# Executive Functioning in Children with Positive Illusory Bias: Examining the Relationship between Cognitive Characteristics and Self-Perception

by

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## Abstract

Optimistic self-perception has been demonstrated to be a common phenomenon in the general population (Bouffard, et al., 1998; Harter, 1988; Mezulis, et al., 2004; Sedikides, et al., 2005). The phenomena of biased perceptions of competence has been well documented in children with ADHD and has come to be known as positive illusory bias (PIB). Though overestimations of competence appear to exist in the general population, the examination of the negative sequelae of inflated self-views in children and the causal factors related to misperception have largely focused on children with ADHD as well as other clinical populations. Recently, researchers have sought to understand the role of cognitive deficits, particularly executive functioning (EF), in the presence of PIB in children with ADHD (McQuade et al., 2011) and populations with other know frontal lobe deficits. The aim of the present study was to expand upon the PIB literature by examining the relationship between executive functioning and PIB in a general sample of 68 children (8 to 13 years) across domains of academic, social, and behavioral functioning using the Delis-Kaplan Executive Function System (D-KEFS; Delis, Kaplan, & Kramer, 2001) and child and teacher ratings of the Self-Perception Profile for Children (SPPC; Harter, 1985). EF composites were developed based on factor analysis by Latzman and Markon (2010), specifically Conceptual Flexibility, Monitoring, and Inhibition constructs. In addition to the three EF composites, working memory (Digit Span Backwards; Wechsler, 2003) was included as an EF variable. Results indicated specific EF deficits relative to PIB in each domain of functioning, but in a pattern somewhat contrary to predictions. Level of

PIB in the academic domain were predicted by Conceptual Flexibility whereas Monitoring predicted PIB in the social domain. PIB in the behavioral domain was not predicted by any of the EF constructs though was correlated with working memory. Results lend additional support for cognitive deficits in children with PIB and extend the findings outside the field of ADHD.

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## Introduction

Self-perception in children has received a great amount of attention in recent years. In particular, research has focused on children's biased self-evaluation of competency across multiple domains of functioning including academic, social, and behavioral areas. Optimistic self-perception has been demonstrated to be a common phenomenon in the general population, especially among young children (Bouffard, Markovits, Vezeau, Boisvert, & Dumas, 1998; Harter, 1988; Mezulis, Abramson, Hyde, & Hankin, 2004; Sedikides, Gaertner, & Vevea, 2005). Recently, this field of study has turned its focus to the negative sequelae of inflated self-views in children and has sought to uncover the causal factors related to misperception.

Though positive bias in self-evaluation has been associated with poor outcomes for healthy children (Gresham, Lane, MacMillan, Bocian, & Ward, 2000), the greatest impact appears to be associated with childhood psychopathology. Children with aggression, learning disabilities, Autism Spectrum Disorder (ASD), traumatic brain injury (TBI), and Attention-Deficit/Hyperactivity Disorder (ADHD) are among the populations that tend to overestimate their abilities which in turn predicts negative academic, behavioral, and social performance (Bivona, Ciurli, Barba, Onder, Azicnuda, Silvestro, et al., 2008; Boivin, Poulin, & Vitaro, 1994; Heath & Glen, 2005; Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007; Zakriski & Cole, 1996). The tendency to demonstrate an overestimation in self-perception of competence across multiple domains of functioning has been particularly well demonstrated in children with ADHD (see Owens et al., 2007). Despite deficits in functioning across academic, social, and behavioral domains it appears that many children with ADHD underreport the presence of these problems and are, in fact, overestimating their competence (Hoza, Pelham, Dobbs, Owens, & Pillow, 2002; Hoza, Pelham, Milich, & Pillow, 1993; Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007). When compared to parent and teacher report or objective measures of competence, children with ADHD report their level of competence to be substantially higher. This phenomenon has come to be termed “positive illusory bias” (PIB). Several theoretical explanations for PIB have been posited, including cognitive immaturity and self-protection motivation, but with mixed support.

A burgeoning field of inquest is examining the role of cognitive deficits in PIB, specifically executive dysfunction. To date, the role of executive functioning (EF) in positively biased self-evaluations appears to be studied only within specific populations including ADHD (McQuade, Tomb, Hoza, Waschbusch, Hurt, & Vaughn, 2011), schizophrenia (Pia Tamietto, 2006), and traumatic brain injury (TBI; Bivona, Ciurli, Barba, Onder, Azicnuda, Silvestro et al., 2006) and there appears to be no study examining the role of cognitive deficits in PIB in a general sense. Given that biased self-perceptions present across a number of disorders, it seems likely that PIB is not explained as a characteristic of any particular disorder but rather by an underlying shared mechanism, namely executive dysfunction. The purpose of this study is to explore the role of EF in PIB.

## Executive Functioning and Self-Perception

The presence of positive illusions in the general population has been well documented (Alicke & Govorun, 2005; Owens et al., 2007) such that individuals tend to rate themselves better than a hypothetical average. Taylor and Brown (1988; 1994) suggest that holding unrealistically positive self-views contributes to mental well-being. Baumeister (1989) describes a curvilinear relationship between positive illusions and psychological functioning whereby there is an optimal margin of positive illusion, and individuals falling above or below are posited to be less well-adjusted. Specifically, individuals exhibiting a lower level of positive illusion have an overly realistic view which may be depressing whereas individuals with higher levels of a positive distortion may be setting themselves up for failure.

**Cognitive characteristics of PIB in children with ADHD**

In a review of the literature on PIB in children with ADHD, Owens et al. (2007) noted three differences in the positive biases of children with ADHD as compared to a normative peer group. First, the discrepancy between perceived competence and actual competence is considerably larger than children without ADHD, suggesting a departure from typical positive cognition. Second, Harter's (1981) model of mastery motivation would suggest that children with ADHD would likely have a lowered sense of self-competence due to repeated failures across multiple domains.  However, results from research examining the self-perceptions of children with ADHD consistently indicate that they have unrealistically high self-perceptions of competence and self-worth despite their history of failures. Third, moderate positive illusions are considered adaptive in that they encourage motivation and task persistence and enhance performance. However, children with ADHD are found to give up more frequently and perform worse on academic tasks despite exhibiting a positive illusory bias.

Interestingly, comorbid disorders associated with ADHD have differential effects on the presentation of PIB (Owens et al., 2007). In terms of comorbid externalizing disorders, children with ADHD and aggression tend to overestimate their competence in the domains of greatest impairment, specifically the social and behavioral domains (Hoza et al., 2002; Jiang & Johnston, 2014; Treuting & Hinshaw, 2001). In domains less likely to be affected by aggression, such as physical appearance, self-perceptions of competence did not differ from the control group. Similarly, children with ADHD experiencing comorbid academic difficulties also overestimated their competence in academic achievement. Internalizing disorders appear to affect the presentation of PIB in the opposite direction (Hoza et al., 2002, 2004). Namely, children comorbid for ADHD and depression demonstrate less of a positive illusory bias, suggesting more realistic perceptions of their competence. Compared to children without comorbid depression, children with ADHD and comorbid depression do not overestimate their competence relative to teacher and parent ratings and do not differ significantly from their non-diagnosed peers.

McQuade and colleagues (2011) conducted one of the first studies examining cognitive/EF deficits and positively biased self-perceptions in children. Five cluster scores from the Woodcock Johnson III Tests of Cognitive Abilities (WJ-III COG; Woodcock & McGrew, 2001), which overlap in subtest content, were chosen to assess EF deficits: Executive Processes, Cognitive Fluency, Broad Attention, and Working Memory. These clusters measure strategic planning, interference control, mental flexibility, efficiency of mental processing, attention, and attentional control/working memory.

McQuade et al. (2011) found that, across academic, social, and behavioral competence domains, children with ADHD and PIB differed from children with ADHD without PIB and control children in terms of EF deficits. Consistent with previous research, children with ADHD regardless of PIB status performed worse than control children in Broad Attention, Cognitive Fluency, and Executive processes in each of the domains of competence. However, across the competence domains, children with ADHD and PIB demonstrated greater deficits in Working Memory compared to both children with ADHD without PIB and control children. When grouped based on presence of domain-specific bias, ADHD children with PIB in the academic domains also displayed greater deficits in Executive Processes compared to children without such a bias. Children with ADHD and positive bias in the social domain additionally experienced greater deficits in Cognitive Fluency, Broad Attention, and Executive Processes. Further research is necessary to understand the impact of cognitive deficits on the presentation of PIB in children with ADHD.

**Anosognosia**

In a review of self-perceptions in children with ADHD, Owens and colleagues (2007) suggested that PIB in children with ADHD may resemble insight deficits, known as anosognosia. Anosognosia describes a neurologically based impairment of self-awareness related to deficits resulting from an illness or disorder (Ownsworth et al., 2002; Shad et al., 2006; Stuss & Benson, 1987). This deficit of insight has been demonstrated particularly in disorders affecting the prefrontal cortex and EF such as schizophrenia and TBI. Patients with frontal lobe damage and executive dysfunction often overestimate their abilities but are able to accurately assess the abilities of others (Duke, Seltzer, Seltzer, & Vasterling, 2002; Kaszniak & Christensen, 1995). Cognitive test data as well as structural neuroimaging studies provide supportive evidence for the role of cognitive dysfunction, mediated by deficits in frontal cortical systems, in insight deficits in patients with schizophrenia. Numerous studies (see Shad et al., 2006) using cognitive tests have found significant correlations between insight and cognitive functioning, especially with the Wisconsin Card Sorting Task (WCST, Heaton, 1981). Although other measures such as the Trail Making Test B and Stroop Task (Reitan & Wolfson, 1992; Stroop, 1935) demonstrated some correlation with insight, overwhelmingly more consistent relationships were demonstrated in studies using measures more sensitive to frontal functioning such as the WCST.

Similarly, Wilson, Donders, and Nguyen (2011) found greater parent-adolescent discrepancies in ratings of EF, as measured by the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), for adolescents with TBI than neuropsychologically healthy controls. Specifically, the TBI group demonstrated significant discrepancy on the Metacognitive Index, which reflects an individual's ability to initiate, plan, organize, self-monitor and sustain working memory. Furthermore, Spikman and van der Naalt (2010) examined impairments of self-awareness and EF, as measured by the Executive Route-finding Task (Boyd & Sautter, 1993), in TBI patients with and without focal frontal injuries. This task is an indoor problem-solving task in which the patient must find the best route to a specific destination. The patient is rated on "adequacy of information seeking," "error detection," and "error correction." The authors found that while both groups demonstrated deficits in EF, only the patients with focal frontal injuries appeared impaired in their perception of their current level of functioning. Wolfe and colleagues (2014) found better social self-awareness to be associated with higher EF as well as greater social adjustment in children with TBI. Similarly, Yeates et al. (2007), has posited a model integrating theory of mind, social information processing, and EF to explain social deficits and related social misperceptions in children with TBI. Together, the literature in the areas of schizophrenia and TBI suggest that it is the executive functioning specifically related to frontal lobe functioning that underlies the awareness of one's deficits.

## Executive Functioning

Lezak (1982) describes EF as "those mental capacities necessary for formulating goals, planning how to achieve them, and carrying out the plans effectively" (p. 281). Generally, EF is thought to involve the neural circuitry that enables "self-regulation" (Vohs & Baumeister, 2004). Although there is no universally accepted definition of EF, several components have often been identified including inhibition, working memory, planning, set-shifting, and interference control (Barkley, 1997, 2011a; Martel et al., 2007).

A major barrier to understanding executive functioning is disagreement as to whether EF is a single, unified construct or a set of independent constructs (Best & Miller, 2010). Miyake, Friedman, Emerson, Wits, Hoverer, and Wager (2000) developed a theoretical framework, described as the "unity and diversity of EF," which suggests that although the components of EF are interrelated, each are distinct and contribute differentially to a given task. Through confirmatory factor analysis (CFA) of nine commonly used EF tasks, Miyake and colleagues established three distinct EF components, which they labelled as foundational executive functions: (a) shifting between tasks or mental sets ("shifting"); (b) updating and monitoring of working memory representations ("updating"); and (c) inhibition of prepotent responses ("inhibition"). Recently, Miyake and Friedman (2012) have attempted to specify the "unity" across all three EFs, termed "common EF." The authors suggest that "common EF is about one's ability to actively maintain task goals and goal related information and use this information to effectively bias lower-level processing" (p. 11).

Given the numerous frameworks posited to describe EF, Latzman and Markon (2010) conducted an exploratory factory analysis (EFA) and CFA using the standardization sample of the Delis-Kaplan Executive Function System (D-KEFS, Delis, Kaplan, & Kramer, 2001) to examine its factor structure. Their analyses also revealed three distinct factors: (a) abilities related to concept formation (Conceptual Flexibility); (b) the ability to engage/disengage task sets despite interference (Monitoring); and (c) the ability to inhibit prepotent responses (Inhibition). A second replication study with early adolescent males by the authors revealed a similar factor structure. Latzman and Markon compared their model of EF to the model established by Miyake et al. (2000) and suggested a strong correspondence between the two. Specifically, Latzman and Markon related their Conceptual Flexibility factor to Miyake et al.'s

Shifting factor based on the requirement of mental set shifting, problem-solving initiation, and concept formulation. The authors related the Updating factor described by Miyake and colleagues to their Monitoring factor due the requirements of monitoring and evaluating new information and updating the information in working memory when appropriate. Both sets of authors described an Inhibition factor that relies on the ability to control prepotent responses.

Pennington and Ozonoff (1996) also describe EF as consisting of distinct components including set-shifting and set maintenance, interference control, inhibition, integration across time space and time, planning, and working memory. In a review of the assessment of EF, Henry and Bettenay (2010) found that five areas of EF commonly appeared across measures of EF: inhibition, executive-loaded working memory, set shifting/switching, planning/problem solving, and fluency/reconstitution.

**Inhibition**

Response inhibition requires the suppression, interruption, or canceling of a prepotent response so as to allow for the integration of new information (Barkley, 1997, 2011a; Henry & Bettenay, 2010; Nigg, 2006). Barkley (1997, 2011a) proposed that inhibition facilitates the uninterrupted operation of EFs through protection from interference so as to direct behavior toward a goal. Inhibition of a prepotent response or interruption of an active response creates a delay in responding during which other EFs can occur. Because behavioral inhibition mediates EF, individuals with deficits in behavioral inhibition experience deficits in the other EFs as secondary effects. Similarly, studies examining the unique variance of the three EFs proposed in the unity and diversity framework (e.g., inhibition, set shifting, and working memory) have found that after accounting for what is common across the EFs (unity), there was no inhibition-specific variance (Friedman, Miyake, Robinson, & Hewitt, 2011; Friedman, Miyake, Young, DeFries, Corley, & Hewitt, 2008). Deficits in inhibition result in a number of negative outcomes, including difficulty following instructions, inability to delay immediate gratification in place of a larger long term goal, and difficulty resisting temptation despite explicit negative consequences.

Inhibition is difficult to measure as most inhibition tasks tap into other executive function processes (specifically working memory) and do not measure a single inhibitory process (Best & Miller, 2010; Nigg, 2000; Simpson & Riggs, 2005). Response inhibition tasks can be divided into simple tasks and complex tasks, requiring limited or greater working memory, respectively (Garon, Bryson, & Smith, 2008). Working memory is necessary in complex response inhibition tasks in order to hold a given rule in mind or to inhibit one response in favor of an alternative response. The Stroop Task (Stroop, 1935), of which there are several variants, is a common measure of inhibition in which a participant is presented with color words printed in different colored inks and asked to name the color of the ink rather than the name of the word. Computerized tasks, such as the Go-No-Go task and continuous performance task (CPT), have become increasingly popular measures of inhibition (Cragg & Nation, 2008). These tasks require the participant to only respond to the "go" stimuli (e.g., all letters except X) and inhibit responding to the "no-go" stimulus (e.g., the letter X).

**Working Memory**

Working memory involves the ability to store, process, and manipulate information. Additionally, working memory includes actively maintaining a finite amount of information while selectively activating relevant pieces. The information stored within working memory can be verbal or spatial in nature (Barkley, 1997, 2011a; Henry & Bettenay, 2010; Nigg, 2006). Nonverbal working memory involves the internalization of sensorimotor actions and consists of hindsight and forethought which serve to connect cross-temporal elements within a contingency.

Deficits in nonverbal working memory can result in forgetfulness, difficulties with time management, poor hindsight and forethought, and trouble generating appropriate responses for anticipated event. As a result, perception of the cross-temporal organization of behaviors is limited and following a string of behaviors directed toward a goal is difficult.

Verbal working memory uses internalized speech to allow for self-description and reflection, self-instruction, self-questioning and problem solving, the invention of self-rules and metarules, and moral conduct (Barkley, 1997, 2011a; Nigg, 2006). Barkley (1997) posits that delayed internalization of speech results in greater public speech or excessive talking, less verbal reflection (thinking) before acting, less self-directed and rule-oriented speech to organize and control behavior, and difficulty following rules or instructions provided by others.

Measuring working memory is complicated by the use of multiple definitions of the construct and different assessment tasks (Best & Miller, 2010). Similar to inhibition tasks, working memory tasks can be divided into simple tasks, requiring only maintenance of information, and complex tasks which require maintenance and manipulation of information to direct goal-oriented behavior (Conklin, Luciana, Hooper, & Yarger, 2007). The level of task complexity varies by the degree of “executive control” required. Gathercole, Pickering, Ambridge, and Wearing (2004) suggest a model of executive working memory in which the verbal storage system and visuospatial storage system are coordinated by a central executive. Simple working memory tasks rely exclusively on the verbal or visuospatial storage system whereas complex tasks requiring multiple and concurrent working memory processes rely on the coordination of the central executive. Forward Digit Span is a simple task commonly used to measure working memory in which the participant is required to repeat successively longer strings of random numbers presented orally; thus it focuses on rote memory and attention. The

Backward Digit Span adds a level of complexity by requiring the participant to repeat the string of numbers in reverse order, thus focusing on transformation of information and mental manipulation. Serving as measures of nonverbal working memory, spatial span tasks are the visual analogues to the digit span tasks. Delayed-response/recognition tasks are also complex working memory tasks in which the participant, following a prescribed delay, is asked to recall items from a previously presented series.

**Set shifting/cognitive flexibility**

Set shifting or cognitive flexibility is the ability to change or adapt a mental set or alternate a strategy in response to feedback (Jurado & Rosselli, 2007; Miyake et al., 2000; 2011). Shifting requires the ability to shift attention between one task and another. More specifically, Allport and Wylie (2000) suggest including the ability to perform a new task despite proactive interference resulting from having previously performed a different operation on a similar task. Best and Miller (2010) posit that inhibition and working memory processes are necessary for efficient set shifting. Deficits in cognitive flexibility result in several negative social outcomes, including difficulty changing behavior based on feedback from others, and difficulty switching between rules within a task/game or across contexts.

Whereas inhibition tasks require suppressing a single response, shifting tasks rely on switching between at least two mental sets in which each set may contain set-specific task rules (Crone, Somsen, Zanolie, & Van der Molen, 2006). The rules of shifting tasks are usually discerned based on positive or negative feedback as compared to inhibition tasks in which the rules are explicitly presented. Sorting tasks, such as the WCST (Heaton, 1981), are common measures of set shifting/ cognitive flexibility. Participants are required to determine rules for matching cards based on feedback from the examiner. The matching criteria change as the tasks progresses, assessing the participant's ability to successfully switch between matching criteria and avoid perseverating on any rule. The Trail Making Test Part B (Reitan & Wolfson, 1992) is another common measure of set-shifting. In this task, the participant is required to alternate drawing a line between letters and numbers in sequence. The Inhibition/Switching condition of the Color Word Interference subtest on the Delis-Kaplan Executive Function System (D-KEFS, Delis, Kaplan, & Kramer, 2001) also provides a measure of shifting. During this Stroop-like task, the participant must switch between the naming the color of the ink and naming the word such that both inhibition of prepotent responses and switching between mental sets are required.

**Planning/problem-solving**

Planning/problem-solving is the ability to develop strategies and solutions based on self-monitoring of performance to attain a goal (Henry & Bettenay, 2010). Zelazo, Carter, Reznick, and Frye (1997) suggest four steps to problem-solving. First, the problem must be represented in the mind which requires selectively attending to the situation and flexible use of rules or models as guides. Second, an individual must select a plan from a list of alternative plans and appropriately sequence the steps of that plan. Third, the plan must be maintained in the mind long enough to guide execution of the prescribed behaviors. Fourth, once the plan has been executed it must be evaluated to determine if the solution has occurred; if not, corrections to the previous steps must be made. Tower tasks, such as the Tower of London (TOL; Shallice, 1982) and Tower of Hanoi (TOH; Simon, 1975), are often used to measure planning and problem-solving (Henry & Bettenay, 2010). These tasks require the participant to rearrange colored balls or different sized discs from a starting point on three posts to a specific end point using the least number of possible moves. The Planning subtest on the WJ-III COG (Woodcock et al., 2001) is a measure of planning/problem-solving in which the participant attempts to trace a complex, overlapping path without lifting the pencil, retracing a part of the path, or skipping any part. The Sorting Task from the D-KEFS (Delis, Kaplan, & Kramer, 2001) is a planning task that also includes a verbal element. In this task, participants are required to sort six items into two piles in as many ways as possible based on either perceptual or verbal sorting rules.

**Fluency/reconstitution**

Fluency/reconstitution involves the ability to efficiently and flexibly process information (Barkley, 1997, 2011a; Nigg, 2006). Through a two-step process of analysis and synthesis, this EF facilitates the generation of new behavior sequences from old ones. Old behaviors are analyzed and broken down into smaller units and then synthesized into new behavior combinations in order to overcome an obstacle impeding successful attainment of the goal. Impaired reconstitution may result in difficulties generating multiple behavior options toward goal attainment as well as impairment in selecting the behavior sequence with the greatest probability of succeeding. Similar to working memory, fluency can be verbal or nonverbal. Verbal fluency tasks typically require the participant to generate a list of items relative to a given criterion such as a beginning letter or category of items (Henry & Bettenay, 2010; Schwartz, Baldo, Graves, & Bugger, 2003). Neuropsychological observations and functional neuroimaging studies suggest that while letter fluency is related to frontal lobe functioning (particularly left frontal lobe), category fluency is more likely to be a function of the temporal lobe (Elfgren & Risberg, 1998; Garrad, Ralph, Hodges, Patterson, & Hodges, 2001; Tranel, Damasio, & Damasio, 1997). Nonverbal fluency tasks require participants to draw different pictures or diagrams based on a given set of rules without repeating a design (Henry & Bettenay, 2010; Jones-Gotman & Miller, 1972).

## Rationale for the Current Study

To date, there is limited research examining the role of cognitive deficits in the presentation of PIB. McQuade et al. (2011) have explored the relationship between executive dysfunction and PIB, however, the sample was limited to children with ADHD and broad measures of EF were used. Similarly, several studies (Donders, & Nguyen, 2011; Ownsworth et al., 2002; Shad et al., 2006; Spikman & van der Naalt, 2010) have demonstrated the existence of anosognosia, a phenomenon similar to PIB, in populations experiencing impairment in frontal lobe functioning. Measures of cognitive functioning have revealed a relationship between executive dysfunction and anosognosia, however, the assessments used also tended to measure executive function more globally. Therefore a primary aim of this study is to expand upon the PIB literature by exploring specific patterns of executive dysfunction in children with PIB to better understand the relationship between cognitive deficits and PIB. Given that the majority of the literature on PIB has been contributed by one group of authors, this study will also serve to independently replicate their findings.

## Hypotheses for the Current Study

The goal of this study is to examine the relationship between executive functioning in PIB in children. Based on previous research (McQuade et al., 2011; Miyake et al., 2011), it is expected that the pattern of EF will differ across the domains of functioning. Therefore, children's perception will be examined across specific domains of competence including academic, behavioral, and social domains. The data will be analyzed to determine which EF factor or combination of EF factors best predicts the presence of PIB in each domain of competence. Four EF factors will be included as predictor variables: working memory, Updating/Monitoring, Conceptual Flexibility, and Inhibition. Four different hypotheses will be tested regarding the pattern of EF in each domain of competence.

1) Across domains of perceived competence, levels of PIB will be predicted by working memory, given that working memory appears closely related to Miyake and Friedman's description of common EF as the ability to maintain and use goal-related information.
2) Levels of PIB in the academic domain will be predicted by the Updating/Monitoring factor. Updating has demonstrated associations with reading, arithmetic, verbal, and nonverbal reasoning (Altemeier, Jones, Abbott, & Berninger, 2006; van der Sluis, Jong, & van der Leij, 2007).
3) Levels of PIB in the social domain will be predicted by Conceptual Flexibility. Jones and Day (1997) found that flexible application of social knowledge was positively associated with social competency and negatively associated with social problems in children as rated by teachers. Additionally, Reiter-Palmon (2003) found cognitive flexibility to uniquely predict leadership beyond social skills and academic ability.
4) Levels of PIB in the behavioral domain will be predicted by inhibition. Inhibition has been found to be most strongly related to externalizing behavior disorders, such as ADHD and conduct disorder, in children and adolescence (Young, Friedman, Miyake, Willcutt, Corley, Haberstick, & Hewitt, 2009).

Given that depressive symptoms have been demonstrated to attenuate positive bias (Hoza et al., 2002, 2004), levels of self-reported depressive symptoms were explored as a potential predictor variable in addition to other grouping variables including data collection site, FSIQ, race, sex, and age.

# Method

## Participants

Participants include a sample of children obtained from several communities primarily located in a rural area in the Southeast (36%) and suburban area in the Northeast (61%). Data were gathered from 69 children (58% female) ranging from 8 to 13 years of age ($M$ = 10.36, SD = 1.59). The age range was selected because of the nature of the normative sample for the primary EF and perceived competence measure. In addition, given the structure of school systems and the different amounts of contact teachers have with students in high school versus elementary/middle school, the upper age limit excluded students in the former setting. Ethnicity of participants included Caucasian (56.5%), African-American (24.6%), Hispanic (7.2%), mixed (8.7%), and Asian (2.9%). Parents reported diagnosis of one or more psychological disorders for 14.5% of children including ADHD (11.6%), Anxiety Disorder (4.3%), and Learning Disability (2.9%). Additionally, 10.1% of children were reported by their parents as currently taking one or more medications for a psychological problem with the majority using stimulant medication for treatment of ADHD symptoms (7.2%) and a small minority using hypertensive medication (2.9%) or atypical antipsychotic medication (1.4%). In order to ensure stability of cognitive processes, children must have had no changes to their medication regimen within the previous six months based on parent responses to the demographic questionnaire and subsequent verification upon arrival to the laboratory testing session.

Participants were recruited through distribution of flyers to community agencies, including physicians’ and dental offices, recreation centers, daycare centers, elementary and middle schools, and mental health professionals. Furthermore, participants in the study were given flyers to pass on to friends or family members who might be interested. Eighty-one parents mailed in signed consent forms for their child to participate in the study with 12 children failing to complete the laboratory research session due to lack of teacher participation or scheduling difficulties. Of the 69 children who completed all portions of the study, one child's data were excluded from analyses due to an IQ score below 80 consistent with exclusionary criteria.

## Measures

**Self- and teacher-reported competence.** Each child and their teacher completed the respective version of the Self-Perception Profile for Children (SPPC; Harter, 1985). The self-report version is a 36-item questionnaire consisting of six separate subscales designed to tap into five specific domains (Scholastic Competence, Social Acceptance, Athletic Competence, Physical Appearance, and Behavioral Conduct) as well as global self-worth. Each domain includes six items which are rated on a 1 to 4 scale, with higher scores suggesting greater perceived competence. The child report version of the SPPC demonstrates adequate internal consistency for third to eight grade children with alphas ranging from .80 to .90. Factor analysis of the normative sample, as well as numerous replications, suggest that the factor structure is sound (Granleese & Joseph, 1993; Miller, 2000; Muris, Meesters, & Fijen, 2003). Additionally, Cole, Jacquez, and Maschman (2001) found that SPPC scores are positively (but imperfectly) correlated with teacher and parent ratings of children's competence.

The original teacher report version is a 15-item questionnaire which includes only three items for each of the five specific domains. Recent research has expanded the teacher report version to include all six items from the child report version for each domain such that the teacher report version consists of the same number and same types of items, reworded for teacher responses (McQuade et al., 2011). McQuade and colleagues did not subsequently confirm the factor structure of the expanded teacher version, relying on the extensive literature of Harter's measures. However, they found alphas ranging from .91 to .97 across the subscales

In the present sample, the alphas ranged from .76 to .82 on the subscales for the child version and from .81 to .90 on the subscales of the expanded teacher version.

Based on the established use of teacher ratings as a more accurate view of child performance, and consistent with McQuade et al. (2011), discrepancy scores derived from the difference between child and teacher ratings on the SPPC (Harter, 1985) were used to determine the level of PIB in each domain of functioning (e.g., Academic, Social, Behavioral) for the current study. In each domain, the teacher's rating was subtracted from the child's score to generate a discrepancy score whereby greater positive discrepancy scores indicate a higher level of positive bias on the part of the child.

**Children's Depression Inventory 2nd Edition Self-Report Short Version (CDI 2: SR[S]).** The CDI 2: SR[S] (Kovacs 2011) is a 12-item scale that was empirically derived from the 28-item full-length form and designed to assess for the severity of current affective, cognitive, and neuro-vegetative symptoms of depression in children and adolescents between the ages of 7 to 17 years. Each item is rated on a scale of 0 to 3 with higher scores indicating greater severity of depressive symptoms. The scale produces T-scores normed by age and sex. The CDI 2: SR[S] demonstrates good internal consistency with alphas ranging from .77 to .84 and good test-retest reliability (r = .92). For the present sample, the coefficient alphas for the total score was .61 .In addition, the CDI 2: SR[S] technical manual reports strong discriminative validity between children with and without major depressive disorder, similar to the full length version.

**Wechsler Abbreviated Scale of Intelligence (WASI).** The WASI (Wechsler, 1999) is a nationally standardized screener of intelligence designed to be individually administered to individuals from 6 to 89. The Full Scale-2 IQ score (FSIQ-2), consisting of the Vocabulary and Matrix Reasoning subtests was used in the current study. Standard scores are derived based on an age-equivalent normative sample. In the children's standardization sample, the FSIQ-2 demonstrates excellent internal consistency ($\alpha = .93$) and good test-retest reliability ($r = .85$). Furthermore, scores on the WASI FSIQ-2 correlate highly with other widely used measures of intelligence.

**Digit Span -- Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV;** Wechsler, 2003**).** This WISC-IV subtest is a well-established measure of working memory, consisting of a Forward and Backward condition. Internal consistency coefficients for Digit Span range from .84 to .89 for the study's age group (Forward: .78 to .88; Backward: .68 to .83). Stability coefficients range from .77 to .85 (Forward: .70 to .79; Backward: .64 to .76). Digit Span backward, in particular, has been shown to be a more pure representation of working memory as compared to the forward condition and, therefore, independently serves as the measure of working memory rather Digit Span total which combines the conditions. Scaled scores are derived based on age-equivalent normative sample.

**Delis-Kaplan Executive Function System (D-KEFS).** The D-KEFS (Delis et al., 2001) is a comprehensive, nationally standardized measure of EF that consists of nine subtests, seven of which are based on traditional and validated EF measures. Delis et al. (2001) describe designing the battery to isolate fundamental cognitive components involved in performing executive function tasks as well as higher-level cognitive abilities such as concept formation, inhibition, planning, and cognitive flexibility. Norms (scaled scores) are provided for individuals between the ages of 8 and 89, with specific norms developed for each year from ages 8 to 15. The D-KEFS was chosen for this study because of its coverage of executive functions consistent with models described earlier and the consistent set of norms derived from this standardization sample, which was based on the 2000 U. S. Census figures.

Appendix A outlines the psychometric properties for the D-KEFS scores used in this study, as reported by Delis et al (2001). Internal consistency and test-retest reliability coefficients range from low to high. Delis et al (2001) also provide evidence of the validity of D-KEFS procedures in terms of sensitivity to detect brain damage and the ability of the tests to measure important areas of higher-level executive functions. Furthermore, they point out that many D-KEFS tests are modifications of long-standing clinical or experimental tests, which have well established validity. A recent study yielded support for convergent relations with the clinical clusters from the WJ-III COG, especially with the Executive Processes cluster (Floyd, McCormack, Ingram, Davis, Bergeron, & Hamilton, 2006). Additionally, modest criterion validity was found for the Verbal Fluency subtest in patients with mild to severe TBI (Strong, Tiesma, & Donder, 2011). Similarly, the Sorting Test Free Sort condition was found to effectively distinguish TBI patients from controls in sample of 67 patients (Heled, Hoofien, Margalit, Natavich, & Agranov, 2012). Furthermore, other clinical populations including children with ASD, ADHD, and prenatal alcohol exposure have demonstrated significantly lower scores across D-KEFS subtests, especially Trail Making, Verbal Fluency, and Color-Word Interference (Kleinhans, Akshoomoff, & Delis, 2005; Mattson, Goodman, Caine, Delis, & Riley, 1999; Rasmussen & Bisanz, 2009; Schonfield, Mattson, Lang, Delis, & Riley, 2001; Wodka, Loftis, Mostofsky, Prahme, Larson, et al., 2008).

D-KEFS measures used in the current study were determined based on their fit with the three factor model established by Latzman and Markon (2010) discussed previously. Specifically, significant factor loadings ($\geq$ .30) were used to create a composite of the relevant

D-KEFS scores for each factor (e.g., Cognitive Flexibility, Monitoring, and Inhibition) (See Appendix B for the excerpted table outlining the D-KEFS factor structure from Latzman and Markon). Each subtest included in the current study is organized below by the EF factor it represents.

**Conceptual Flexibility.** The Sorting Test is similar to the WCST and was designed to assess for the higher-order EF skills of problem-solving, abstract reasoning, initiation, and cognitive flexibility. During Condition 1 (Free Sorting), the participant is presented with six cards, displaying both verbal and perceptual features, and asked to sort the cards into two groups according to as many different sorting rules as possible. For each sort, the participant is asked to describe the rule s/he used for sorting the cards (Free Sort Description). During the Sort Recognition Condition, the *examiner* sorts the cards into two groups according to eight different sorting rules and the participant is required to identify the correct sorting concept. Cognitive flexibility is engaged in order to identify novel patterns based on abstract concepts rather than perseverating on previous categorization. All three Sorting Test condition scores were used for the Conceptual Flexibility composite.

**Monitoring.** The Verbal Fluency (VF) Test measures the ability to generate words fluently given specific task constraints. VF consists of three conditions: Letter Fluency, Category Fluency, and Category Switching. Letter Fluency and Category Fluency require the participant to generate as many words as possible that begin with a specified letter or belong to a designated semantic category, respectively. The first two conditions measure vocabulary, attention, semantic organization, initiation, and processing speed. The third condition, Category Switching (total correct responses and total switching accuracy), requires the participant to quickly alternate between generating words from two different semantic categories, assessing the individual's cognitive flexibility. All three VF condition scores were used for the Monitoring composite.

**Inhibition.** The Trail Making Test (TMT) is a visual attention task consisting of five conditions in which the participant is required to complete a series of increasingly complex "connect-the-dot" tasks. The Number-Letter Switching condition, similar to Part B of the traditional Trail Making Test, requires multi-tasking, simultaneous processing, and divided attention. The other four conditions allow for gathering data on the underlying component skills necessary for switching such as visual scanning, number and letter sequencing, and motor speed. Latzman and Markon (2010) suggest the Number-Letter Switching condition assesses for the ability to inhibit overlearned responses to allow for flexible thinking, and thus, is included in the Inhibition composite for this study.

Similarly, much like the Stroop (1935) task, the Color Word Interference Test (CWI) measures the ability to inhibit automatic prepotent verbal responses in order to generate a conflicting response. The CWI consists of four conditions, the first two being baseline conditions used for measuring the key component skills of the higher-order task (i.e., Condition 1: naming the color; Condition 2: reading the word). Condition 3 consists of the traditional interference task in which the participant must inhibit reading the word in favor of naming the dissonant ink color. Condition 4 is a measure of both inhibition and cognitive flexibility as the participant must switch between naming the dissonant ink color and reading the word. CWI Conditions 3 and 4 were used, in combination with TMT Number-Letter Switching Condition, to derive the Inhibition composite in accordance with the Latzman and Markon (2010) three factor model.

## Procedure

All study procedures were approved by the Auburn University Institutional Review Board (IRB) prior to recruitment. Prior to participation, parents/guardians completed a packet containing a consent form and demographic questionnaire including contact information for the child's general education teacher. For children in middle school, contact information for the child's English teacher was requested. Upon receipt of the parent forms, the eligible child's teacher was sent a packet containing a consent form and the teacher form of the SPPC. Subsequent to teachers returning the signed consent form and completed SPPC, children were scheduled for a laboratory research session. Child assent was secured prior to starting the session. Parents/children and teachers were compensated $25 and $5, respectively.

Given that perceived performance on the WASI and EF measures could potentially influence the participant's rating of his or her self-perception, administration of the measures were partially counterbalanced such that the SPPC self-report and CDI 2:SR[S] was administered first in a counterbalanced fashion followed by counterbalanced administration of the WASI, Digit Span Backwards, and D-KEFS. For the self-report measures (i.e., SPPC, CDI 2: SR [S]), instructions were read aloud to the participant to ensure comprehension. The sessions lasted approximately 2 ½ hours, with 5 minute breaks between each task. Tests were administered by two trained clinical psychology graduate-level research assistants (Southeast) and the Principal Investigator (Southeast, Northeast).

### Analytical Approach

Weighted EF composite variables were developed by applying the factor loadings established by Latzman and Markon (2010) to their relevant D-KEFS measures. Specifically, the sum of the cross-products (score X loading) was divided by the sum of the loadings. Data were first examined for differences in independent and dependent variables between the Southeast and Northeast cohort groups as well as between examiners. Study variables were then combed for outliers and inspected for normality. Next, bivariate correlations were conducted among study variables. Finally, regression analyses were conducted to examine the relationship between the predictor variables and each dependent variable (e.g., Academic, Social, and Behavioral PIB), a total of three regression analyses. Variables were only retained as predictor variables if they were significantly correlated with the respective PIB variable in the bivariate analyses ($p < .05$). Therefore, the regression approach differed across PIB domains depending on the preliminary analyses.

# Results

## Group Differences

Independent samples t tests were used to examine whether the study variables differed between the Southeast and Northeast cohorts. Results indicated that the two cohorts did not differ on any variable. Additionally, a one-way ANOVA was conducted to examine potential differences in study variables between examiners. No significant differences were found.

## Outliers and Normality

Data were combed for outliers by examining standardized residual $z$ scores. All variables were found to be within the acceptable range (e.g., -3 and 3) and thus no outliers were identified. Additionally, $z$ scores were calculated for skewness and kurtosis by dividing by their respective standard errors. All variables were found to have acceptable skew and kurtosis (i.e., $z$ score values within $\pm$ 2.58). Furthermore, visual analysis of residual plots indicated that all variables were normally distributed.

## Correlational Analyses

Correlations were examined to determine which independent variables (e.g., CDI, Digit Span Backward, FSIQ-2, Conceptual Flexibility, Monitoring, and Inhibition) and which demographic variables (e.g., Age, Sex, and Race) were associated with the dependent variables (e.g., Academic, Social, and Behavioral PIB). Table 1 presents correlations among study variables as well as means, standard deviations, and ranges. FSIQ-2 scores were moderately to strongly correlated with all the EF composite variables. Additionally, all EF composite variables were moderately correlated with each other. However, the correlations among the EF composite variables and between the EF composite variables and FSIQ-2 scores were not so high as to suggest problems with multicollinearity (e.g., all correlations were below .7). In terms of potential covariate variables, FSIQ-2 scores were significantly correlated with Academic PIB scores and thus retained as a predictor variable for the respective regression analyses. No significant correlations were found between CDI scores and the dependent variables. Furthermore, no significant correlations were found between demographic variables and dependent variables. In terms of the study hypotheses, the EF variables (e.g., Digit Span Backwards, Conceptual Flexibility, Monitoring, and Inhibition) correlated with the dependent variables in manners contrary to proposed hypotheses. Digit Span Backwards scores were only significantly correlated with Social and Behavioral PIB rather than associated across all dependent variables. However, the direction of the correlation was as predicted. In addition to FSIQ-2, Academic PIB scores were found to be significantly correlated with Conceptual Flexibility rather than Monitoring. Social PIB scores were significantly associated with Monitoring, in addition to Digit Span Backwards, rather than Conceptual Flexibility. Behavioral PIB scores were only significantly correlated with Digit Span Backwards scores as opposed to both Digit Span Backwards and Inhibition. Significant correlations were retained for inclusion in regression analyses.

## Regression Analyses

Regression analyses were conducted for each of the three dependent variables to determine to association between the EF variables and respective PIB levels. For all regression analyses, the assumptions of linearity, independence of errors, homoscedasticity, unusual points and normality of residuals were met. Additionally, no variance inflation factor (VIF) values were above 2 (values >10 are typically considered problematic) and no tolerance values were below .70 (values < .10 are typically considered problematic; Cohen, Cohen, West, & Aiken, 2002), indicating that the regression models did not suffer from problems with collinearity.

**Academic PIB.** A hierarchical multiple regression was conducted to determine if the addition of Conceptual Flexibility improved the prediction of Academic PIB over and above FSIQ-2 alone. See Table 2 for full details on each regression model. The full model of FSIQ-2 and Conceptual Flexibility to predict Academic PIB (Model 2) was statistically significant, $R^2$ = .10, $F(2, 65) = 3.62$, $p < .05$; adjusted $R^2 = .07$. The addition of Conceptual Flexibility to the prediction of Academic PIB led to a statistically significant increase in $R^2$ of .06, $F(1, 65) = 4.43$, $p < .05$.

**Social PIB.** A standard multiple regression was conducted to predict Social PIB from Digit Span Backwards and Monitoring (See Table 2). These variables significantly predicted Social PIB, $F(2, 65) = 3.38$, $p < .05$, adj. $R^2 = .07$. Neither Digit Span Backwards nor Monitoring added statistically significantly to the prediction, however, Monitoring approached significance, $p = .053$.

**Behavioral PIB**. A linear regression was conducted to predict Behavioral PIB from Digit Span Backwards. Digit Span Backwards did not significantly predict Behavioral PIB, $F(1, 66) = 3.49$, $p = .07$. Despite a significant bivariate correlation, Digit Span Backwards only accounted for 4% of the explained variance in Behavioral PIB.

## Discussion

The goals of the present study were to expand upon the PIB literature by exploring specific patterns of executive dysfunction in children with varying levels of PIB to better understand the relationship between cognitive deficits and PIB. Previous research (McQuade et al., 2011; Miyake et al., 2011) suggested that patterns of EF differed across domains of academic, social, and behavioral functioning, thus, hypotheses were established for each specific domain of functioning in addition to hypothesis related to a global pattern of EF functioning. Based on existing PIB literature which found that children with ADHD and comorbid academic, social, and/or behavioral problems tend to overestimate their competence in the domains of greatest impairment (Hoza et al., 2002; Jiang & Johnston, 2014; Treuting & Hinshaw, 2001), specific EF deficits were hypothesized according to empirical support for relationships between the EF factor and impairment in the relevant domain of functioning. Though the findings from this study did support differences in EF patterns related to different domains of functioning, the hypothesized relationships between the specific EF constructs and their respective domain of functioning were not supported. Additionally, previous research has established an inverse relationship between depressive levels and PIB such that children who report higher levels of depressive symptoms tend to have more realistic views of their competence. This study failed to find a significant association between depressive symptoms, as measured by the CDI: 2 SR[S], and PIB for any domain. However, it should be noted that the internal consistency of the CDI 2:

SR[S] for the present study was lower than the normative sample, though still within the acceptable range, suggesting that our sample may not be representative of the normative sample. Post hoc item analysis did not identify any item that, if deleted, dramatically changed alpha levels. Thus, the CDI 2: SR[S] may not accurately describe depressive levels for participants in this study.

First, it was hypothesized that levels of PIB in the academic domain would be predicted by the Updating/Monitoring factor based on demonstrated associations between Updating/Monitoring and reading, arithmetic, verbal, and nonverbal reasoning in previous findings (Altemeier, Jones, Abbott, & Berninger, 2006; van der Sluis, Jong, & van der Leij, 2007). Instead, Conceptual Flexibility were found to be associated with inflated estimates of academic performance when controlling for effects of IQ. Latzman and Markon (2010) related their Conceptual Flexibility factor to Miyake et al.'s Shifting factor based on the requirement of mental set shifting, problem-solving initiation, and concept formulation. In a meta-analysis of the relationship between shifting ability and academic performance, Yeniad and colleagues (2012) found a substantial association between capacity to switch a conceptual representation and performance in math and reading. Furthermore, the authors found a strong association between intelligence and shifting similar to the findings of this study which also revealed a strong correlation between the two.

Second, it was hypothesized that levels of PIB in the social domain would be predicted by Conceptual Flexibility. The prediction seemed reasonable given that previous studies found cognitive flexibility, particularly flexible application of social knowledge, to be positively associated with prosocial abilities and negatively associated with social difficulties in children (Jones & Day, 1997; Reiter-Palmon, 2003). Rather, working memory, as measured by Digit Span

Backwards, and Updating/Monitoring together were found to predict overestimations of social competence, however, neither independently contributed to the prediction, though Updating/Monitoring approached significance. The Monitoring construct identified by Latzman and Markon is comprised entirely of conditions from the D-KEFS Verbal Fluency Test subtest. There is some support for the relationship between verbal fluency and social skills in populations demonstrating deficits in frontal lobe functioning including schizophrenia (Stain, Hodne, Joa, ten Velden Hegelstad, Wenche, Douglas, et al., 2012) and TBI (Marsh & Knight, 1991). However, it is important to note that Latzman and Markon labeled the construct Updating/Monitoring to emphasize the verbal and semantic monitoring demands of the Category Switching tasks, whose loadings anchor the factor, as opposed to the other Verbal Fluency subtests which focus primarily on production. The authors suggested that Monitoring is closely related to working memory. As such, it is possible that Digit Span Backwards and Monitoring both represent aspects of working memory as predictors for Social PIB. In terms of social functioning, McQuade and colleagues (2011) demonstrated similar findings in that working memory deficits were uniquely associated with overestimations of social competence, though their sample was limited to children with ADHD. Theoretical models of EF have hypothesized that working memory plays an important role in social functioning (Barkley, 1997; Barrett, Tugade, & Engle, 2004). Specifically, working memory (i.e., the ability to store, process, and manipulate verbal and visuo-spatial information) is important in goal-directed behavior and retrospective and prospective thinking. In order to complete a goal, an individual must be able to maintain goal-related information in mind while searching for previously held goal-related information and determining future goal-oriented behavior. Therefore, children with working memory deficits may have difficulty maintaining social goals in mind while updating those goals with other social information and planning their next social response. Empirically, McQuade and colleagues (2013) found working memory deficits to be associated with poor social competence both in terms of overall social impairment as well as specific social impairments including aggression and poor conflict resolution skills.. Additionally, given that the previous findings of significant associations between cognitive flexibility and social competence focused on flexible use of social information, it is possible that the nature of the tasks identified as measuring flexibility failed to find the same association because they are novel tasks which do not incorporate social specific information. This speaks to the ecological validity of EF measures which is discussed later in this section.

Next, it was hypothesized that levels of PIB in the behavioral domain would be predicted by the Inhibition factor as inhibition has been found to be strongly related to disruptive behavior (Young, Friedman, Miyake, Willcutt, Corley, Haberstick, & Hewitt, 2009). However, results from this study suggested that none of the EF variables predict inflated self-views of behavioral performance despite a significant negative correlation with working memory. This suggests that while working memory is associated with overestimation of behavioral competence, the association is not strong enough to singularly predict levels of PIB. Therefore, it would seem that another EF factor in addition to working memory is necessary to predict behavioral PIB. Working memory impairments have been equivocally demonstrated in children with behavior problems including physical aggression and disruptive behavior (Séguin, Boulerice, Harden, Tremblay, & Pihl, 1999; Séguin, Pihl, Harden, Tremblay, & Pihl, 1995), however as mentioned previously, inhibition has the strongest demonstrated association with problematic behavior. Given that composite EF factors were constructed, it is possible that the lack of relationship between Inhibition and PIB in the behavioral domain in this study results from the composition of tasks comprising the Inhibition factor such that they are too diverse and represent a multidimensional factor. Additionally, inspection of the items which comprise the behavioral domain of the SPPC suggest that they may be too vague to detect actual problematic behavior and appear to be addressing the same issue (i.e., whether a child “behaves well”) rather than multiple aspects of behavior as compared to the academic and social domains.

Finally, it was hypothesized that working memory would predict levels of PIB across domains of functioning as Miyake and Friedman’s description of common EF appears closely related to working memory. This hypothesis was partially supported as working memory was negatively associated with positively biased perceptions of social and behavioral competence, such that poorer working memory scores predicted higher levels of inflated estimates of social and behavioral performance. It is possible that the relationship between working memory and perceived competence in the social and behavioral domains of functioning may be influenced by participants with a reported psychological diagnosis as working memory has been found to be particularly impaired in children with ADHD (Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005) as well as children with anxiety disorders (Vance, Ferrin, Winther, & Gomez, 2013) and learning disorders (Francis & Thomas, 2015). Post hoc analysis revealed the mean DSB score for children with a reported psychological diagnosis to be significantly lower ($M$ = 9.89, SD = 2.15) than children with no reported psychological diagnosis ($M$ = 11.47, SD = 1.68). Additionally, working memory scores for the study sample were slightly higher and tended to converge around the mean as compared to the normative data suggesting that the somewhat restricted range of this sample may have been unable to detect relationships between poor working memory and PIB across domains of functioning and account for the lack of association with Academic PIB. Interestingly, the Inhibition factor did not predict positively biased perceptions of competence for any domain of functioning. However, as mentioned previously, studies examining the unique variance of EFs proposed in the unity and diversity framework have found that after accounting for what is common across the EFs (unity), there was no inhibition-specific variance (Friedman, Miyake, Robinson, & Hewitt, 2011; Friedman, Miyake, Young, DeFries, Corley, & Hewitt, 2008).

Taken together, the findings from this study bear resemblance to Kruger and Dunning’s (1999) theory of ignorance of incompetence which proposes that individuals who are incompetent in a given domain are unable to recognize their incompetency because they lack the necessary skills required to accurately evaluate their abilities. Ignorance of incompetence posits that if an individual is lacking the skills to perform successfully in a given domain, it is likely that the skills required to assess performance in that domain are also lacking (Dunning, Johnson, Ehrlinger, & Kruger, 2003). Similar to the findings that children with ADHD overestimate their competence in the domains of greatest impairment, it can be reasoned that a child’s impairment in a given domain of functioning is responsible for inflated self-reports of competence and that the impairment in functioning and the subsequent impairment in self-evaluation result from deficits in executive functioning. For example, working memory deficits may make it difficult for a child to hold and process the social information necessary to plan appropriate social responses and that difficulty maintaining and updating social information may also impede a child’s ability to evaluate his or her social behaviors. It should be noted that impairment in domains of functioning were not examined in this study, but rather discrepancies between teacher and child ratings. Without further analysis, it is not possible to know if differences in EF levels exist between children whose scores are discrepant from their teachers and those who demonstrate actual impairments in functioning. However, as mentioned previously, an association between highly discrepant ratings and impairment has been demonstrated (Bivona, Ciurli, Barba, Onder, Azicnuda, Silvestro, et al., 2008; Boivin, Poulin, & Vitaro, 1994; Heath & Glen, 2005; Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007; Zakriski & Cole, 1996).

Several limitations for this study should be noted. An important consideration is the ability for the selected performance tasks to accurately measure the EF constructs which they were developed to measure. EF tests such as the subtests of the D-KEFS are often purported as the gold standard in detection of EF deficits despite little support for their ecological validity (Barkley & Murphy, 2011). Specifically, EF tests are novel in nature and do not resemble real life activities that exercise use of EF. Not surprisingly, EF tests are poorly associated with measures of EF in natural settings including ratings of EF in daily life activities and observation of EF performance related to real-world tasks. For example, Barkley and Murphy (2011) found that self-reported ratings of EF in daily life as measured by the Barkley Deficits in Executive Functioning Scale (BDEFS; Barkley, 2011) identified clinical levels of EF impairment in individuals with ADHD as well as substantial differences in EF functioning between clinical and community samples whereas performance-based measures of EF only identified a portion of the ADHD or clinical sample as impaired with largely no differences between the community sample. Barkley (2011b, 2012) also presents clear evidence of the association between self- and parent-rated EF and psychosocial functioning. Therefore, it is possible that the low effect sizes for the findings of the present study result from an incongruence between the performance-based measures of EF and the ratings of academic, social, and behavioral performance in natural settings. The ecological validity of the EF measures derived for the D-KEFS battery could be improved in future studies by the addition of EF rating scales.

A second measurement concern involves the use of discrepancy analysis as an estimation of PIB. Owens et al. (2007) note the limitation in the use of differences scores in populations such as children with ADHD in which individuals are statistically more likely to overestimate their competence in given domains due to their demonstrated lower levels of actual competence, and corresponding lower criterion scores, as compared to other children. Conversely, developmentally typical children may demonstrate a ceiling effect whereby it is mathematically impossible to overestimate the performance if the rating of their performance is too high. Furthermore, though teacher reports are considered the standard criterion against which to compare child self-reports of competence, it is possible that inflated self-reports in some clinical populations result from negatively biased teacher reports due to the difficulties teachers sometimes experience with such children, especially children demonstrating disruptive behaviors. Future studies could control for potential rater bias through the use of more objective measures of competence including achievement scores and lab task performance.

Additionally, the EF composite variables used in this study to predict levels of PIB were based on a factor structure of the D-KEFS measures that was derived after the development of the D-KEFS battery and therefore not grounded by empirically-supported theory. Furthermore, the factor loadings used to weight the EF composite variables are based on the sample measured by Latzman and Markon (2010). Though their three-factor model was supported by a confirmatory factor analysis, it is impossible to know if the current study sample would yield the same factor loadings without exploratory factor analysis, which is outside the scope of this study. Additionally, the current sample size is smaller than the sample used to determine the three-factor model. Therefore, it is possible that the D-KEFS tests and the corresponding assigned weight chosen to comprise the composite EF variables do not accurately depict the intended EF factors for this sample. Further research on the factor structure of the D-KEFS and other EF tests is necessary to validate the model posited by Latzman and Markon and the subsequent use of the EF composites in this study.

To the best of our knowledge, this study is only the second to examine the relationship between cognitive deficits and positive illusory bias and the first to extend its scope outside children with ADHD to the general population. Ultimately, more research across populations is necessary to examine the relationship between executive functioning and positive illusory bias. Given that biased self-evaluations are associated with negative outcomes for varied clinical samples, understanding the underlying contributing factors may provide critically useful information in developing interventions to remediate academic, social, and behavioral impairments.

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Table 1

*Means, Standard Deviations, and Intercorrelations of Study Variables*

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sex | — | .10 | -.22 | .05 | .13 | .21 | .10 | .09 | .05 | -.11 | -.03 | -.18 |
| 2. Race | | — | -.21 | .25* | .20 | . 05 | -.04 | .08 | -.06 | -.12 | .15 | .00 |
| 3. Age | | | — | -.08 | .04 | -.01 | .18 | .10 | .21 | .05 | .00 | .06 |
| 4. CDI | | | | — | -.21 | -.24* | -.07 | -.10 | -.17 | -.07 | -.17 | .11 |
| 5. FSIQ-2 | | | | | — | .21 | .50** | .50** | .50** | -.28* | .00 | -.11 |
| 6. DSB | | | | | | — | .13 | .12 | .02 | -.16 | -.27* | -.29* |
| 7. Conceptual Flexibility | | | | | | | — | .26* | .39** | -.31* | -.12 | -.05 |
| 8. Monitoring | | | | | | | | — | .48** | -.18 | -.26* | -.10 |
| 9. Inhibition | | | | | | | | | — | -.23 | .05 | -.02 |
| 10. Academic PIB | | | | | | | | | | — | .42** | .18 |
| 11. Social PIB | | | | | | | | | | | — | .30* |
| 12. Behavioral PIB | | | | | | | | | | | | — |
| *M* | — | — | 10.66 | 53.17 | 104.74 | 11.19 | 99.36 | 100.08 | 100.99 | -1.52 | -1.07 | 0.75 |
| SD | — | — | 1.58 | 9.93 | 10.63 | 2.00 | 13.30 | 11.97 | 10.47 | 4.53 | 5.03 | 5.14 |
| *Minimum* | | | | 40 | 80 | 7 | 68.82 | 74.76 | 76.35 | -12 | -11 | -15 |
| *Maximum* | | | | 75 | 126 | 14 | 124.94 | 122.29 | 126.35 | 8 | 9 | 11 |

*Note.* Age is calculated in years. CDI = Children's Depression Inventory 2$^{nd}$ Edition Self-Report Short Version total T-score; FSIQ = Wechsler Abbreviated Scale of Intelligence Full Scale-2 IQ; DSB = Wechsler Intelligence Scale for Children – Fourth Edition Digit Span Backwards subtest. *n* = 68.

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

Table 1

*Regressions Predicting Biased Perception of Competence in Domains of Functioning*

| | Step/Model 1 | | | | | Step/Model 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | SE | β | t | *p* | B | SE | β | t | *p* |
| DV: Academic PIB | $F(1,66) = 2.66$, $R^2 = .04$, adj. $R^2 = .02$, $\Delta F = 2.66$ | | | | | $F(2, 65) = 3.62$*, $R^2 = .10$, adj. $R^2 = .07$ $\Delta R^2 = .06$, $\Delta F = 4.43$ | | | | |
| FSIQ-2 | -.09 | .05 | -.20 | -1.63 | .11 | -.02 | .06 | -.06 | -.40 | .69 |
| Conceptual Flexibility | | | | | | -.10 | .05 | -.29 | -2.11 | .04* |
| DV: Social PIB | $F(2, 65) = 3.38$*, $R^2 = .09$, adj. $R^2 = .07$ | | | | | | | | | |
| DSB | -.09 | .07 | -.17 | -1.44 | .15 | | | | | |
| Monitoring | -.10 | .05 | -.24 | -1.97 | .05† | | | | | |
| DV: Behavioral PIB | $F(1, 66) = 3.49$, $R^2 = .05$, adj. $R^2 = .036$ | | | | | | | | | |
| DSB | -.13 | .07 | -.22 | -1.87 | .07 | | | | | |

Note. N = 68. FSIQ-2 = Wechsler Abbreviated Scale of Intelligence Full Scale-2 IQ; DSB = Wechsler Intelligence Scale for Children – Fourth Edition Digit Span Backwards subtest. **p* < .05, †*p* = approaching significance

Appendix A

*Psychometric Properties of Relevant D-KEFS Variables*

| D-KEFS Test/Variable | Latent Variable | Internal Consistency for Ages 8-19 | Test-Retest $r_{12}$ for Ages 8-19 |
|---|---|---|---|
| Trail Making Test | | | |
| Condition 4: Number-Letter Switching | Inhibition | * | .20 |
| Color Word Interference | | | |
| Condition 3: Inhibition | Inhibition | * | .90 |
| Condition 4: Inhibition/Switching | Inhibition | * | .80 |
| Verbal Fluency | | | |
| Letter Fluency | Monitoring | .68-.81 | .67 |
| Category Fluency | Monitoring | .58-.75 | .70 |
| Category Switching Total | Monitoring | .37-.62 | .65 |
| Category Switching Accuracy | Monitoring | .53-.76 | .53 |
| Sorting Test | | | |
| Condition 1: Free Sorting | Conceptual Flexibility | .55-.82 | .49 |
| Condition 2: Free Sorting Description | Conceptual Flexibility | .55-.80 | .67 |
| Condition 3: Sort Recognition | Conceptual Flexibility | .62-.74 | .56 |

*Note*. *No information provided in D-KEFS Technical Manual regarding the Internal Consistency for indicated items due to item-interdependences and ability for examinees to adjust their performance according to feedback and rehearsal on previous components.

Appendix B

*Excerpted Factor Structure Table from Latzman and Markon (2011)*

**Table 2.** Study I: Quartimin Rotated Exploratory Factor Model for 18- to 19- Year-Olds

| D-KEFS Achievement Tests | Conceptual Flexibility | Monitoring | Inhibition | $h^2$ |
|---|---|---|---|---|
| Sorting Cond. I: Free Sort | **.97** | –.00 | –.02 | .07 |
| Sorting Cond. II: Free Sort Description | **1.00** | –.02 | –.01 | .03 |
| Sorting Cond III: Sort Recognition | **.53** | .13 | .12 | .60 |
| Trail Making Test | .07 | .10 | **.38** | .81 |
| Color–Word Test: Inhibition | –.03 | .01 | **.82** | .34 |
| Color–Word Test: Inhibition/Switching | .02 | –.08 | **.69** | .54 |
| Twenty Questions Test | .20 | .02 | .20 | .89 |
| Verbal Fluency: Letter Fluency | .10 | **.37** | .25 | .71 |
| Verbal Fluency: Cat. Fluency | .06 | **.46** | .21 | .67 |
| Verbal Fluency: Cat. Switching Accuracy | .00 | **.92** | –.02 | .17 |
| Verbal Fluency: Cat/Switch Accuracy | –.03 | **.80** | –.05 | .40 |
| Design Fluency | .07 | .08 | .25 | .90 |
| Tower Test: Achievement | –.11 | .01 | –.05 | .98 |
| Tower Test: Accuracy Ratio | .25 | .24 | .17 | .77 |
| Word Context Test | .24 | .19 | .18 | .81 |

Note: D-KEFS = Delis-Kaplan Executive Function System; N = 702; $h^2$ = unique variance. Loadings ≥ .30 are in given boldface.