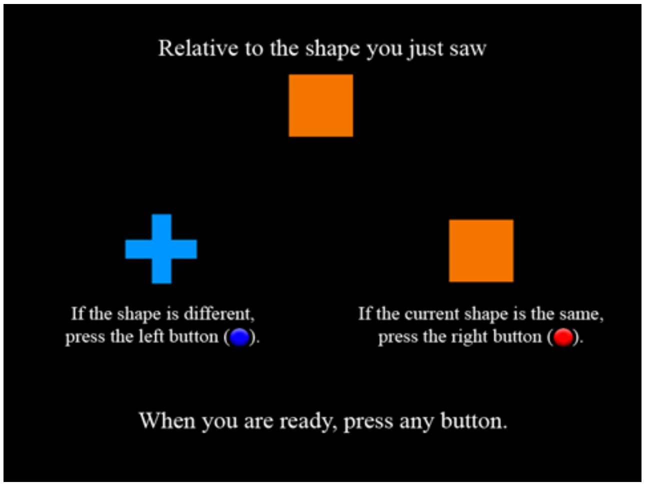
N-Back Task Instructions

1-back

This is a computer task that will ask you to remember whether the same or different shapes pop up on the screen. You are going to see a series of six different shapes. They will be presented one at a time in the middle of the screen. Your goal is to remember if the current shape matches the shape you saw before it (show example cards).

For example, if you see is a square followed by a square, they are the same. If the shapes are the same, you should respond with the right (red) button. If the very next shape that pops up is a plus sign, (and the shape before was a square) then you should respond with the left (blue) button. Don't respond to the first shape you see but try to remember it and see if it matches the next shape you see. Try to respond to every shape that pops up on the screen as fast and as accurately as possible. Do you understand (any questions)?

Figure 6. *N*-Back 1 Instruction Page

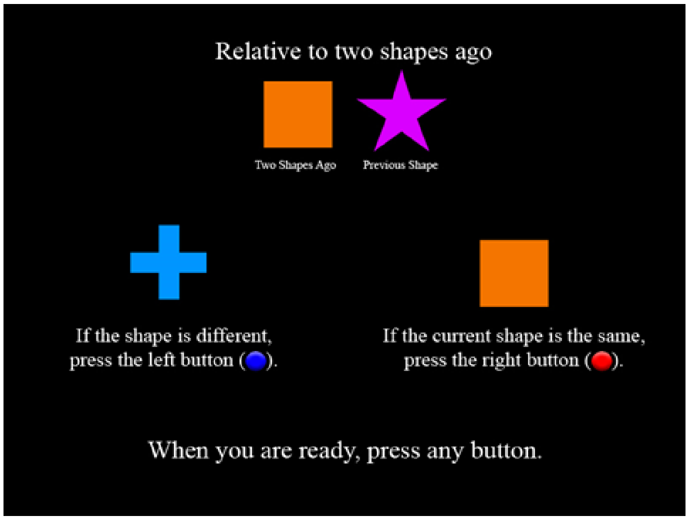


2-back

This is a computer task that will ask you to remember whether the same or different shapes pop up on the screen. You are going to see a series of six different shapes. They will be presented one at a time in the middle of the screen. Your goal is to remember if the current shape matches the shape you saw two before it (show example cards).

For example, if the first shape you see a square, then you see a star, then you see a square, the square you currently see matches the square two before it. Since the shapes match, you would respond with the right (red) button. If the very next shape you see is a plus sign, the correct response would now be the left (blue) button since the plus sign is different than the star shape two before it. Don't respond to the first two shapes you see but try to remember them and see if they match the next shape you see. Try to respond to every shape that pops up on the screen as fast and as accurately as possible. Do you understand?

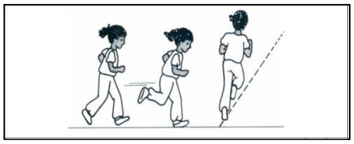
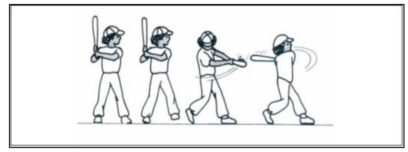
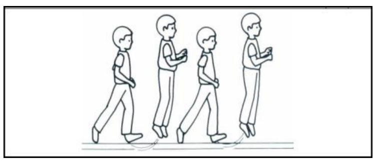
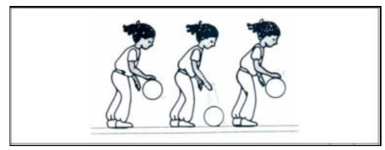
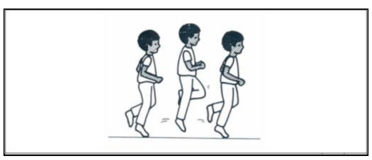
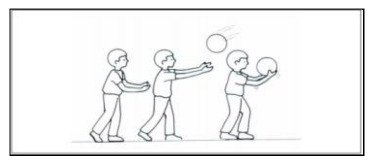
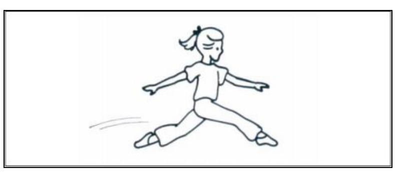
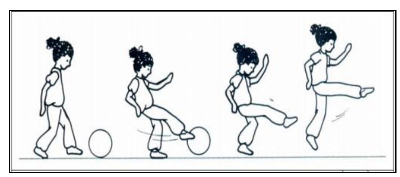
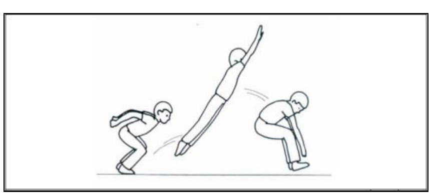
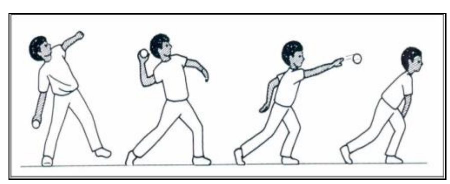
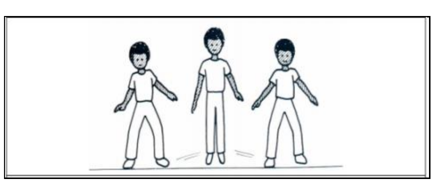
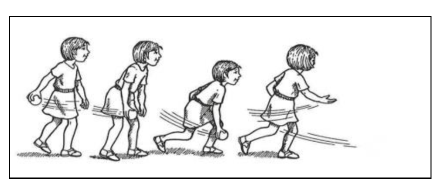
Figure 7. *N*-Back 2 Instruction Page



APPENDIX M

Sticker Chart for TGMD-2

Figure 8. Sticker Chart for TGMD-2

1. Run 	7. Striking a Stationary Ball 
2. Gallop 	8. Stationary Dribble 
3. Hop 	9. Catch 
4. Leap 	10. Kick 
5. Horizontal Leap 	11. Overhand Throw 
6. Slide 	12. Underhand Roll 

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