The Positive Illusory Bias in Children with ADHD: An Examination of the Executive Functioning Hypothesis

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This dissertation titled
The Positive Illusory Bias in Children with ADHD: An Examination of the Executive Functioning Hypothesis

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Abstract

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Numerous studies have found evidence to support the presence of a positive illusory bias (PIB) in children with attention-deficit/hyperactivity disorder (ADHD; Diener & Milich, 1997; Hoza et al., 2004; Hoza, Pelham, Dobbs, Owens, & Pillow, 2002; Ohan & Johnston, 2002; Owens & Hoza, 2003). However, the underlying mechanism of the PIB has yet to be determined. Although a number of researchers have hypothesized that underlying executive functioning deficits in children with ADHD may be associated with a PIB (Hoza et al., 2001; Owens & Hoza, 2003), to date, no study has examined the relationship between executive functioning and the PIB in children with ADHD. Thus, the primary purpose of this study is to examine executive functioning as it relates to the PIB in children with ADHD. Participants included 34 children in the ADHD group and 30 children in the CTL group. Participants completed six tests of executive functioning including: a Stop Signal Task, the D-KEFS Color-Word Test, Digit Span, the Stanford-Binet Spatial Working Memory Test, the D-KEFS Tower Test, and the D-KEFS Sorting Test. Following each task, participants completed a task-specific self-evaluation estimate. Participants also completed a set of easy mazes and impossible mazes followed by post-task self-evaluation estimates. In conjunction with a parallel research project, the following measures were also obtained from participants: Self-Perception Profile for Children (SPPC), Teacher Rating Scale of Child’s Actual Behavior, Wechsler
Abbreviated Scale of Intelligence (WASI), Disruptive Behavior Disorder Rating Scale (DBD), Parent and Teacher Impairment Rating Scale (IRS), Children’s Interview for Psychiatric Syndromes – Parent Version (P-ChIPS), and a demographic questionnaire. Consistent with previous studies, group differences in executive functioning and overestimations of competence were found. The ADHD group performed significantly worse than the CTL group on four of six measures of executive functioning, even after controlling for IQ. In support of the PIB, it was hypothesized that children with ADHD would overestimate their performance on executive functioning tasks significantly more than control children. This hypothesis was partially supported by analyses revealing that children with ADHD overestimated their performance more than controls on three of six task-specific self-perception discrepancy scores. Additionally, the relative contributions of depression, executive functioning performance and ADHD symptoms in the self-perceptions of participants were examined by using both traditional SPPC discrepancy scores as well as task-specific discrepancy scores. Results of the current study provide preliminary evidence that executive functioning may influence the self-perceptions of children with ADHD. Specifically, higher executive functioning was found to be related to lower overestimation of competence in one broad domain (e.g., SPPC Scholastic) and a number of task-specific domains.

Approved: _____________________________________________________________

Julie Sarno Owens

Associate Professor of Psychology
Dedication

To my father and mother, Vince and Loretta Golden, in gratitude for nearly three decades of love and support and for being the educators who have influenced me the most.
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I wish to express my sincerest thanks to the parents and children who participated in this study, as well as the principals, teachers and staff at the elementary schools in Logan-Hocking School District. Additional thanks are provided to Rev. Tom Gates, who allowed me to meet with participants on many Saturday mornings throughout the data collection stage of this project at the Logan Church of the Nazarene. I am appreciative of the guidance and direction from my dissertation committee: Drs. Bruce Carlson, Christine Gidycz, Julie Suhr and Tracy Leinbaugh. Deepest thanks to Dr. Julie Sarno Owens, who has provided me with the support, encouragement and structure necessary for completion of this project and completion of graduate school in general. I am quite sure that without her help, this project would never have come to fruition. I would like to thank Melissa Dvorsky for her assistance regarding collection of this project. Sincerest thanks to Nicole Evangelista, as I am not only indebted to her for the countless hours of consultation and mentorship she provided for this project but for her strong friendship throughout all of graduate school. Additional thanks to Matt Lindberg, who supported me unconditionally through a master’s thesis, comprehensive exams, dissertation, broken leg, internship interviews and many other hurdles and challenges over the past three years. I would also like to thank my mother, father, siblings, and numerous other family members who provided me with love and support from afar as I completed this degree.
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The Positive Illusory Bias in Children with ADHD: An Examination of the Executive Functioning Hypothesis

Children with attention-deficit/hyperactivity disorder (ADHD) experience functional impairment in multiple domains including academic and social settings (Barkley, 1997; Barkley, 1998; Gaub & Carlson, 1997). Because children with ADHD show deficits in multiple areas, one might expect that they would present with low self-esteem and low perceptions of self competence. However, an intriguing phenomenon called the positive illusory bias (Taylor, 1983; Hoza, Pelham, Milich, Pillow, & McBride, 1993) reveals just the opposite. The positive illusory bias (PIB) is defined as an overestimation of one’s own performance or competence as compared to a criterion.

Numerous studies have found evidence to support the presence of a PIB in children with ADHD (see Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007 for a review). However, the underlying mechanism of the PIB has yet to be determined. One possible explanation for the PIB in youth with ADHD is an underlying executive functioning (EF) deficit often displayed in this population (Hoza et al., 2001; Owens et al., 2007; Owens & Hoza, 2003). “Executive functioning” (EF) typically refers to a wide assortment of processes that includes attention, working memory, the ability to shift easily from one task to another, planning, and regulation of goal directed behavior. Because EF deficits are associated with inaccurate, overly positive self-perceptions in other patient populations (described below), such deficits may also explain positive illusory self-perceptions in children with ADHD. The goal of the study was to (a) replicate the presence of the PIB in children with ADHD using task-specific, self-evaluation ratings following completion of the EF tasks and (b) to examine the relative
roles of EF and ADHD symptomatology in explaining the PIB. In the paragraphs that follow, information regarding the self-perceptions in children with ADHD, the EF hypothesis, and the neuropsychological performance in children with ADHD is reviewed.

Young children in general tend to overestimate their abilities and show unrealistic optimism in performance expectations (Bjorklund & Green, 1992; Mash & Wolfe, 2002) and moderately positively inflated thinking may be a normative experience in adulthood (Taylor and Brown, 1988); however children with ADHD tend to overestimate their ability significantly more than children without ADHD. This extreme overestimation is noteworthy, as it indicates that the self-perceptions of children with ADHD are outside of normal limits. Additionally, although most people tend to rate themselves as “better than average” (Alicke & Govorun, 2005), asking someone to compare themselves to a hypothetical “average” individual differs from methodology traditionally utilized in examination of the PIB (e.g., discrepancy score comparison).

Furthermore, although inflated self-perceptions appear to be somewhat normative within the general population, the relative adaptiveness of the PIB is unclear. Some research suggests that inflated self-perceptions may serve adaptive functions (Bjorklund & Green, 1992; Taylor & Brown, 1988). However, other researchers have disagreed regarding the adaptive nature of positive illusions, criticizing methodological issues in the studies included in Taylor and Brown’s review and note that self-enhancement has been associated with psychological maladjustment (Colvin & Block, 1994). Other researchers have reported a link between inflated positive self-perceptions and aggression in both adults (Baumeister, Smart, & Boden, 1996; David & Kistner, 2000) and children (Gresham, MacMillan, Bocian, Ward, & Forness, 1998; Hymel, Bowker, & Woody,
Lastly, research from the brain injury literature reports that an inability to understand the degree of one’s deficits “reduces motivation for rehabilitation, leads to setting unattainable goals” and “precipitates conflict with family members” (Trudel, Tryon, & Purdum, 1998, p. 267). This association between inaccurate self-evaluation and poor treatment response has also been found in a recent study of youth with ADHD attending an intensive summer treatment program (Hoza, 2009). Based upon this research, it appears that inflated self-perceptions may have a number of negative implications. As such, additional examination of possible mechanisms that may be associated with positive illusions in children with ADHD is warranted.

Self-Perceptions in Children with ADHD

Although some studies have found that children with ADHD report lower levels of competence than control children (Horn, Wagner, & Ialongo, 1989; Ialongo, Lopez, Horn, Pascoe, & Greenberg, 1994; Treuting & Hinshaw, 2001), the majority of studies have revealed consistent evidence in support of the PIB (Owens et al., 2007).

An early study on the PIB compared the absolute self-perception scores of children with ADHD to the scores of a control group utilizing the Self-Perception Profile for Children (SPPC; Harter, 1985) (Hoza et al., 1993). This study revealed that although children with ADHD displayed significantly higher levels of problems in behavioral, social and academic domains, self-perception ratings for this group did not significantly differ from those of the non-ADHD group. Researchers argued that the lack of difference between these groups on self-perception measures indicated inflated self-perceptions among the children with ADHD (Hoza et al., 1993).
Subsequent studies improved upon this methodology through exploration of the effect of success and failure conditions on task-specific self-evaluation scores of children with ADHD in both the social and academic domains. Hoza, Waschbusch, Pelham, Molina, and Milich, (2000) found that boys with ADHD rated themselves as more successful on a social “get acquainted” task than did control boys, despite the fact that observers who were blind to group status rated the ADHD children as less socially effective than controls (Hoza et al., 2000). These results suggested that boys with ADHD overestimated their competence relative to the observer’s rating during this social task, and provide further evidence for the PIB. An additional study that was conducted simultaneously and on an overlapping sample examined task-specific self-evaluations of ADHD and non-impaired boys in a success-failure manipulation task in the academic domain (Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001). In this study, boys with ADHD solved fewer test puzzles correctly and quit sooner than controls, but did not rate their performance significantly different than did the non-impaired boys. This study provides further evidence of the PIB in that the boys with ADHD still displayed an overestimation of competence (i.e., reported perceptions that were more positive than actual performance).

Further studies assessed the PIB by creating discrepancy scores between child and adult reports on parallel forms of a rating scale. More specifically, two studies (Hoza et al., 2004; Hoza et al., 2002) compared the self-perception ratings of children with ADHD to teacher and parent-rated perceptions of the child’s competence. In these studies, higher scores indicate higher overestimation on the part of the child. Significant group differences were found for scholastic competence, social acceptance, and behavioral
conduct such that boys with ADHD overestimated their competence in these areas as compared to teacher reports significantly more than did controls (Hoza et al. 2002).

Hoza and colleagues (2002) also explored the role of comorbid conditions (i.e., low achievement, aggression, depression). Results provided preliminary evidence that children with ADHD tend to overestimate their self-perceptions most in the domain of greatest impairment. Specifically, children with ADHD plus low achievement overestimated their competence in the scholastic domain significantly more than the normal-achieving ADHD group as well as the control group, who actually underestimated their competence (Hoza et al., 2002). Similarly, children with ADHD plus aggression overestimated their competence in the social and behavioral domains significantly more than the children with ADHD without aggression as well as the control group (Hoza et al., 2002). However, examination regarding the effects of depression suggests that high levels of depressive symptomatology may be associated with reduced levels of inflation of self-ratings in some domains, but not in others, yielding inconsistent results (Hoza et al., 2002). Taken together, results suggest that comorbid symptoms may moderate the relative presence of the PIB in some domains.

These results were supported by another study that included a larger sample size, parent and teacher ratings regarding each child’s behavior, and both boys and girls. Consistent with previous studies, results revealed that children with ADHD overestimated their competence significantly more than the control group across a number of discrepancy scores (e.g., child-mother, child-father, child-teacher) regardless of the criterion used. These results suggest that previous findings were not solely a function of bias on the part of the teacher. Positive illusory self-perceptions in children
with ADHD were relatively consistent across genders. The only exception was that relative to the teacher report, girls in general (ADHD and control) had lower self-perception discrepancy scores than boys in the behavioral conduct and physical appearance domains (Hoza et al., 2004).

To date, only one study has explored the relationship between gender and ADHD subtype in the PIB (Owens & Hoza, 2003). In this study, results revealed that hyperactive/impulsive/combined children overestimated their scholastic competence more than inattentive children when reading and math achievement scores (Woodcock-Johnson Achievement Test) were used as a comparison criterion and more than control children when math achievement scores and teacher perceptions (Harter SPPC) were used as a comparison criterion. In general, the self-perceptions of inattentive children did not differ from control children. Gender effects were found only for the math achievement subtest, where girls overestimated their competence more than boys. This study suggests that ADHD subtype, as well as gender, may influence the PIB.

Taken together, this body of literature suggests that children with ADHD overestimate their competence relative to a criterion, regardless of whether the criterion is parent or teacher report, actual task performance or a standardized achievement measure. That the PIB has been displayed utilizing multiple samples of children with ADHD, and has been found across multiple domains regardless of the criterion used, lends credibility to the findings. However, the studies mentioned above are not without limitations. Many of the studies examining the PIB have relied on discrepancy score analyses that have a number of inherent problems and criticisms (see Owens et al., 2007 for a review). However, given the nature of the phenomenon (i.e., accuracy of self-perceptions) some
argue that utilizing discrepancy score analyses is conceptually better than alternative methodologies (Colvin, Block, & Funder, 1995; Owens et al., 2007; Rogosa, Brandt, & Zimowski, 1984; Tisak & Smith, 1994). Because of this, and because examination of discrepancy scores represents the standard in the field of PIB inquiry (Owens et al., 2007), the current study will utilize discrepancy scores in relevant analyses. However, the current study will also incorporate post-task performance evaluations to serve as a comparison criterion in addition to teacher report to reduce potential biases in teacher ratings.

PIB and the Executive Functioning Hypothesis

Taken together, the above studies reveal that the PIB has been reliably displayed in children with ADHD and that the PIB has been found across numerous domains (e.g., academic, social, and behavioral). Research on the PIB has proliferated within the last 15 years and a number of explanations for this phenomenon have been proposed (see Owens et al., 2007 for a review). Three of these explanations, the cognitive immaturity hypothesis, the ignorance of incompetence hypothesis, and the self-protective hypothesis have undergone preliminary evaluation (Diener & Milich, 1997; Evangelista & Owens, 2009; Golden et al., 2007; Hoza et al., 2001; Ohan & Johnston, 2002; Owens & Hoza, 2003). A fourth hypothesis, the executive functioning (EF) hypothesis, has also been mentioned as a viable mechanism regarding the positive illusory bias (Hoza et al., 2001; Owens & Hoza, 2003; Owens et al., 2007). This hypothesis suggests that underlying EF deficits, such as attention, working memory and planning, may impact the self-perceptions of children with ADHD. Researchers have reported for over a decade that the three symptoms of ADHD (hyperactivity, impulsivity, inattention) are all related to an
underlying deficit in executive function (Pennington & Ozonoff, 1996). Sergeant, Geurts, & Oosterlaan (2002) note that there are at least 33 definitions of executive functioning (EF) that have been reported in the literature, making this a rather broad construct to study. Perhaps one of the most inclusive definitions is that used by Willcutt and colleagues (2005) in their meta-analysis, defining EF as “neurocognitive processes that maintain an appropriate problem-solving set to attain a later goal” (p. 1336). In general, researchers agree that there are multiple processes involved in EF with this term typically referring to a wide assortment of processes that includes attention, working memory, the ability to shift easily from one task to another, planning, and regulation of goal directed behavior (Gazzaley & D’Esposito, 2007).

Preliminary evidence regarding deficits in EF in children with ADHD is found in the literature examining intellectual performance in this population. Although numerous researchers have found no significant differences between the Full Scale IQ (FSIQ) of children with ADHD and control children (MTA, 1999), more recent studies have revealed relatively large differences.

Evidence regarding significant group differences between ADHD and non-ADHD group on IQ can be found in a recent meta-analysis that utilized 86 studies comparing the FSIQ of children with ADHD to control children (Frazier et al., 2004). Results revealed that the ADHD groups displayed significantly lower FSIQ scores compared to the CTL groups. Similarly, other reviews reveal that children with ADHD tend to score approximately 7 to 15 points lower than their peers on tests of intelligence (Barkley, 1998; Schuck & Crinella, 2005). Hence, although children with ADHD may still fall
within the “average” range on intellectual test performance, their performance is significantly below their non-ADHD peers.

Information derived from the normative data of the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV; Wechsler, 2003) helps to resolve these discrepancies. In this sample, the ADHD group fell significantly below the matched CTL group on the working memory index and the processing speed index \((p \leq .01; \text{ Wechsler, 2003})\), but not on FSIQ. Both the working memory index and the processing speed index rely heavily upon EF and it appear that subtests of intellectual functioning in which ADHD and CTL groups tend to differ are those that reflect EF. In sum, while studies indicate that children with ADHD tend to score lower than their non-ADHD peers on tests of intellectual performance, evidence suggests that this deflated score is likely caused by underlying EF problems that load onto the full scale IQ score.

In addition to group differences on IQ scores, extant literature reveals that children with ADHD display deficits on EF measures compared to children without ADHD. Inhibition, one task of EF often studied in children with ADHD, is typically tested through stop-signal tasks, the Stroop task and continuous performance tasks (CPT). All of these tasks require participants to inhibit an automatic response in lieu of a recently-learned, less automatic response. Results from a meta-analysis revealed that children with ADHD were slower than controls (weighted mean effects size \(d = .64, z = 4.97\)) on stop-signal reaction time tasks (Oosterlaan et al., 1998) and that these tasks reveal adequate ability to distinguish between individuals with ADHD and controls (Nigg et al., 2006; Schachar et al., 2000). Research utilizing the Stroop test also reveals additional support for an inhibitory deficit in individuals with ADHD (Sergeant, et al.,
Additionally, a meta-analysis by Frazier and colleagues (2005) revealed large ADHD and CTL group differences on stop signal reaction time, even above and beyond the effect of FSIQ (e.g., FSIQ versus SSRT; $t = 2.75, p = .03$).

In addition to deficits in inhibition, multiple research laboratories have concluded that working memory is impaired in children with ADHD (Nigg, 2006; Sergeant et al., 2002; Willcutt et al., 2005). Results of a recent meta-analysis revealed that children with ADHD exhibited moderate to large impairments in working memory, with the largest impairment evident in nonverbal working memory domains and moderate impairment in verbal working memory domains (Martinussen et al., 2005). More specifically, this meta-analysis revealed a standardized mean difference between ADHD and CTL groups of 1.06 ($t = 6.2, p < .001$) on tasks measuring spatial EF and .56 ($t = 4.1, p < .001$) on tasks measuring verbal EF.

Finally, although tests of planning are not as well-studied as tests of inhibition and working memory, there is evidence that tests of planning may serve utility in distinguishing individuals with ADHD from individuals without ADHD (Sergeant et al., 2002). Specifically, a recent meta-analysis revealed that five studies that utilized planning tasks differentiated ADHD from controls while two studies revealed no differences (Sergeant et al., 2002).

After reviewing the literature on EF in children with ADHD, a number of measures provide both convincing empirical evidence, as well as a strong theoretical basis for utilization in the current study. Additionally, experts recommend that “multiple component processes should be included in the evaluation of patients with a suspected frontal lobe dysfunction” (Cummings & Miller, 2007, p. 17) as there is not a specific EF
profile common to everyone with executive dysfunction; hence it is important to utilize a number of different tasks in the current study.

Although researchers are not in complete agreement regarding the components of EF most often implicated in ADHD, a number of common generalizations can be found. It appears that behavioral inhibition has the most empirical support as a deficit in individuals with ADHD (Barkley, 1997; Frazier et al., 2004; Oosterlaan et al., 1998; Pennington, 1997; Preston, Fennell, & Bussing, 2005; Schacher et al., 1993; Seidman, 2006; Sergeant et al., 2002; Willcutt et al., 2005) followed by a deficit in working memory (Barkley, 1997; Martinussen, et al., 2005; Nigg, 2006; Pennington, 1997; Sergeant et al., 2002; Willcutt et al., 2005). Additionally, planning appears to have strong support as an EF deficit in individuals with ADHD (Pennington, 1997; Willcutt et al., 2005), though this construct has been less studied than the other two mentioned above.

Agnosognosia

In addition to research indicating clear ADHD and CTL group differences on measures of executive functioning, researchers (Owens & Hoza, 2003) note that the poor self-evaluation characteristic of children with ADHD may be reminiscent of deficits seen in patients who display poor evaluation of self due to conditions or injury that most typically affect the brain’s frontal lobe, the area of the brain most often implicated in EF. Patients with significant frontal lobe damage often experience agnosognosia, or the lack of knowledge or awareness of one’s own deficits. Individuals who display agnosognosia display difficulty in accurately evaluating self, but often maintain the ability to accurately evaluate others (e.g., Duke et al., 2002; Kaszniak & Christensen, 1995). Preliminary work by Evangelista and colleagues (2008) indicated that children with ADHD display a
similar pattern of evaluation. Specifically, within this population, positive illusions appear to be exclusive to self but not to evaluation of others.

Agnosognosia has been documented among individuals who have experienced a stroke (Starkstein et al., 1993), dementia (Watkins, Cheston, Jones, & Gilliard, 2006), brain injury (Chandrashekar & Benshoff, 2007; Malec, Testa, Rush, Brown, & Moessner, 2007), and Alzheimer’s disease (Starkstein, Jorge, Mizrahi, & Robinson, 2007). The commonality among these populations is frontal lobe damage due to injury or disease.

The population where this trait has been most documented is among individuals with Alzheimer’s disease (AD). The presentation of AD typically begins with impairment in memory but later affects higher-order processes including EF (Johnson, Brun, & Head, 2007, p. 429). Individuals with AD tend to display higher levels of agnosognosia as the disease progresses (Starkstein et al., 2007) and this increased inability to accurately self-reflect is likely related to the loss of higher-level neuropsychological processes.

In sum, literature provides evidence that EF deficits are associated with inaccurate self-perceptions in patients with frontal lobe damage. Consequently, the same pattern of self-perceptions may be present in children with ADHD given that ADHD is correlated with frontal lobe dysfunction (Samango-Sprouse, 2007).

**Current Study**

The purpose of the study was to examine the role of EF in the PIB in youth with ADHD. More specifically, the study intended to (a) replicate the presence of the PIB in children with ADHD using task-specific, self-evaluation ratings following completion of the EF tasks and (b) examine the relative roles of EF and ADHD symptomatology in
explaining the PIB. This study is the first to directly examine the relationship between EF performance and the PIB in children with ADHD.

First, it was hypothesized that children with ADHD would perform significantly worse than the children without ADHD on all six neuropsychological tasks. Second, it was hypothesized that the children with ADHD would not recognize these deficits, and thus, would overestimate their performance on all of the neuropsychological tests (i.e., exhibit positive illusions) significantly more than the non-ADHD children. Third, it was hypothesized that deficits in EF would account for more variance in the self-perception discrepancy scores than ADHD symptoms, after controlling for depression.

Method

Participants

Participants were recruited from a pool of participants who took part in a companion study (Evangelista, 2009). Participants for the companion study were initially recruited through (a) six elementary schools in a rural school district, (b) a community mental health (CMH) center in Southeastern Ohio, (c) a University Psychology and Social Work Clinic, (d) a university faculty and staff listserv and (e) an afterschool program. Children diagnosed with a Pervasive Developmental Disorder, Mental Retardation, Adjustment Disorder or significant language deficits were excluded. The age range was restricted to children in grades 3, 4, and 5 for the companion study because the primary self-perception assessment tool used in the companion study (Self-Perception Profile for Children) was normed on this age range. However, the participants for the current study ranged from grades 3 to 6 due to the delay in testing children after their initial participation in the companion study. Participants in the companion study who
provided written consent for future contact (see Appendix A) were pursued as participants in the current study (see Appendix F for Recruitment Flow Chart and Appendix G for Group Classification Procedures and a description of the sample relative to the companion study).

Of the 110 children who participated in the full companion study protocol, 65 participated in the current study. The remaining 45 did not participate either because they did not consent to future contact, were unreachable or declined to participate. Further, one child who presented with conflicting data regarding diagnostic status (e.g., on stimulant medication, but did not meet clinical criteria for ADHD) was removed from the final analyses, thus resulting in a total of 64 participants in the current study. Consistent with group classification procedures from the companion study, participants were assigned to either an ADHD group (ADHD) or a non-ADHD CTL group (CTL). See Appendix G for Group Classification procedures. Of note, a 12-hour medication hiatus for children on stimulant medication was implemented prior to participation in the current study (See Procedures section).

Final group assignment resulted in 34 children assigned to the ADHD group (20 males; 14 females) and 30 children assigned to the CTL group (15 males; 15 females). See Table 1 for participant characteristics by group.

Measures

Although all of the measures described below were utilized in the current project, many of the measures were completed in the context of the previously-mentioned companion study (see Table 2 for a list of measures administered in each study).
Measures Administered in the Companion Study

Self-Perception Profile for Children (SPPC). The Self-Perception Profile for Children (SPPC; Harter, 1985) is a revision to the Perceived Competence Scale for Children (Harter, 1982). The SPPC contains six separate subscales that measure scholastic competence, social acceptance, athletic competence, physical appearance, behavioral conduct, and global self-worth. Subscale scores are derived by averaging the six items in each subscale; higher scores indicate higher perceived competence. Previous studies reveal internal reliabilities that range from .71 to .86 across subscales (Harter, 1985; Owens & Hoza, 2003; Hoza et al., 2004). Internal reliability for the present sample ranged from .75 to .83. Factor loadings in a sample of 5th and 6th grader range from .59 to .67 on the scholastic competence subscale, .41 to .70 on the social acceptance subscale and from .36 to .82 on the behavioral conduct scale (Harter, 1985), with no “cross-loadings” greater than .18. In the current study, this measure was used to create three self-perception discrepancy scores (e.g., scholastic, social, behavior conduct) in accordance with methods used in previous studies (i.e., child score minus teacher score). The child-teacher discrepancy scores are used in hypothesis 3.

Wechsler Abbreviated Scale of Intelligence (WASI). The Wechsler Abbreviated Scale of Intelligence (WASI) was developed to provide a short and reliable estimate of intelligence (Wechsler, 1991). The WASI is designed for use with individuals ranging from 6 to 89 years. An estimate of general intellectual ability can be obtained by using a two-subtest form (FSIQ-2) including the vocabulary and matrix reasoning subtests. The two-subtest form shows adequate reliability for children between the ages of 7 to 11 years, with internal consistency coefficients for vocabulary ranging from .86 to .92 and
matrix reasoning ranging from .98 to .94 (WASI, 1999). The correlation coefficient between the 2-subtest WASI FSIQ and the WISC-IV full scale IQ is .83 (Homack & Reynolds, 2007). This measure was used as a covariate in Hypotheses 1, 2 and 3.

Demographic Questionnaire. A demographic questionnaire was completed by a parent of each participant in order to obtain sample characteristics. Specific sample characteristics of interest include information on the child such as age, gender, ethnicity, grade level, previous grade-retention, current diagnoses, medication status, as well as occupation and education level of the parent. Questions regarding the parents were used to assess socioeconomic status using the Hollingshead method (Hollingshead, 1975).

Disruptive Behavior Disorder Rating Scale (DBD). The DBD was completed by parents and teachers of participants. The DBD consists of 45 DSM-IV-TR criteria items that assess for the presence and severity of ADHD, oppositional defiant disorder (ODD), and conduct disorder (CD). There are four subscales that assess for symptoms of inattention, hyperactivity/impulsivity, ODD, and CD, with subscale scores determined by computing the average of the items that load onto each subscale. Scale items are rated on a 4-point scale ranging from 0 (“not at all” present) to 3 (“very much” present). Higher scores on each subscale indicate more severe symptoms. Tests of reliability indicated internal consistency scores for ADHD, ODD, and CD of .96, .95, and .75, respectively (Pelham et al., 1992). Additionally, DuPaul and colleagues (1998) revealed that this measure displayed adequate convergent validity when compared to classroom observations of distractibility, fidgeting, and academic accuracy. Internal reliability for the present sample ranged from .83 to .96 (parent) and .95 to .96 (teacher). This measure contributed to the determination of diagnostic group status.
**Parent and Teacher Impairment Rating Scale (IRS).** The IRS was completed by both parents and teachers and is a measure that assesses the perceptions of adults regarding child impairment across a variety of domains (e.g., peer relationships, sibling relationships, relationships with adults, family functioning, academic progress, self-esteem) as well as globally. Higher scores indicate greater levels of impairment in that domain. The IRS correlates with multiple measures of impairment, with correlations ranging from 0.36 to .70 (Fabiano, Pelham, Waschbusch, Gnagy, Lahey, & Chronis, 2006). Scores of 3 or higher have strong predictive validity when identifying children with ADHD (Fabiano et al., 2006). This measure contributed to the determination of diagnostic group status.

**Teacher Rating Scale of Child’s Actual Behavior.** The Teacher Rating Scale of Child’s Actual Behavior is the teacher parallel to the SPPC (Harter, 1985). This measure assesses teacher’s perceptions of a child’s competency in scholastic competence, social acceptance, athletic competence, physical appearance, and behavioral conduct domains. Subscale scores are derived by averaging the six items in each subscale; higher score indicate higher perceived competence. Internal consistency estimates are adequate, ranging from .82 to .95 for the subscales (Harter, 1985). The internal consistency for the present sample ranged from .91 to .95. Validity data is not provided by Harter (1985). However, Evangelista et al. (2008) found that the behavioral conduct subscale was adequately correlated to the ADHD ($r = -.58$) and the ODD ($r = -.53$) subscales of the teacher DBD Rating Scale. In the current study, this measure was used to create three self-perception discrepancy scores (e.g., scholastic, social, behavior conduct) in
accordance with methods used in previous studies (i.e., child score minus teacher score).
The child-teacher discrepancy scores are used in hypothesis 3 of the current study.

*Children’s Interview for Psychiatric Syndromes – Parent Version (P-ChiPS).* The P-ChiPS is a structured parent interview. The full version of the P-ChiPS screens for 20 different disorders based on DSM-IV-TR (American Psychological Association) criteria. In the companion study, only the disruptive behavior disorders (i.e., ADHD, ODD, CD) and mood disorders sections (i.e., depression/dysthymia, mania/hypomania) were administered. Scores contributed to the determination of diagnostic group status.

*Measures Administered in the Current Study*

*Children’s Depression Inventory (CDI).* The Children’s Depression Inventory (CDI) is a 27-item self-report test used to assess depression in children and adolescents between the ages of 6 and 17 (Kovacs, 1992). Each item is scored on a 3-point scale. The CDI contains five subscales including negative mood, interpersonal problems, ineffectiveness, anhedonia and negative self-esteem and these subscales also load onto a Total CDI score. Higher scores indicate more severe depression and scores are transformed into t-scores based upon age and gender. The Total CDI t-score was utilized in the present study’s analyses. The CDI has adequate reliability (e.g., internal consistency ranges from .71 to .89). Internal consistency for the Total CDI t-score in the current sample was .77.

*Mazes.* At the end of the assessment session, participants completed five “easy” mazes and five “impossible” mazes that the principal investigator constructed. The easy mazes were modeled after a maze activity for children much younger than those participating in the current study (e.g., based upon mazes from WPPSI-R). The
impossible mazes were constructed by copying difficult mazes with only one possible completion path and then creating a barrier approximately half-way through the path. Half of the participants completed all five easy mazes first and half of the participants completed all five impossible mazes first. Additionally, participants were only allotted one minute per maze in order to eliminate the likelihood that they would suspect that the impossible mazes were, in fact, impossible. A post-task question was administered after the five easy mazes (see Appendix C7) as well as the five impossible mazes (see Appendix C8). The purpose of including the mazes was to administer a task where the comparison criterion could be held constant and thus provide more confidence that if positive illusions were detected, it was because of the true phenomenon and not just mathematical likelihood.

*Measures of Inhibition (Current Study)*

*Stop-Signal Task.* The Stop-Signal Task is a computerized task that measures response inhibition. Participants were instructed to press a specific key when they saw an “X” on the screen and to press another key when they saw an “O” on the screen. They were instructed to do this as quickly as possible. Participants were also instructed to refrain from pressing the key if they heard a brief tone immediately following the presentation of the “X” or “O” stimuli. On approximately 25% of the trials, the participant heard the brief tone; future presentations of the tone were determined based upon the participant’s ability to inhibit his or her response on the previous inhibition trial. The primary dependent variable of interest for this task is Stop Signal Reaction Time (SSRT), which is an estimate of the latency (e.g., time delay between the initiation of the stimulus and the participant’s response) of the inhibitory process. SSRT indicates the
probability of inhibition given a signal. Longer SSRTs indicate increased difficulty with inhibition. The stop-signal task has been incorporated in a number of studies, revealing adequate ability for this task to distinguish between individuals with ADHD and controls (Nigg et al., 2006; Oosterlaan et al., 1998; Schachar et al., 2000).

**D-KEFS Color-Word Interference Test.** The Delis-Kaplan Executive Function System (D-KEFS) Color-Word Interference Test measures response inhibition and interference control. It has four conditions (i.e., exposed to color only and names color; reads color word printed in black ink; names the ink color of a color word; switches back and forth from reading the word printed in colored ink and naming the color of the ink). Internal consistency values for the current subtest among 8, 9, 10, and 11 year-olds were .79, .72, .73, and .72, respectively (Delis, Kaplan, & Kramer, 2001). Both test-retest reliability and internal consistency coefficients for the current task yield adequate results (i.e., .70-.79) (Strauss, Sherman, & Spreen, 2006). Because the third condition described above is similar to the Stroop task, a classic task of EF and inhibition where a person must inhibit reading a word and instead name the color of the ink in which the word is written, performance on condition three is the dependent variable used in the current study. Raw scores on this measure are converted to age-scaled scores, with a mean of 10 and a standard deviation of 3.

**Measures of Working Memory (Current Study)**

**Digit Span.** The Digit span subtest from the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) was utilized as a test of verbal working memory. During the Digit Span subtest, participants were instructed to listen to a sequence of numbers and are instructed to recite the chain as accurately as possible. There are two
parts to this subtest: Digit Span Forward and Digit Span Backward (i.e., child asked to repeat numbers in reverse sequence). Convergent and divergent validity are evidenced by high correlation with the Working Memory Index \( r = .86 \), moderate correlations with Full Scale IQ \( r = .62 \) and low correlations with the Verbal Comprehension Index \( r = .44 \), the Perceptual Reasoning Index \( r = .42 \), and the Processing Speed Index \( r = .30 \); Sattler & Dumont, 2004). For the current study, the total scaled score was utilized for analysis. The total raw score on this measure (e.g., score for Digit Span Forward plus score for Digit Span Backward) is converted to an age-scaled score, with a mean of 10 and a standard deviation of 3.

**Stanford-Binet Spatial Working Memory Test.** The Stanford-Binet Spatial Working Memory Test was utilized as a test of nonverbal working memory. Participants were instructed to perform a sequence of movements utilizing small blocks. As the subtest advances, the participant must sort out (in memory) the sequence of “taps” which are occurring on blocks across two different colored strips. Reliability coefficients for children aged 8, 9, 10, and 11 on non-verbal working memory were .83, .85, .81, and .82, respectively (Roid, 2003). The dependent variable of interest in the current study is the nonverbal Working Memory scaled score. This measure provides an age-scaled score with a mean of 10 and a standard deviation of 3.

**Measures of Planning (Current Study)**

**D-KEFS Tower Test.** The D-KEFS Tower Test was utilized as a measure of planning. This task involves moving five disks over three pegs in order to build a tower. The goal is to build the tower in the fewest moves possible. This task is believed to assess planning, rule learning, and inhibition (Strauss et al., 2006). Although this task currently
provides only marginal (.60-.69) internal consistency and low (≤ .59) test-retest reliability (Strauss et al., 2006), a decision was made to include this measure as a test of planning due to the limited number of planning measures available with age-scaled scores for use with children. The primary dependent variable of interest is the total achievement scaled score as this provides a “global measure of overall performance” (Delis et al., 2001). The total raw score on this measure is converted to an age-scaled score, with a mean of 10 and a standard deviation of 3.

**D-KEFS Sorting Test.** Although the Wisconsin Card Sorting Test (WCST) is considered the “prototypical EF task in neuropsychology” (Pennington & Ozonoff, 1996), its limited normative data for children was problematic for the current study. Therefore, the Delis-Kaplan Executive Function System (D-KEFS) Sorting Test was utilized as a second test of planning. The Sorting Test is similar to the WCST and consists of a Free Sorting condition and a Sort Recognition condition. In the Free Sorting condition, the participant must sort six cards into two groups (i.e., three cards per group) according to as many different themes as possible. In the Sort Recognition condition, the examiner must sort the cards into groups and the participant must explain the sorting rule that was utilized. Internal consistency was assessed by correlating card set 1 and card set 2. Correlation coefficients for 8 to 11 year-olds fall between .59 and .80 for the Free Sorting condition (condition 1), between .62 and .77 for the Free Sorting Description condition (condition 2), and between .62 and .74 for the Sort Recognition Total (condition 2) (Delis et al., 2001). The primary variable of interest for the current study is the Sorting Test composite scaled score, as it is the score that offers the “best overall
measurement of performance on the D-KEFS Sorting Test” (Delis et al., 2001, p. 145). This age-scaled score has a mean of 10 and a standard deviation of 3.

Post-Task Questions

Following each neuropsychological task, post-task questions were verbally administered. Children were asked to rate on a 1 to 10 scale, how well they performed on each of the neuropsychological tasks. (See Appendix C.) These scores represented task-specific self-evaluations.

Procedure

The principal investigator conducted an individual assessment session that lasted approximately 1 ½ to 2 hours with each participant. Each participant was assessed in a quiet room located at either (a) the participant’s school or school district office, (b) a local church, (c) a local library, or (d) at the university clinic.

Research suggests that individuals with ADHD who are prescribed stimulant medication perform better on tests of executive functioning than individual with ADHD who do not take medication (Chow & Cummings, 2007; Pliszka, 2007; Seidman et al., 2006). As such, participants who were prescribed a central nervous system (CNS) stimulant medication (see Appendix E for a list of medications that are included in this class) were required to take a 12-hour stimulant hiatus prior to their participation in the current study. Parents of participants were given multiple options regarding scheduling, including scheduling a Saturday session or a session during the summer months to minimize the impact that the stimulant hiatus would have on their child’s academic performance/functioning. Nineteen children (56%) in the ADHD group were required to participate in the stimulant hiatus prior to their participation in the current study.
Although reminder telephone calls were provided for all of the parents of participants the
day before or the day of their child’s assessment session, this contact was also used to
remind parents of the importance of implementing medication hiatus procedures if
relevant. Additionally, the principal investigator questioned both parents and children
who were asked to follow medication hiatus procedure to ensure that this procedure had
occurred prior to the child’s participation in testing procedures.

At the start of the assessment session, the child’s parent(s) provided written informed
consent (See Appendix B1) and signed the form entitled “Ohio University Authorization
for the Use and Disclosure of Identifiable Health Information for Research Purposes”
(See Appendix B2) so that data from the companion study could be included in the
current study. Following receipt of the parent’s signature on these forms, child assent was
obtained (see Appendix B3).

During the assessment session, the principal investigator administered six
neuropsychological tests in a randomized, counterbalanced sequence, along with a post-
test question following each neuropsychological test. Following completion of the six
neuropsychological tests, participants completed an “easy” maze task and an
“impossible” maze task, with an additional post-test question associated with each set of
mazes. The order of the two maze tasks was also randomized. At the end of the session,
participants and their parents were debriefed and provided a Debriefing letter (see
Appendix D). Parents were compensated for their time with $15.00 and the child
participants were compensated for his/her time with a small toy. Additionally, a two to
three page summary report regarding the child’s performance on each of the
neuropsychological tests along with recommendations based upon their results was mailed to the participant’s parent(s) within three months of testing.

Results

**Hypothesis 1**

The first hypothesis focused on evaluating performance differences between the ADHD and CTL groups on six neuropsychological measures. To assess the effect of group status (ADHD, CTL) on children’s neuropsychological performance and to maximize the number of children in each group comparison, six ANCOVAs were conducted on the neuropsychological test results, with the WASI full-scale IQ serving as a covariate.

After accounting for IQ score, results revealed that the ADHD group performed significantly worse than the CTL group on four of the six neuropsychological measures: stop signal reaction time, $F(1,59) = 8.25, p < .01$; D-KEFS Color-Word test, $F(1,60) = 8.25, p = .001$; Stanford-Binet Working Memory test $F(1,61) = 5.00, p < .05$; D-KEFS Sorting test, $F(1,61) = 6.79, p = .01$. Group differences were nonsignificant on two of the six neuropsychological measures: Digit Span test $F(1,61) = .72, p = ns$; D-KEFS Tower test $F(1,61) = 2.60, p = ns$. Adjusted and unadjusted means and standard deviations for all neuropsychology test scores can be found in Table 4.

**Hypothesis 2**

To examine children’s’ self-perceptions compared to a criterion, z-scores were created for children’s’ scores on the six neuropsychological measures, as well as for their post-test self-evaluation scores on these measures. Means and standard deviations for the neuropsychological post-test scores can be found in Table 5. The standardized stop signal
reaction time score was reverse-coded to increase ease of interpretation. (Of note, a 
natural log transformation of stop signal reaction time was performed, but incorporation 
of the log transformed stop signal reaction time data did not change results. As such, 
results based on the untransformed data are reported below.) Six discrepancy scores were 
then calculated by subtracting the standardized test scores from the related standardized 
self-evaluation scores. Higher scores suggest higher overestimation of competence by the 
child. Means and standard deviations for all discrepancy scores can be found in Table 6.

Six T-tests were conducted to compare the two groups on discrepancy scores. T-
test results revealed that the ADHD group overestimated their performance significantly 
more than the CTL group on three of six neuropsychological measures: D-KEFS Color 
Word, $t = -2.93, p < .01$; Stanford-Binet Working Memory Test, $t = -3.09, p < .01$; D-
KEFS Sorting Test, $t = -2.33, p < .05$. Group differences were nonsignificant on three of 
the six self-perception scores: stop signal reaction time, $t = -1.85, p = \text{ns}$; Digit Span Test, 
$t = .66, p = \text{ns}$; D-KEFS Tower test, $t = -1.49, p = \text{ns}$. Results of t-tests can be found in 
Table 6 under the unadjusted means and standard deviations columns.

To remain consistent with past research, ANCOVAs were also conducted to 
control for child depression scores using scores from the Children’s’ Depression 
Inventory (CDI). Because the pattern of results did not change, these data are not 
reported.

To remain consistent with Hypothesis 1, ANCOVAs were also conducted using 
IQ as a covariate. Results remained consistent with t-tests, with the exception of the self-
perception discrepancy score for the D-KEFS Sorting task, which was no longer 
significant. Results of ANCOVA analyses are reported in Table 6 (see adjusted means).
Two independent samples t-tests were also conducted to assess self-perception differences between the ADHD and CTL group regarding the easy maze task and the impossible maze task. Because all participants successfully completed the easy maze task, all participants received a score of 10 regarding their actual performance. Additionally, because no participant could complete the impossible maze task, all participants received a score of 1 regarding their actual performance. Since all participants received the same scores regarding their actual performance on these two tasks, standardizing their responses and subtracting them from their predicted performance was unnecessary (i.e., standardized performance score would be 0 for everyone, with the product being the original predicted score). As such, direct comparison need only to occur between the groups’ predicted performance scores. The t-test assessing predicted scores on the easy maze task revealed no significant differences between the ADHD group and the CTL group, t(62) = .56, p = ns. Similarly, the t-test assessing predicted scores on the impossible maze task indicated that the ADHD group and CTL groups did not differ significantly, t(62) = -1.44, p = ns. The trend in the data suggests that children with ADHD had a tendency to endorse higher post-task performance scores than did control children; however, the power to detect this difference was limited (power = .32). Means and standard deviations of the prediction scores for the easy and impossible mazes can be found in Table 7.

Hypothesis 3

Harter SPPC Discrepancy Scores. In order to examine the relative contribution of EF performance in the PIB, a composite EF score was created, by averaging the standardized scores of the six neuropsychological measures (Note: the reverse-coded
SSRT score was utilized in this calculation). The reliability analysis of this composite score revealed a Cronbach’s Alpha of .72. Item-total statistics indicated that removal of any of the neuropsychological tests would not increase reliability; thus, all standardized neuropsychological variables were included in the EF composite score.

Three discrepancy scores were then calculated. To obtain the Harter discrepancy scores, the teacher and child Harter scores were standardized and then the child score was subtracted from the teacher score. Hierarchical multiple regressions were conducted in order to examine the amount of variance that ADHD symptoms (based upon a combination of DBD and P-CHIP interview symptom count), EF (composite score), and their interaction account for regarding the Harter self-perception discrepancy scores (e.g., scholastic, social, behavioral). Means and standard deviations for the Harter SPPC absolute self-perception scores can be found in Table 8. Means and standard deviations for the Harter SPPC discrepancy scores can be found in Table 9.

Consistent with previous literature, depression was entered on the first step, the EF composite score and ADHD symptoms were entered on the second step, and the interaction of the EF composite score and ADHD symptoms was entered on the third step of each model. Prior to computing the ADHD and EF interaction, predictors were standardized to minimize multicollinearity.

For the scholastic discrepancy score, ADHD symptoms ($\beta = -.03$, $p = \text{ns}$) and the interaction ($\beta = -.16$, $p = \text{ns}$) were not significant predictors. However, both depressive symptoms ($\beta = -.37$, $p < .01$) and EF ($\beta = -.42$, $p < .01$) were significant predictors. The betas suggest that lower levels of depression and lower levels of EF were associated with greater overestimation in the child’s scholastic self-evaluation discrepancy score.
For the social discrepancy score, none of the variables were significant predictors of self-perception discrepancy scores: depression symptoms ($\beta = -.15$, $p = \text{ns}$), ADHD symptoms ($\beta = .22$, $p = \text{ns}$), EF ($\beta = -.17$, $p = \text{ns}$), and the interaction ($\beta = .03$, $p = \text{ns}$).

Lastly, for the behavioral conduct discrepancy score, EF ($\beta = -.14$, $p = \text{ns}$) and the interaction ($\beta = -.13$, $p = \text{ns}$) were not significant predictors. However, both depressive symptoms ($\beta = -.30$, $p < .01$) and ADHD symptoms ($\beta = .29$, $p < .05$) were significant predictors. The beta suggests that lower levels of depression and higher levels of ADHD symptomatology were associated with greater overestimation in the child’s self-evaluation discrepancy score. See Table 10 for information regarding regression analyses utilizing the Harter self-perception discrepancy scores.

*Task-Specific Self-Perception Scores.* Six hierarchical multiple regressions exploring task-specific self-perceptions were also conducted. To obtain the task-specific discrepancy scores, the neuropsychological performance scores and the post-task prediction scores were standardized. Then, the neuropsychological score was subtracted from the post-task prediction score. Hierarchical multiple regressions were conducted in order to examine the amount of variance that ADHD symptoms, EF, and their interaction account for regarding the task-specific self-perception discrepancy scores. However, because the EF composite score could not be utilized (i.e., cannot include a variable as a predictor that is also utilized in computing the dependent variable), a decision was made to create six different EF composite scores. Each of these composite scores excluded the EF score that was utilized in calculating the dependent variable of interest (i.e., for the discrepancy score examining self-perception on the stop-signal task, the stop signal score was not included when calculating the EF composite score, etc.).
Depression was entered on the first step, EF composite score and ADHD symptoms were entered on the second step, and the interaction of the EF composite score and ADHD symptoms was entered on the third step of each hierarchical multiple regression. Prior to computing the EF composite scores and their interaction with ADHD symptoms, predictors were standardized to minimize multicollinearity.

For the regression analyses that utilized Stop Signal Reaction Time (Stop-Signal Task), none of the factors were significant predictors of self-perception discrepancy scores (see Table 11 for betas).

Similarly for the other five regression models (e.g., D-KEFS Color Word, Digit Span, Stanford-Binet Working Memory, D-KEFS Tower, D-KEFS Sorting), depressive symptoms, ADHD symptoms, and the interaction were not significant predictors of self-perception discrepancy scores. However, EF was a significant predictor in all five of these regression models. Specifically, regression analyses revealed that EF was a significant predictor on task-specific discrepancy scores examining the Color-Word task ($\beta = -.55, p \leq .001$), the Digit Span task ($\beta = -.41, p \leq .001$), the Stanford-Binet Working Memory task ($\beta = -.37, p \leq .001$), the D-KEFS Tower task ($\beta = -.49, p \leq .001$) and the D-KEFS Sorting task ($\beta = -.29, p \leq .05$). The betas suggest that higher levels of EF were associated with less overestimation in the child’s self-evaluation discrepancy score. See Table 11 for information regarding regression analyses utilizing the task-specific EF self-perception discrepancy scores.

Discussion

This is the first study to directly examine the relationship between EF performance and the PIB in children with ADHD. Consistent with previous studies,
group differences in EF and overestimations of competence were found. The implications of these findings as well as the role of EF in explaining the PIB are discussed below.

Children with ADHD have consistently displayed deficits in EF compared to controls. These group differences have been reliably substantiated in domains such as behavioral inhibition (Barkley, 1997; Frazier et al., 2004; Oosterlaan et al., 1998; Pennington, 1997; Preston et al., 2005; Schacher et al., 1993; Seidman, 2006; Sergeant et al., 2002; Willcutt et al., 2005), working memory (Barkley, 1997; Martinussen, et al., 2005; Nigg, 2006; Pennington, 1997; Sergeant et al., 2002: Willcutt et al., 2005) and planning (Pennington, 1997; Willcutt et al., 2005).

In the current study, it was hypothesized that the ADHD group would perform significantly worse on all six EF measures compared to the CTL group. As expected, the ADHD group performed significantly worse than the CTL group on four of six measures of EF, even after controlling for IQ. The nonsignificant group difference on the Digit Span subtest measure was surprising, given that working memory deficits in children with ADHD have been well-documented (e.g., Martinussen et al., 2005; Nigg, 2006; Sergeant et al., 2002; Willcutt et al., 2005). However, a recent meta-analysis that explored working memory deficits in children with ADHD revealed that this population displays greater impairment in nonverbal working memory tasks than in verbal working memory domains (Martinussen et al., 2005). Results from the current study support this pattern after controlling for IQ. Namely, a larger effect size was displayed regarding group differences on the Stanford-Binet Working Memory Task, a measure of nonverbal working memory (.81) than on Digit Span, a measure of verbal working memory (.38). The nonsignificant group difference on the Tower Task was less surprising, as the
domain of planning has not been as well-studied as other domains in children with ADHD and results are less consistent (Willcutt et al., 2005).

Of note, though controlling for IQ in studies of EF is controversial and often “methodologically tenuous “(Frazier et al., 2004, p. 552) a decision was made to control for IQ to provide a more conservative exploration of group differences and to better understand the differences in EF not accounted for by general IQ. After controlling for IQ, results revealed that the ADHD group still performed significantly worse than the CTL group on four of the six EF measures (e.g., stop signal reaction time, D-KEFS Color-Word test, Stanford-Binet Working Memory test, D-KEFS Sorting test).

These results advance the literature by demonstrating significant group differences after controlling for IQ. Indeed, a comprehensive meta-analysis that included 123 studies found that only a few of the studies demonstrated that group differences on EF were above and beyond differences accounted for by IQ. To the author’s knowledge, this is the first study to measure ADHD and non-ADHD group differences on tasks of inhibition, working memory and planning while controlling for IQ and while simultaneously requiring a stimulant medication hiatus. It is likely that both the medication hiatus procedures and the use of a multi-method, multi-informant process to determine diagnostic status contributed to the robust effects found in the current study. Previous research suggests that when studies control for medication use or require a medication hiatus of participants, much larger ADHD and CTL group differences tend to be found (Losier et al., 1996; Martinussen et al., 2005). Similarly, differences between ADHD and CTL groups on IQ tend to be larger in studies that recruit clinical samples through strict diagnostic criteria (Frazier, et al., 2004).
In order to examine the role of EF deficits in the PIB, it was necessary to establish a wide range of EF performance within the current sample; requiring a medication hiatus maximized this opportunity. Because EF deficits were present in the ADHD group, information can be gleaned regarding the relationship between these deficits and this population’s tendency to inflate their reports of their perceived performance relative to actual performance. Neuropsychological literature provides evidence that EF deficits are associated with inaccurate perceptions of self, but not others, in patients with frontal lobe damage (Samango-Sprouse, 2007). Consequently, it has been hypothesized that this same phenomenon may be an underlying mechanism for the PIB in children with ADHD.

**Task-Specific Discrepancy Scores**

In support of the PIB, it was hypothesized that children with ADHD would overestimate their performance on EF tasks significantly more than control children. This hypothesis was partially supported by analyses revealing that children with ADHD overestimated their performance more than controls on three of six task-specific self-perception discrepancy scores. This partial replication of the PIB indicates that although children with ADHD are performing significantly worse on the majority of the EF tasks, they are either unaware of their impairment or are not acknowledging their impairment.

If they are not aware of their impairment, it is possible that a number of underlying mechanisms may be implicated. Specifically, Owens and colleagues (2007) discuss three hypotheses that may contribute to a lack of awareness of ones’ deficits (e.g., EF, cognitive immaturity, ignorance of incompetence). However, if children with ADHD are aware of their deficits, but are not acknowledging them or are attempting to mask them, the self-protective hypothesis may be a better explanation for the PIB. Although
this study did not directly examine self-protection, the pattern of significance across these tests and domains may help to elucidate the possible underlying mechanisms further.

First, the pattern of significance across tests and within each domain was interesting. Namely within each EF domain, prior to controlling for IQ, group differences were found on one, but not both of the tests within each domain. More specifically, significant group differences were found on one test of inhibition (i.e., D-KEFS Color Word), but not the other (i.e., Stop Signal), on one test of working memory (i.e., Stanford-Binet Working Memory), but not the other, (i.e., Digit Span), and on one test of planning (i.e., D-KEFS Sorting Test), but not the other (i.e., D-KEFS Tower test).

This pattern suggests that overestimation does not seem to be more likely within any one type of EF task. Instead, the pattern that emerged may have to do with the nature of the task and the participants’ evaluation skills related to the task. Although no verbal feedback was provided, it is possible that feedback may have been more salient in the three measures where group differences were not found. For example, on the Tower Task, children can visually compare their tower to a picture to determine if they accomplished their goal; this may provide them with salient feedback. If the ADHD and CTL group differences are simply due to the ADHD group requiring more feedback to make accurate evaluations of self, results would not support the EF hypothesis. However, this interpretation is unlikely, given that the PIB has been found across domains where feedback is both direct and salient (e.g., academic) and subtle (e.g., social), and that a preliminary study demonstrated that direct and explicit feedback (i.e., via an intensive point system in the Summer Treatment Program) does not appear to modify the PIB (Hoza et al., 2009).
An alternative explanation is that inaccurate self-evaluations are pervasive across all six EF tasks. Indeed, the pattern of results was the same for five of the six task-specific discrepancy scores; however, there was limited power to detect group differences on some of the measures. More specifically, the ADHD group displayed a tendency to overestimate their competence (with the exception of Digit Span) while the non-ADHD group displayed a tendency to underestimate their competence (with the exception of Digit Span). Regarding the two discrepancy scores where this pattern was present but where significant group differences were not established (e.g., Stop-Signal, D-KEFS Tower), the power to correctly detect significant differences was low (e.g., .44, .32 respectively).

Post-task prediction scores were administered following an “easy” maze task and an “impossible” maze task. It was important to include tasks in the current study that did not assess EF and on which the ADHD group should not be significantly more impaired than the CTL group. The goal of including the maze task was to administer a task where the comparison criterion could be held constant and thus provide more confidence that if positive illusions were detected, it was because of the true phenomenon and not just mathematical likelihood. There were no significant group differences on either of the post-task prediction scores related to the mazes (i.e., no positive illusions). However, this does not necessarily indicate that the PIB is simply due to an increased “mathematical likelihood” within the current sample. First, it appears that the “easy” maze task may have been too easy, as the means of the ADHD and CTL groups on the post-task prediction measure were 9.8 and 9.9 out of 10, respectively. Additionally, although the “impossible” maze task revealed no significant group difference, these results may have
been influenced by the wording of the post-task prediction question (e.g., “How good were you at completing the last five mazes”). Use of more ambiguous language may have increased the likelihood of finding significant group differences (e.g., “How good did you do on the last five mazes?”). Additionally, although results revealed that children with ADHD had a tendency to endorse a higher post-task performance score on the impossible mazes than children without ADHD, results did not reach a level of significance. However, the current analysis displayed limited power to accurately detect a difference on this comparison (power = .29).

Contributions of Executive Functioning in Predicting the PIB

The relative contributions of depression, EF performance and ADHD symptoms in the self-perceptions of participants were examined by using both traditional SPPC discrepancy scores as well as task-specific discrepancy scores.

In the SPPC scholastic domain, depression ($\beta = -.37$, $p < .01$) and the composite EF score ($\beta = -.42$, $p < .01$) were significant predictors of the self-perception discrepancy score, whereas ADHD symptoms and the interaction were not significant predictors. These results may indicate a lack of awareness of ones deficits, or agnosognosia. However, this trend was not displayed in the SPPC social or behavioral conduct domains.

In the SPPC social domain, no variables (e.g., depression, EF, ADHD symptoms, interaction) were significant predictors of the self-perception discrepancy score. However, in the SPCC behavioral conduct domain, depression ($\beta = -.30$, $p < .05$) and ADHD symptoms ($\beta = .29$, $p < .05$) were significant predictors of the self-perception discrepancy score while EF and the interaction were not significant predictors. Given that ADHD symptoms, but not EF, was found to be a significant predictor of self-perception
discrepancy score in this domain, this may be the first evidence of weakened support for the EF hypothesis. More specifically, agnosognosia is typically viewed as a broad impairment in self-evaluation and is not specific to one domain; thus, for children with ADHD to display mild agnosognosia, we would expect EF impairment across all domains of evaluation.

Although the EF hypothesis does not appear to be a viable explanation regarding the SPPC behavioral conduct discrepancy score, results of the task-specific regression analyses provide further support for this hypothesis. Regression analyses revealed the presence of significant predictors on five of the six task-specific self-perception measures. Specifically, EF score was a significant predictor of the D-KEFS Color Word ($\beta = -.55$, $p < .001$), Digit Span ($\beta = -.41$, $p < .001$), Stanford-Binet Working Memory ($\beta = -.37$, $p < .001$), D-KEFS Tower ($\beta = -.49$, $p < .001$) and D-KEFS Sorting ($\beta = -.29$, $p < .05$) discrepancy scores. These betas suggest that higher levels of EF were associated with decreases in the overestimation of competence and that lower levels of EF were associated with increases in overestimation of competence (i.e., positive illusions).

Taken together, the results of the study revealed a number of interesting results. First, it appears that depression may influence general self-perception scores more heavily than task-specific self-perception scores. Unlike results of the SPPC discrepancy scores, depression was not a significant predictor in any of the task-specific self-perception scores. Multiple studies have revealed that depression significantly impacts the self-perceptions of children with ADHD on the SPPC (Owens et al., 2007). Hence, there seems to be strong evidence that depression impacts children’s perceptions of competence in a given broad domain (e.g., scholastic, social, behavioral conduct) but not
on a novel task that children may perceive as unrelated to past performance. Because depression appears to account for such a large amount of variance in children’s self-perceptions, it is critical to include a measure of depression when evaluating the self-perceptions of children with ADHD due to the likelihood of co-morbid mood problems.

Unlike past studies (Evangelista, 2009; Hoza et al., 2004; Hoza et al., 2002), ADHD symptoms did not account for a significant amount of variance in Harter SPPC discrepancy scores, with the exception of the Behavioral Conduct domain. Examination of task-specific self-perception discrepancy scores also revealed an absence of ADHD symptoms as a significant predictor. In sum, it appears that EF score was a stronger predictor (i.e., accounted for the most variance) across the SPPC discrepancy scores and task-specific self-perception discrepancy scores than ADHD symptomatology, thus providing preliminary evidence that EF performance may indeed be implicated in the PIB.

Although the goal of the current study was to explore the plausibility of the EF hypothesis in the PIB, results also implicate other potential hypotheses. One theory, the ignorance of incompetence hypothesis, suggests that individuals who are incompetent in a specific domain tend to overestimate their competence in that domain. In other words, because they are lacking the necessary skills to adequately perform in a given domain, they are also lacking the necessary skills to evaluate their performance in the domain (Kruger & Dunning, 1999). Another theory, the self-protective hypothesis, suggests that children with ADHD are indeed aware of their deficits but “self-protect” by bolstering their rating of perceived competence on a given task. However, the administration of novel, nonacademic neuropsychological tasks in the current study would likely decrease
the need for these children to inflate their evaluations, yet the PIB was still displayed on three of the six tasks prior to controlling for IQ. Additionally, acknowledgement is made that the pattern of self-perceptions displayed in the current sample may be related to the ignorance of incompetence phenomenon. However, past studies exploring self-protection reveal that scores in the ADHD group tend to decrease following positive feedback, which is inconsistent with the ignorance of incompetence hypothesis.

Limitations and Future Directions

Although this study was the first to directly examine the relationship between EF and the PIB, it is not without limitations. First, although the sample size of the current study was respectable, some analyses were limited regarding their power to detect the effect. Additionally, there are inherent challenges and limitations regarding working with discrepancy scores (Edwards, 2001; Zuckerman & Knee, 1996) even though this approach is currently the standard in the field regarding the PIB (Owens et al., 2007). Additionally, although both girls and boys were well-represented in the ADHD and CTL groups, there was limited racial diversity within the sample. Future studies should strive to ensure a more comprehensive exploration of the PIB by recruiting a more diverse sample. Finally, although an attempt was made to recruit children for the current sample who met criteria for different subtypes of ADHD, subtype analyses could not occur due to the limited number of children who met criteria for ADHD inattentive-type in the current study. Only one study (Owens & Hoza, 2003) has explored the effect of subtype on the self-perceptions of children with ADHD. More information is needed regarding the influence that subtype may have on this phenomenon.
Owens and colleagues (2007) noted that “simply identifying the existence of the PIB is not enough” and that “research in this area must strive to understand the underlying mechanism or function of the bias” (p. 337). Future research on the PIB should continue to explore the underlying mechanism of this phenomenon. Although there are a number of hypothesized mechanisms for the PIB (e.g., cognitive immaturity, self-protection, EF, ignorance of incompetence), it appears that these mechanisms may not be mutually exclusive. More specifically, it appears that different sample characteristics related to these mechanisms may help to account for the “presence” of these mechanisms. As such, future research should examine not just which mechanism displays the most utility in the PIB, but what mechanisms appear to be present under what specific circumstances.

Conclusions

This is the first study to directly examine the relationship between EF performance and the PIB in children with ADHD. The results provide additional support for the presence of the PIB in children with ADHD by using task-specific, self-evaluation ratings following completion of EF tasks. The current study also explored the relative roles of EF and ADHD symptomatology in explaining the PIB in task-specific discrepancy scores, as well as in more traditionally utilized self-perception scores (e.g., Harter SPPC).

Results of the current study provide preliminary evidence that EF may influence the self-perceptions of children with ADHD. Specifically, higher EF was found to be related to lower overestimation of competence in one broad domain (e.g., SPPC Scholastic) and a number of task-specific domains. However, nonsignificant results were
found when exploring group differences across a number of the self-perception measures, suggesting that positive illusory self-perceptions may be accounted for by another mechanism, or by another mechanism in addition to EF performance.
Table 1

**Descriptive Characteristics of Participants by Group**

<table>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n = 30</td>
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</tr>
<tr>
<td>Age (M, SD)</td>
<td>10.27 (1.11)</td>
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<td>Gender (% Male)</td>
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<td>20 (58.8%)</td>
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<tr>
<td>Race</td>
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<tr>
<td>Biracial</td>
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<td>1 (2.9%)</td>
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<tr>
<td>Amer. Indian/Alaskan Native</td>
<td>0 (0%)</td>
<td>2 (5.9%)</td>
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<tr>
<td>Home (% in Two Parent Home)</td>
<td>25 (83.3 %)</td>
<td>25 (73.5 %)</td>
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<tr>
<td>SES (M, SD)**</td>
<td>38.18 (13.64)</td>
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<td>Prescribed Medication for ADHD***</td>
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<tr>
<td>Repeated a Grade*</td>
<td>1 (3.33%)</td>
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<tr>
<td>WASI FSIQ (M, SD)**</td>
<td>101.43 (15.96)</td>
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<td>Depression Score (CDI)</td>
<td>46.07 (7.54)</td>
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<td>DBD Hyper/Impulsivity Count***</td>
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<td>PChIPS Hyper/Impulsive Count***</td>
<td>1.03 (1.45)</td>
<td>6.73 (2.05)</td>
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*Note.* * Indicates variables for which there were significant group differences, $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$.
Table 1 (continued)

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<td>Graduate Training</td>
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*Note.* * Indicates variables for which there were significant group differences, $p \leq .05$, **$p \leq .01$, ***$p \leq .001$
Table 2

*Measures Administered in the Current Study and the Companion Study*

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<th>Current Study</th>
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<tr>
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<td></td>
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<td>P-ChiPS</td>
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<td>Demographic Questionnaire</td>
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<td>Stop Signal Task</td>
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<tr>
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<td>Digit Span (WISC-IV)</td>
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<td>Stanford-Binet Spatial WM Task</td>
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<td></td>
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<tr>
<td>D-KEFS Tower</td>
<td>Child</td>
<td>X</td>
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<tr>
<td>D-KEFS Sorting</td>
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<td>Mazes (Easy/Impossible)</td>
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*Note.* Two children in the ADHD were unable to complete the Stop-Signal Task due to computer problems; one child in the ADHD was unable to complete the Color-Word Task due to frustration with the task.
Table 3

Correlation Table

<table>
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<th>SSRT</th>
<th>CW</th>
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<th>WM</th>
<th>Tower</th>
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<td>-.18</td>
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</table>

* p ≤ .05, ** p ≤ .01; SES = Socioeconomic status; FSIQ = Full Scale IQ; SSRT = Stop signal reaction time; CW = D-KEFS Color-Word Task; DS = Digit Span; WM = Working Memory Task; Tower = D-KEFS Tower Task; Sort = D-KEFS Sorting Task; Dsrt = SSRT discrepancy score; DCW = CW discrepancy score; DDS = DS discrepancy score; DWM = WM discrepancy score; DTow = Tower discrepancy score; DSort = Sort discrepancy score
Table 3 (continued)

<table>
<thead>
<tr>
<th></th>
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<th>SSRT</th>
<th>CW</th>
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</tr>
<tr>
<td>DWM</td>
<td>-.17</td>
<td>-.36**</td>
<td>.17</td>
<td>-.24</td>
<td>-.20</td>
<td>-.76**</td>
<td>-.30*</td>
<td>-.52**</td>
<td>.21</td>
<td>.48**</td>
<td>.15</td>
<td>1</td>
<td>.31*</td>
<td>.46**</td>
</tr>
<tr>
<td>DTow</td>
<td>-.19</td>
<td>-.18</td>
<td>.17</td>
<td>-.28*</td>
<td>-.28*</td>
<td>-.15</td>
<td>-.58**</td>
<td>-.29*</td>
<td>.26*</td>
<td>.53**</td>
<td>.34**</td>
<td>.31*</td>
<td>1</td>
<td>.35**</td>
</tr>
<tr>
<td>DSort</td>
<td>-.25</td>
<td>-.33**</td>
<td>.21</td>
<td>-.40**</td>
<td>-.16</td>
<td>-.21</td>
<td>-.17</td>
<td>-.68**</td>
<td>.25*</td>
<td>.51**</td>
<td>.26*</td>
<td>.46**</td>
<td>.35**</td>
<td>1</td>
</tr>
</tbody>
</table>

* p ≤ .05, ** p ≤ .01; SES = Socioeconomic status; FSIQ = Full Scale IQ; SSRT = Stop signal reaction time; CW = D-KEFS Color-Word Task; DS = Digit Span; WM = Working Memory Task; Tower = D-KEFS Tower Task; Sort = D-KEFS Sorting Task; Dsrt = SSRT discrepancy score; DCW = CW discrepancy score; DDS = DS discrepancy score; DWM = WM discrepancy score; DTow = Tower discrepancy score; DSort = Sort discrepancy score
Table 4

Means and Standard Deviations for Neuropsychological Performance

<table>
<thead>
<tr>
<th>Neuropsychological Measure</th>
<th>ADHD</th>
<th>CTL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
</tr>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (Std. Error)</td>
</tr>
<tr>
<td>SSRT**</td>
<td>423.34 (167.12)</td>
<td>418.75 (25.03)</td>
</tr>
<tr>
<td>Color-Word***</td>
<td>7.70 (3.11)</td>
<td>7.87 (0.55)</td>
</tr>
<tr>
<td>Digit Span</td>
<td>8.06 (2.60)</td>
<td>8.24 (0.43)</td>
</tr>
<tr>
<td>Stanford-Binet WM*</td>
<td>7.53 (2.61)</td>
<td>7.85 (0.44)</td>
</tr>
<tr>
<td>Tower</td>
<td>9.21 (2.77)</td>
<td>9.33 (0.46)</td>
</tr>
<tr>
<td>Sorting**</td>
<td>6.15 (2.61)</td>
<td>6.55 (0.44)</td>
</tr>
</tbody>
</table>

Note. Higher scores indicate better performance, with the exception of the SSRT test where lower scores indicate better performance; * Adjusted means represent performance scores while controlling for IQ p ≤ .05, ** p ≤ .01, *** p ≤ .001.
Table 5

*Means and Standard Deviations for Neuropsychological Post-Task Evaluations*

<table>
<thead>
<tr>
<th>Post Task Question</th>
<th>ADHD</th>
<th></th>
<th>CTL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M (SD)</td>
<td>n</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Stop Sig. Reac. Time</td>
<td>33</td>
<td>7.06 (2.32)</td>
<td>30</td>
<td>7.33 (1.63)</td>
</tr>
<tr>
<td>Color-Word</td>
<td>34</td>
<td>6.41 (2.78)</td>
<td>30</td>
<td>6.47 (2.29)</td>
</tr>
<tr>
<td>Digit Span*</td>
<td>34</td>
<td>6.12 (2.46)</td>
<td>30</td>
<td>7.47 (1.48)</td>
</tr>
<tr>
<td>Stanford-Binet WM</td>
<td>34</td>
<td>7.91 (1.96)</td>
<td>30</td>
<td>7.27 (1.70)</td>
</tr>
<tr>
<td>Tower</td>
<td>34</td>
<td>7.68 (2.59)</td>
<td>30</td>
<td>7.87 (2.05)</td>
</tr>
<tr>
<td>Sorting</td>
<td>34</td>
<td>7.03 (1.99)</td>
<td>30</td>
<td>7.20 (2.27)</td>
</tr>
</tbody>
</table>

*Note.* ** Indicates variables for which there were significant group differences p ≤ .01
Table 6

Means and Standard Deviations for Discrepancy Scores by Group

<table>
<thead>
<tr>
<th>Neuropsychological Measure</th>
<th>ADHD Unadjusted M (SD)</th>
<th>ADHD Adjusted M (Std. Error)</th>
<th>CTL Unadjusted M (SD)</th>
<th>CTL Adjusted M (Std. Error)</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop Sig. Reac. Time</td>
<td>.33 (1.75)</td>
<td>.23 (.25)</td>
<td>-.33 (.95)</td>
<td>-.23 (.26)</td>
<td>.47</td>
</tr>
<tr>
<td>Color-Word*</td>
<td>.45 (1.40)</td>
<td>.34 (.21)</td>
<td>-.47 (1.03)</td>
<td>-.35 (.23)</td>
<td>.75</td>
</tr>
<tr>
<td>Digit Span</td>
<td>-.12 (1.70)</td>
<td>-.22 (.27)</td>
<td>.13 (1.31)</td>
<td>.25 (.28)</td>
<td>.17</td>
</tr>
<tr>
<td>Stanford-Binet WM*</td>
<td>.52 (1.42)</td>
<td>.40 (.24)</td>
<td>-.59 (1.43)</td>
<td>-.45 (.26)</td>
<td>.78</td>
</tr>
<tr>
<td>Tower</td>
<td>.20 (1.23)</td>
<td>.16 (.20)</td>
<td>-.23 (1.04)</td>
<td>-.19 (.22)</td>
<td>.38</td>
</tr>
<tr>
<td>Sorting^a</td>
<td>.36 (1.35)</td>
<td>.25 (.23)</td>
<td>-.41 (1.27)</td>
<td>-.28 (.24)</td>
<td>.59</td>
</tr>
</tbody>
</table>

Note. Higher difference scores indicate higher estimation of competence. * Adjusted means represent difference scores while controlling for IQ p ≤ .05; ^a significant while not controlling for IQ
<table>
<thead>
<tr>
<th></th>
<th>ADHD</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>N = 34</td>
<td>N = 30</td>
</tr>
<tr>
<td><strong>M (SD)</strong></td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Easy Maze</td>
<td>9.85 (.70)</td>
<td>9.93 (.37)</td>
</tr>
<tr>
<td>Impossible Maze</td>
<td>4.71 (2.74)</td>
<td>3.80 (2.23)</td>
</tr>
</tbody>
</table>
Table 8

Means and Standard Deviations for Harter SPPC Absolute Scores

<table>
<thead>
<tr>
<th>Subscale</th>
<th>ADHD</th>
<th>CTL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted M (SD)</td>
<td>Adjusted M (Std. Error)</td>
</tr>
<tr>
<td>Schol. Competence*</td>
<td>2.53 (.82)</td>
<td>2.58 (.11)</td>
</tr>
<tr>
<td>Social Acceptance</td>
<td>2.68 (.84)</td>
<td>2.72 (.12)</td>
</tr>
<tr>
<td>Behavior Conduct</td>
<td>2.89 (.73)</td>
<td>2.94 (.10)</td>
</tr>
</tbody>
</table>

Note. Adjusted means represent difference scores while controlling for depression,

*p ≤ .05.
Table 9

*Means and Standard Deviations for Harter SPPC Discrepancy Scores*

<table>
<thead>
<tr>
<th>SPPC Discrepancy</th>
<th>ADHD</th>
<th>CTL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 32</td>
<td>N = 29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Unadjusted</th>
<th>Adjusted</th>
<th>Unadjusted</th>
<th>Adjusted M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (Std. Error)</td>
<td>M (SD)</td>
<td>(Std. Error)</td>
</tr>
<tr>
<td>Scholastic Competence</td>
<td>.13 (.39)</td>
<td>.20 (.20)</td>
<td>-.21 (.97)</td>
<td>-.28 (.21)</td>
</tr>
<tr>
<td>Social Acceptance*</td>
<td>.17 (1.19)</td>
<td>.20 (.20)</td>
<td>-.36 (1.11)</td>
<td>-.39 (.21)</td>
</tr>
<tr>
<td>Behavior Conduct**</td>
<td>.32 (1.34)</td>
<td>.37 (.20)</td>
<td>-.38 (.94)</td>
<td>-.45 (.21)</td>
</tr>
</tbody>
</table>

*Note.* * Adjusted means represent difference scores while controlling for depression, *p* ≤ .05, ** *p* ≤ .01.
Table 10

*Statistics from Regression Analyses Predicting Broad Self-Perception Discrepancy Scores*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Scholastic Competence</th>
<th>Social Acceptance</th>
<th>Behavior Conduct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔR²</td>
<td>B</td>
<td>ΔR²</td>
</tr>
<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>.14**</td>
<td>-.37**</td>
<td>.02</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD</td>
<td>.15**</td>
<td>-.03</td>
<td>.11*</td>
</tr>
<tr>
<td>Exec. Function</td>
<td></td>
<td>-.42**</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>.03</td>
<td>-.16</td>
<td>.00</td>
</tr>
<tr>
<td>Total Adjusted R Square</td>
<td>.32</td>
<td></td>
<td>.13</td>
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</tbody>
</table>

*Note.* *p ≤ .05, **p ≤ .01
Table 11

Statistics from Regression Analyses Predicting Task-Specific Self-Perception Discrepancy Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Stop Signal Reaction Time</th>
<th>Color Word</th>
<th>Digit Span</th>
<th>SB Working Memory</th>
<th>D-KEFS Tower</th>
<th>D-KEFS Sorting Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta R^2$</td>
<td>$\beta$</td>
<td>$\Delta R^2$</td>
<td>$\beta$</td>
<td>$\Delta R^2$</td>
<td>$\beta$</td>
</tr>
<tr>
<td>Step 1 Depression</td>
<td>.00</td>
<td>-.03</td>
<td>.00</td>
<td>.02</td>
<td>.02</td>
<td>.04</td>
</tr>
<tr>
<td>Step 2 ADHD Exec. Function</td>
<td>.08</td>
<td>.14</td>
<td>.34***</td>
<td>.12*</td>
<td>.18**</td>
<td>.18**</td>
</tr>
<tr>
<td></td>
<td>-.20</td>
<td>-.20</td>
<td>-.55***</td>
<td>-.25</td>
<td>-.41**</td>
<td>-.37**</td>
</tr>
<tr>
<td>Step 3 Interaction</td>
<td>.00</td>
<td>-.03</td>
<td>.04</td>
<td>.01</td>
<td>.01</td>
<td>.02</td>
</tr>
<tr>
<td>Total R Square</td>
<td>.08</td>
<td>.38</td>
<td>.15</td>
<td>.21</td>
<td>.24</td>
<td>.17</td>
</tr>
</tbody>
</table>

Note. *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$
References


Appendix A

Consent for Future Research Participation

In the future, we may be interested in contacting you to participate in other research projects. Your signature below gives Dr. Julie Owens, Nicole Evangelista, or other research assistants supervised by Dr. Owens permission to contact you in the future. Your permission for future contact is entirely voluntary. If you choose not to sign this consent form, you will not be penalized in any way. Your signature below only gives us permission to contact you in order to inform you of future research projects. **If you do choose to sign this consent form, you are not obligated to participate in future studies.** Participation in future research projects is entirely voluntary and you will not be penalized if you choose not to participate. If you would like to give us permission to contact you, please complete the information below and send it to us in the self-addressed postage paid envelope. **Thank you!**

________________________________________________________________________
Print Your Name

________________________________________________________________________
Signature Date

________________________________________________________________________
Child’s Name Child’s Grade

________________________________________________________________________
Please PRINT your name and Permanent Address

________________________________________________________________________
Telephone Number
Appendix B1
An Examination of Self Perceptions and Cognitive Performance in Children with ADHD

Principle Investigators:
Catherine Golden, M.S.    Julie S. Owens, Ph.D.
Graduate Student    Assistant Professor
Ohio University, Dept. of Psychology    Ohio University, Dept. of Psychology
740-597-2925     740-593-1074

What is the Purpose of the Project?
• The purpose of the project is to learn more about the connection between children’s self-esteem, their behavior and their cognitive performance.
• We hope to use what we learn from this study to improve interventions for children with behavioral problems.

What will the Project Involve?
• Children who are in grades 3, 4, or 5 will be invited to participate
• Children will participate in a 1 to 1 ½ hour individual session with a master’s level psychology student. Children will complete six cognitive tests that specifically examine *executive functioning*. Executive functioning is the ability to use problem-solving skills to obtain a goal.
• This consent form allows us to obtain information gathered during an earlier study (“A Study of Self-Perceptions in Children with ADHD and Learning Difficulties”) under the direction of Nicole Evangelista, M.S.
• As part of this study, we are asking individuals who are currently taking stimulant medication to manage symptoms of ADHD to refrain from using this medication 12 hours to participation in this study, as these medications can influence performance on the tests that will be administered. The most common medications under this category include Ritalin, Adderall, Focalin, Concerta, Metadate, Dexedrine, and Cylert but may also include other generic forms of these medications. If your child is currently taking any of the stimulant medications above and you have been informed by your child’s physician that it is acceptable for your child to occasionally miss a dose or two of medication, we ask that your child participate at a time that allows him or her to refrain from use of that medication in the 12 hours prior to participation in the current study. Only stimulant medications are included in this medication suspension and no other medications should be suspended. Therefore, if your child is taking any other medications (e.g., medications in another class such as allergy medications, antidepressants, antipsychotic medications, etc.), your child may remain on these medications during the assessment session.

How Will Information Be Kept Private?
• All information gathered from your child will be kept strictly confidential and private or will be disclosed only with your written permission.
• Your child will be assigned a code number that will identify all of his/her information. Your child’s name will not be written on any of the project materials.
• If you (parent) provide an additional written authorization, we can provide a brief summary of the results of the neuropsychological tests. This brief summary can be sent to you, your child’s school, or your child’s counselor/case manager. For example, if your child is receiving treatment at a clinic, then you may wish to have the brief report sent to your child’s counselor. We will not release any information about you or your child without your written authorization.

• You agree that scientific data not identifiable with you or your child from this study may be presented at meetings and published so that the information from the study can be useful to others.

• While not anticipated, the principle investigators and staff are required to break confidentiality if safety issues arise (e.g., child is at risk for harming self or others, child abuse is discovered).

**What are the Potential Risks and Benefits?**

• There are no known significant risks to participating in this study. Your child may not enjoy completing the activities, but these activities are made for children and most children will like doing these tasks. Your child will be provided with a break if needed.

• Children with ADHD are prescribed stimulant medication for the treatment of specific symptoms (e.g., inattention, hyperactivity, impulsivity). With the absence of this medication, it is possible that some of these symptoms will remerge or worsen temporarily. However, there are no known physical risks to suspending medication for 12 hours. Additionally, the principal investigator has worked extensively with children with behavior problems and is appropriately prepared to handle disruptive behavior problems that may be displayed throughout the session.

• After your child participates, you may request a brief summary of your child’s performance on the cognitive tests.

• There are no other direct benefits to you or your child by participating in this study, other than a sense of helping others to better understand and treat behavioral problems in children.

**Will I or My Child Be Compensated?**

• You will receive $15.00 for allowing your child to participate in this study. (If you provide your social security number below, Ohio University will send you a check. If you would prefer to be paid in cash you may contact us and we can arrange to meet you). If, for some unforeseen reason your child can not complete all scheduled activities (e.g., child refuses, child illness), you will still receive payment in full.

• Children who participate will get a small toy.

**Is My Child Required to Participate?**

• Your child’s participation is voluntary. Your refusal to allow your child to participate will involve no penalty or loss of benefits. Your child has the right to refuse to answer particular questions. You and your child both have the right to stop participation at any time.
Contact Information
If you have any questions regarding this study please contact Catherine Golden (cg193203@ohio.edu or 740-597-2925) or Dr. Julie Owens (owensj@ohio.edu or 740-593-1074). If you have any questions about your child’s rights as a participant in research, you should contact Jo Ellen Sherow, the Director of Research Compliance at Ohio University, who can be reached by calling (740) 593-0664.

My signature below means that I have voluntarily agreed to have myself and my child take part in this project. I certify that I have read and understand the above information and have had all of my questions answered to my satisfaction. I voluntarily agree to have my child, of whom I am legal guardian, participate in the research described. I have given permission for my child’s teacher and school to release any and all information regarding my child’s behavioral, social, and academic performance. I agree that all known risks to me and my child have been explained to my satisfaction and I understand that no compensation is available from Ohio University and its employees for any injury resulting from my child’s participation in this research. Finally, I certify that my child’s participation in this research is given voluntarily and my child may discontinue participation at any time without penalty or loss of any benefits to which he/she may otherwise be entitled. I have the right to withdraw my child’s data at anytime even after the data has been collected. I have been given a copy of this consent form.

___________________________   ______________
Child’s Full Name -- Please Print

___________________________   ______________
Parent/Guardian Signature     Date

Phone Number:_________________   Address:_________________

Parent/Guardian Social Security Number: _______________________ (so that Ohio University may pay you by check for your participation)

Name of Child’s Teacher:_________________  

Name of Child’s School:_________________
Appendix B2

Ohio University
Authorization for the Use and Disclosure of
Identifiable Health Information for Research Purposes

You have been asked to be part of a research study under the direction of Catherine Golden, M.S., the Principal Investigator, and Julie S. Owens, Ph.D., the Co-Investigator, and their research team. The study is called “An Examination of Self Perceptions and Cognitive Performance in Children with ADHD.” The purpose of the project is to learn more about the connection between children’s self-esteem, behavior problems, and cognitive functioning.

This authorization form describes information about you and about your health that will be obtained by the researchers when you participate in the research study. Health information is considered “protected health information” when it may directly identify you as an individual. By signing this form you are agreeing to permit the researchers and/or other parties (described in detail below) to have access to this information. If there are any parts of this form that you do not understand, please be sure to ask us for further clarification.

1. What protected health information will be collected about you as part of this research study?

* New Health Information created from study, procedures, visits, and/or questionnaires as described in the attached consent form.
* Name, address, telephone number: so we may contact you throughout the duration of the project.
* Child’s date of birth: so we may conduct age calculations at different times during the project.
* Social security number: so we may provide payment in the form of a check from Ohio University.

**Please note: once your participation in the project is complete, your name and your child’s name will not be associated with any other data materials (e.g., questionnaires).

2. Who is authorized to provide or collect this information?

☑ Principal Investigator or research associates

3. With whom may your protected health information be shared?
Your health information may be shared with others outside of the research group for purposes directly related to the conduct of this research study or as required by law, including but not limited to:

- Your information may also be shared with individuals responsible for general oversight and compliance of research activities. Examples of this include the institution’s Privacy and Security Officers or other internal oversight staff, Safety Monitoring Boards, or an Institutional Review Board, and accrediting bodies. Your information may also be shared with other entities as permitted or required by law. All reasonable efforts will be used to protect the confidentiality of your individually identifiable health information that may be shared with others as described above.

Once your health information has been disclosed to anyone outside of this study, the information may no longer be protected under this authorization. All reasonable efforts will be used to protect the confidentiality of your protected health information. There is the potential for individually identifiable information and the associated health information obtained with this authorization to be re-disclosed by the recipient(s). After such a disclosure, the information may no longer be protected by the terms of this authorization against further re-disclosure.

4. How long will this information be kept by the Principal Investigator?

This authorization will expire at the end of the research study. After that time, this authorization may not be used to acquire additional information about you.

5. What are your rights after signing this authorization?

You have the right to revoke this authorization at any time. If you withdraw your authorization, no additional efforts to collect individually identifiable health information about you will be made. You should know, however, that protected health information acquired using this authorization prior to its withdrawal may continue to be used to the extent that the investigator(s) have already relied on your permission to conduct the research. If you chose to withdraw this authorization, you must do so in writing to the following individual(s):

Catherine Golden, M.S.  
Graduate Student  
Ohio University  
Porter Hall 200  
Athens, OH 45701  
740-597-2925  
cg193203@ohio.edu

Julie S. Owens, Ph.D.  
Assistant Professor of Psychology  
Ohio University  
Porter 243  
Athens, OH 45701  
740-593-1074  
owensj@ohio.edu
6. What will happen if you decide not to sign this authorization?

Refusing to sign this authorization will not affect the present or future care you receive at this institution and will not cause any penalty or loss of benefits to which you are otherwise entitled. If you decide not to sign this authorization, you will not be able to participate in the research study.

**Parent/Legal Guardian Name (please print)**

____________________________________

**Signature**

____________________________________

**Date:**

____________________________________

After signing, you will be provided with a signed copy of this authorization form.
Appendix B3

Child’s Assent to be in a research study

Who am I?
My name is Katie Golden. I want to tell you about a project that involves kids like you. I want to see if you would like to be in this project too.

Why are we doing this project?
We are doing this project to see what kids think about themselves. We want to see how kids think they do at some activities.

What will you do if you are in the project?
This project will only take about 1 hour and I will help you. You will answer some questions and do some activities.

Who will know that you are in the study?
We will not tell other kids about your participation. Your answers will be kept private and we will not put your name on the papers. We will not tell other kids what you said or did while you completed the project.

Do you have to be in the project?
No, you do not have to be in the project. No one will get angry or upset with you if you do not want to do this. If you agree to be in this project, you can stop at any time. You can change your mind later if you do not want to do this project.

Do you have any questions?
You can ask me questions now or later. You can even ask me questions while you are doing the project. You can also ask your parents questions.

IF YOU WANT TO BE IN THE STUDY, WRITE AND SIGN YOUR NAME ON THE LINE BELOW

Child’s Name___________________________________________________
Child’s Signature___________________________________Date_________
Appendix C1

CID: ____________

Question after the Stop-Signal Task (Post-Task)

How good were you at stopping yourself from pressing the button when you heard the beep?

1  2  3  4  5  6  7  8  9  10
Bad   OK    Excellent
Appendix C2

CID: ____________

Question after the D-KEFS Color-Word Interference Test (Post-Task)

How good were you at switching back and forth from reading the word printed in colored ink and naming the color of the ink?

1 2 3 4 5 6 7 8 9 10
Bad  OK  Excellent
Appendix C3

CID: ____________

Question **after** Digit Span (Post-Task)

How good were you at remembering all of the numbers that I said?

<table>
<thead>
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<td>Excellent</td>
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CID: ______________

Question *after* the Spatial Working Memory Test (Post-Task)

How good were you at tapping the blocks in the right order?

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<tr>
<td></td>
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Appendix C5

CID: __________

Question after the D-KEFS Tower Test (Post-Task)

How good were you at building the tower?

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<tbody>
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<td>OK</td>
<td>Excellent</td>
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Appendix C6

CID: __________

Question after the D-KEFS Sorting Test (Post-Task)

How good were you at sorting the cards and picking the sorting rule that I used?

1  2  3  4  5  6  7  8  9  10
Bad  OK  Excellent
Appendix C7

CID: ___________

Question after E Mazes

How good were you at completing the last five mazes?

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<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>OK</td>
<td></td>
<td></td>
<td>Excellent</td>
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Appendix C8

CID: ____________

Question after I Mazes

How good were you at completing the last five mazes?

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Appendix D

Debriefing Letter

Dear Parents:

Thank you for allowing your child to participate in our project. Your child’s participation is greatly appreciated! The information we obtained is important, as the knowledge we gain from this project will contribute to the development of improved services for children with disruptive behavior problems. This study will investigate if differences in self-perceptions have more to do with behavior problems or more to do with neuropsychological functioning. If desired, you may request (please contact Catherine at the telephone number below) a brief summary of your child’s neuropsychological functioning.

If you have any additional questions or concerns regarding your child’s participation in this study or would like to discuss this study further, please feel free to contact Catherine Golden at 740-597-2925 or Dr. Julie S. Owens 740-593-1074. If you have any questions about your child’s rights as a participant in research, you should contact Jo Ellen Sherow, the Director of Research Compliance at Ohio University, who can be reached by calling, 740-593-0664. If you would like us to contact you about any of our future research projects, please complete the attached form and return in the self-addressed stamped envelope. Thank you for your consideration and help with this project.

Sincerely,

Catherine Golden, M.S.  
Graduate Student  
Ohio University

Julie S. Owens, Ph.D.  
Assistant Professor and Faculty Supervisor  
Ohio University
Appendix E

Most Common CNS Stimulants

Methylphenidate:

   Trade Names: Ritalin, Metadate, Concerta, Methylin, Focalin

Dextroamphetamine compounds:

   Trade Names: Dexedrine, Dextrostat, Vyvanse

Amphetamine:

   Trade Names: Adderall

Pemoline:

   Trade Names: Cylert
Appendix F

Recruitment Flow Chart

Children in grades 3, 4 and 5 recruited through (a) six elementary schools, (b) a community mental health center, (c) a University Psychology and Social Work Clinic, (d) a university faculty and staff listserv, (e) an afterschool program (N = 141)

Parents completed DBD, IRS and demographic questionnaire (N = 110)

History of Pervasive Developmental Disorder, Mental Retardation, Adjustment Disorder or significant language deficit?

No – Complete full companion study protocol (N = 104)

YES – Excluded from further participation (N = 6)

Provide consent for future contact regarding current study?

No – Excluded from participation in current study

YES – Parents contacted and if interested, children scheduled to participate in current study. (N = 65)
Appendix G

Group Classification Procedures

Prior to their participation in the companion study, participants were originally screened using the parent and teacher versions of the DBD Rating Scale (Pelham et al., 1992), the IRS (Fabiano, et al. 2006) and a demographic questionnaire. Initially, 141 children were screened using this procedure. Children with a history of Pervasive Developmental Disorder, Mental Retardation, Adjustment Disorder or significant language deficits (i.e., one child could not talk) were excluded from further participation.

Inclusion criteria for the companion study were based upon the DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria for ADHD. Specifically, six or more symptoms of either inattention or hyperactivity/impulsivity had to be endorsed as “pretty much” or “very much” present on either the parent or teacher DBD Rating Scale or a combination of both parent and teacher rating scales. Of note, symptoms were not counted “twice” if endorsed by both parent and teacher ratings. Additionally, at least one score on both the parent and teacher IRS had to be higher than a two to meet the ADHD group inclusion criteria.

Inclusion criteria for the non-ADHD group required three or fewer symptoms of hyperactivity/impulsivity and inattention on the DBD Rating scales. The impairment rating scale (IRS) was not utilized in determining the non-ADHD group status, as it is likely that some children, though not ADHD, still evidence impairment in multiple domains (i.e., children with depression, etc.).

Inclusion and exclusion criteria as well as participant attrition resulted in 110 children participating in the full companion study protocol following the screening
procedure. Children with full scale intelligence scores that were two standard deviations below or above the group mean were excluded from the analyses \( n = 6 \), which resulted in 104 companion study participants.

In the companion study as well as current study, final group classification was determined after examining both the DBD rating scales and results of a diagnostic interview (i.e., P-ChIPS). The P-ChIPS (Weller et al., 1999) interview was administered as a comprehensive tool to aid in diagnostic clarification. Parents were asked to complete the P-ChIPS with either the principal investigator of the companion study or of the current study. In the majority of cases, DBD rating scale results were consistent with P-ChIPS results.

Specifically, for 53 children in the current sample (83%), both methods resulted in the same group classification. However, for 11 children in the current sample (18%) there was a disparity (ADHD vs. non-ADHD) between the methods of group classification. For these cases, the investigator examined each child’s case to make a clinical decision for group classification. For eight of these cases, the investigator utilized results of the P-ChIPS interview to determine group status, due to evidence that these parents likely overlooked specific instructions provided with the DBD rating scales (i.e., rating scales to reflect what behaviors child exhibits when not taking stimulant medication). The investigator utilized the DBD rating scales to classify the other three cases because there was no clear evidence that the P-ChIPS interview results served greater utility for group classification. Additionally, there was one additional child who presented with conflicting data regarding diagnosis status (e.g., on stimulant medication, but did not meet clinical criteria for ADHD); this participant was removed from final analyses. Group assignment
resulted in 34 children assigned to the ADHD group (20 males; 14 females) and 30 children assigned to the CTL group (15 males; 15 females).