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## The Impact of Ethnicity on Executive Functioning in Youth

Silvia M. Henriquez Gerken  
*DePaul University*, shenriqu@depaul.edu

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The Impact of Ethnicity on Executive Functioning in Youth

A Dissertation  
Presented in  
Partial Fulfillment of the  
Requirements for the Degree of  
Doctor of Philosophy

By  
Silvia Margarita Henriquez

June 2015

Department of Psychology  
College of Science and Health  
DePaul University  
Chicago, Illinois

**Dissertation Committee**

Jocelyn Carter, Ph.D., Chairperson

Antonio Polo, Ph.D.

Trina Davis, Ph.D.

Patrice Bounds, Ph.D.

Mojdeh Bayat, Ph.D.

Scott Hunter, Ph.D.

### **Biography**

Silvia Henriquez was born in Santo Domingo, Dominican Republic on September 14, 1986. She graduated from St. Michael's High School in Santo Domingo. She received her Bachelor of Science degree from the University of Florida University in 2008, and her Master of Arts degree in Psychology from DePaul University in 2012.

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## **Abstract**

Executive function can be defined as a group of processes that guide and direct cognitive functions (Isquith, Roth & Gioia, 2013). Relatively little is known about executive function in ethnic minority children. This dissertation examined whether ethnicity predicts performance and parent rating scores on three executive function processes. To date, no study has teased apart the effects of ethnic minority status and its confounding variables in executive function. A total of 134 Caucasian and African American youth between the ages of 11-17 were included in the study. Of those 134 youth, 116 had complete data (both performance-based scores and rating scales) and 18 had rating scales only and no performance-based scores. Results of the current study demonstrate that ethnicity does not predict performance scores or parent-report scores on any executive function after controlling for age, gender, comorbidity, diagnosis, and socioeconomic status. Comorbidity, or number of diagnoses was a significant predictor of performance scores and parent-report scores. Finally, socioeconomic status and age moderated the relationship between rating scales and performance-based measures, with youth over the age of 13 and youth of higher socioeconomic status reporting significantly fewer executive function deficits regardless of their scores on performance-based measures. Executive functions are an integral part of success across settings. There is a continued need to identify variables that impact executive functions in order to implement appropriate interventions.



## INTRODUCTION

### **Theoretical Models of Executive Function**

There are several definitions of executive functions. This study uses Gioia and colleagues' definition given this is the most widely accepted and fits with the measures administered. Executive function can be defined as a group of processes that guide and direct cognitive functions (Gioia, Isquith, Guy, & Kenworthy, 2000, page 1; Isquith, Roth & Gioia, 2013). Throughout the years, several theoretical models of executive function have been developed. The following section will introduce some of the most accepted models of executive function and will explain how models have changed over time. Zelazo's theory of executive function was used as the dominant theory in the current project and will be described in detail in its corresponding section.

### **Frontal Lobe Syndrome**

Luria introduced the concept of EF in connection with his description of "the frontal lobe syndrome" (FLS) in 1969. This syndrome was observed when there was observable damage to the frontal lobes of the brain and individuals with FLS typically demonstrated deficits in problem solving, which was attributed to this damage. Luria's operationalization of EF was based on his theory of the brain's functional systems (Luria, 1964) derived from his work with brain-injured patients. In his theory, Luria hypothesized a relationship between the frontal lobes, purpose, and decision-making. Luria observed significant deficits in executive skills in patients with damages to prefrontal lobes. These patients were disorganized, impulsive, and demonstrated poor planning which lead to increased

difficulty reaching goals. Luria regarded executive function as a single, homogeneous construct meaning that it served as one function: creating goal-directed behavior (Luria, 1964). Overall, Luria's frontal lobe theory was the first to introduce executive functions and served as a starting point for later theories (Canavan, Janota & Schurr, 1985; Kotik-Friedgut, 2006).

### **The Central Executive**

The central executive theory, introduced by Baddeley and Hitch (1974), provided a more thorough understanding and definition of executive functions. The "central executive" was described as a component linking together several neural networks including the dorsolateral prefrontal cortex. The central executive theory integrated attentional control theory (Norman & Shallice, 1980) as essential for understanding tasks involving decision making, inhibitory control, and problem solving in novel situations. Attentional control theory is the purposeful planning during new situations while avoiding errors, monitoring performance, and modifying unsuccessful strategies to solve problems. The central executive also included individuals' ability to shift between tasks, and their motivation to complete goal-oriented tasks. The central executive was regarded as a system linking all of these processes and extensive damage to the frontal lobes resulted in "Dysexecutive Syndrome," a syndrome resulting in poor inhibition, motivation, and problem solving when confronted with goal-oriented behavior or novel tasks (Baddeley, 1986). The central executive theory integrated different neural networks (e.g., phonological and visuospatial) and moved away from Luria's view of executive function as a single construct.

### **Zelazo's Executive Function Theory**

Zelazo's theory of executive function built on the Central Executive Theory but incorporates theories of development and awareness (Carlson, 2005; Garon, Bryson, & Smith, 2008). Zelazo's theory of executive function is dependent on development and the ability of an individual to use increasingly complex processes; for example, self-directed speech or self-talk develops in middle childhood and is considered an important component in novel problem solving (Garon, Bryson, & Smith, 2008). His theory also incorporates Cognitive Complexity & Control Theory, which states that self-awareness develops through stages or levels that involve the pre-frontal cortex. This involvement of self-awareness relates to the individual's experiences and affect recall and cognitive control (Zelazo, 2004). Given the involvement of awareness and consciousness in his theoretical model, Zelazo distinguishes between "cool" and "hot" executive functions. "Cool" functions are associated with more cognitive functions (problem-solving, planning) and are associated with the dorsolateral prefrontal cortex. "Hot" executive functions are associated with affective states (emotional regulations, behavioral inhibition) and are associated with the medial regions of the prefrontal cortex. Zelazo's theory of executive function is currently the most dominant theory of executive function and has been widely studied and supported including cross-cultural studies, experimental studies, and EEG studies (Carlson, 2005; Garon, Bryson, & Smith, 2008; Jurado & Rosselli, 2007; Miller & Marcovich, 2015). Zelazo's theory of executive function was used as the dominant theory in the current project.

## **Components of Executive Function**

Many of the factors implicated in executive functions can be divided into two broad dimensions. Egeland and Fallmyr (2010) examined the factor structure of EF based on the models put forth by Gioia and colleagues (2000). Gioia and colleagues used factor analysis to determine the factor structure of executive functions in parent and teacher ratings and found the same two-factor structure for both clinical participants and controls. Results of Egeland and Fallmyr's (2010) study support Gioia's results and state executive functions are best classified into eight categories, which fall under two main subtypes: Metacognition and Behavioral Regulation. The metacognition subtype is comprised of monitoring, planning and organization, working memory, initiation, and organization of materials. The Behavioral Regulation subtype is comprised of inhibition, cognitive flexibility/shifting, and emotional control. The Metacognition Index is related to "cool" processes whereas the Behavioral Regulation Index is related to "hot" processes.

Research findings suggest that different aspects of executive function are worth assessing both in a controlled setting and in everyday life (Fuhs, Farran & Nesbitt, 2015). It is important to assess multiple executive functions in various settings in order to obtain a complete assessment of the person's strengths and weaknesses. Assessing executive function across settings could provide important information. For example, teacher and parent reports of executive function may provide insight as to how youth use executive skills in day-to-day settings while performance-based measures may provide insight into youth's abilities in a

distraction-free, one-on-one setting (Fuhs, Farran & Nesbitt, 2015). Further, it is important that different raters assess daily functions in order to observe differences across environments (Wochos, Semerjian & Walsh, 2014).

The executive function tests selected for this study are some of the most commonly studied: inhibition, working memory, and cognitive flexibility. These three components were chosen because they are among the most commonly assessed in neuropsychological batteries (Best & Miller, 2010; Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000) and the tasks measure these constructs independently, which facilitates the interpretation of results. Currently, there are no pure measures of executive function; however, the measures selected have most of the variance attributed to the operationalization of the selected executive functions.

Each of the executive functions measures will be described in more detail in the following sections, first providing a conceptual overview and then discussing performance-based and self-report assessment of the construct. Procedures used to operationalize executive function in clinical settings include performance-based measures. Performance-based measures are administered by a trained examiner in a standardized manner. Rating scales of executive function involve an informant providing insight into challenges faced everyday functioning (Roth, Isquith, & Gioia, 2005). Commonly used rating scales of executive function include the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and the Comprehensive Executive Function Inventory (CEFI; Goldstein & Naglieri, 2012). The current study will

use the BRIEF to measure every-day executive function in youth. The BRIEF was part of the neuropsychological battery administered to all participants being evaluated through the neuropsychology service. The BRIEF was chosen because it has a long history of use and validity compared to the CEFI. On the BRIEF, examinees, their parents, and/or their teachers answer a total of 86 questions related to everyday activities (Gioia et al., 2000).

Table 1. Executive functions based on the BRIEF factor structure.

<b><u>Metacognition</u></b>	
Planning	Ability to plan ahead when involved in a particular task
Monitoring	Extent to which an individual can check his/her behavior in reference to their work
<i>Working Memory</i>	Ability to retain information for a short period of time and use it, as needed
Initiation	Ability to start a task
Organization of Materials	Ability to keep information organized
<b><u>Behavioral Regulation</u></b>	
<i>Inhibition</i>	Ability to resist impulses
<i>Cognitive Flexibility/Shifting</i>	Ability to transition from one activity or situation to the next without disruption or difficulty
Emotional Control	Ability to regulate emotional responses

\*Note: Italicized executive functions will be examined as part of the current study.

### **Inhibition**

Inhibition is defined as “the ability to control impulses” (Miyake et al., 2000). Inhibition is essential in directing goal-oriented behavior through resisting interference from non-essential information (Logue & Gould, 2013). For example,

in children or adolescents, inhibitory control is the ability to resist the impulse to use social media while doing homework. Additionally, inhibition can include the ability to resist the use of previously learned unsuccessful strategies. For example, a child uses a guessing strategy on his last test and earns a poor grade. Despite this, he is unable to resist the use of this strategy on his next test. Inhibition is particularly relevant when facing new problem-solving tasks that require the use of new strategies.

Development plays a central role in inhibitory control. Inhibition emerges in early childhood and continues to develop through adolescence. Inhibition begins to develop around age one and continues to improve over the course of development (Hunter & Sparrow, 2012, p.24). Language and motor development help toddlers facilitate their responses to their environment. As children enter preschool, neural proliferation and active pruning merge with increasing myelination of the frontal and prefrontal systems, which lead to increase inhibitory control (Garon, Bryson & Smith, 2008; Hunter & Sparrow, 2012, p.26). By age three, most children can inhibit simple responses (Hughes, 1998); however, they continue to struggle with other inhibitory responses such as delayed gratification (Carlson & Moses, 2001; Lehto & Uusitalo, 2006; Sabbagh, Xu, Carlson, Moses & Lee, 2006) and may score poorly on tasks of inhibitory control that require motor control or other underdeveloped skills (Diamond & Taylor, 1996). By kindergarten and first grade, children begin to learn self-direction and are taught “stop and think” strategies that allow them to consider multiple options. A study by Zelazo and colleagues (2003) showed that three and

four-year olds were able to inhibit responses but had difficulty identifying rule systems which led them to make perseverative errors. Rule systems are learned with age and thus impacted the scores on this task of inhibition. Zelazo's study is an example of the different developmental sequences of inhibition.

In middle childhood, particularly as children enter the fourth grade, demands for inhibitory control are greater in order for children to achieve independent goals (Gerstad, Hong & Diamond, 1994). There are mixed findings regarding the development of inhibitory control past age 12. Some research suggests that inhibitory control is fully developed between 10 and 12 years of age (Hunter & Sparrow, 2012, p.28; Klenberg, Korkman & Lahti-Nuutila, 2001; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003). On the other hand, researchers have also found evidence of increased inhibitory control during adolescence and adulthood, when myelination of the orbitofrontal region of the prefrontal cortex and maturation of white matter tracts further strengthens executive skills (Brocki & Bohlin, 2004; Casey, Trainor, Orendi, Schubert, Nystrom, Giedd, et al., 1997; Cragg & Nation, 2008; Hunter & Sparrow, 2010, p. 29; Jonkman, 2006; Jonkman, Lansbergen, & Stauder, 2003; Lamm, Zelazo, & Lewis, 2006).

**Inhibition: performance-based assessments.** Performance-based assessments of inhibition typically involve elements of accuracy and/or response time in response to particular tasks (Best & Miller, 2010). Many tasks in performance-based assessments involve variable amounts of inhibitory control and simultaneously measure other areas (e.g. attention). There are specific performance-based assessments that are designed to primarily assess inhibition.



For example, the go/no go task, the stop signal task, and the Stroop task are measures of inhibition.

The Stroop Interference Task (Adams & Jarrold, 2009; Jensen & Rohwer, 1966; MacLeod, 1991; Stroop, 1935) is another commonly used task to assess inhibition. In this task, individuals are asked to read a list of color words, where the words are printed in colors that do not match the word. Next they are required to name the color of the ink rather than reading the word. Scores reflect how accurately individuals can inhibit the impulse to read the word versus naming the color of the ink. At least fifteen studies have examined the Stroop Interference Task in children with inhibitory control deficits (e.g., Borella, De Ribaupierre, Cornoldi & Chicherio, 2013; Cao et al., 2013; Van der Oord, Geurts, Prins, Emmelkamp & Oosterlaan, 2012), while hundreds of other studies have created variations of the Stroop task. Overall, numerous studies confirm that the Stroop task is an adequate differentiator of children with and without inhibitory control deficits (Borella et al., 2013; Cao et al., 2013). The Stroop task differentiates typical performance from impaired performance by measuring response time (e.g., delay in response and inconsistent responding). Although the Stroop task differentiates between individuals with ADHD and other diagnoses involving poor inhibitory control, few studies have looked at the Stroop task in relation to ethnic differences and the few that exist have methodological flaws. The current study will use a Stroop task from the D-KEFS (Delis, Kaplan, & Kramer, 2001a) to assess inhibition in children. More information regarding previous research on ethnic differences on the Stroop task will be presented later in this proposal.

**Inhibition: rating scale assessments.** The BRIEF measures inhibition using, items that ask about difficulties controlling impulses such as interrupting others, waiting in line, and the ability to stop behaviors. Differences in inhibitory control between individuals with frontal lobe lesions and frontal lobe deficits compared to controls have been found on the BRIEF (Skogan et al., 2015; Skogli, Teicher, Andersen, Hovik & Oie, 2013). Approximately 30 studies have used the BRIEF when comparing youth with and without frontal lobe deficits on every day executive functions (e.g., Skogan et al., 2015; Qian, Shuai, Cao, Chan & Wang, 2010). Research using the BRIEF suggests that individuals with frontal lobe deficits have more difficulties with everyday tasks involving inhibition (McCandless & O'Laughlin, 2007; Qian, Shuai, Cao, Chan & Wang, 2010). In summary, the inhibition subscale of the BRIEF is able to differentiate between youth with and without every-day difficulties in the area of inhibition; however, no studies have examined ethnic differences on this subscale.

### **Working Memory**

Working memory is the ability to retain information and to use it during goal-directed behavior (Logue & Gould, 2013). Working memory involves engaging, encoding and retrieving information. It is argued that working memory is the building block of many other executive functions and serves as the basis of other self-directed actions given that more working memory provides capacity for more complex processes (Luciana, Conklin, Hooper, & Yarger, 2005). Currently, there are two dimensions of working memory that are commonly studied: verbal and visual memory. Verbal memory involves phonological processes whereas

visual memory involves spatial processing. Working memory is present in early childhood and is evident by toddlers' ability to keep a representation in mind and act accordingly (Hunter & Sparrow, 2012, p.23). For example, the emergence of object performance demonstrates short-term memory since the child is able to remember that a previously presented object continues to exist and the child may search for this object when it is not present. Working memory improves throughout the life span, or as the prefrontal cortex continues to develop (Garon et al., 2008). The development of language is a significant milestone influencing working memory (Gathercole, Pickering, Ambridge, & Wearing, 2004; Luciana et al., 2005). Through language, children can better organize processes and consolidate information more effectively. By preschool, children can demonstrate understanding of time and are able to hold long-term information more effectively, which will then guide decision-making (Luciana et al., 2005). Attentional control at this stage is still quite immature and influences children's ability to encode information. By middle school, a significant demand is placed on children to learn academic concepts and to retrieve important information. Similar to inhibition, working memory continues to improve in adolescence due to ongoing pruning and myelination and improvements in processing speed (Conklin, Luciana, Hooper, & Yarger, 2007; Luciana & Nelson, 1998). Working memory reaches its maximum level of effectiveness during an individual's 20's and begins to decrease due to the decrease of white matter volume (Luciana & Nelson, 1998).

**Working memory: performance-based assessments.** There are a number of tasks commonly used to assess working memory. Non-verbal memory tasks involve recall of images, faces, shapes, or other visual stimuli (Li, Cowan & Saults, 2013). Verbal memory is commonly assessed through list-learning tasks, which require participants to learn a long list of numbers, letters, or words. Simpler verbal memory tasks (e.g., letter and number learning) are comprised of multiple single exposures to numbers and letters. More complex tasks involve exposure to a list of words several times and participants are allowed to develop serial or semantic strategies to recall the information. Examples of verbal memory tasks include Digit Span and Letter-Number Sequencing in the Wechsler Intelligence Scale for Children, the California Verbal Learning Test for Children, and other variations included in larger executive function batteries such as the NEPSY and D-KEFS (Conklin et al., 2007; Loukusa, Mäkinen, Kuusikko-Gauffin, Ebeling & Moilanen, 2014). The current study used verbal tasks of working memory (Digit Span and Letter-Number Sequencing subscales) from the Wechsler Scales of Intelligence. Digit Span and Letter Number sequencing were used because they provide a less culturally loaded assessment than other working memory tasks (e.g. use of numbers rather than images and culturally loaded vocabulary). Subscales from the Wechsler Scales of Intelligence were used because there is a vast amount of research supporting these scales as adequate measures of working memory in children (Bowden, Petrauskas, Bardenhagen, Meade & Simpson, 2013; Cornoldi, Orsini, Cianci, Giofre & Pezzuti, 2013; Hill, et al., 2010).

Hundreds of studies have examined the Working Memory index of the WISC-IV (Digit Span & Letter-Number Sequencing) in relation to child diagnoses such as ADHD, anxiety, and depression (Gau & Chiang, 2013; Hadwin, Brogan & Stevenson, 2005; Mayes, Calhoun, Chase, Mink & Stagg, 2009; Nazarboland & Farzaneh, 2009), language (Chincotta & Underwood, 1996), gender differences (Lynn & Irwing, 2008), and race (Jensen & Figueroa, 1975). These studies have found that inattention, high state anxiety, and depression are associated with poor performance on both verbal and nonverbal tasks of working memory. With regard to race, Jensen and Figueroa (1975) found that African American youth scored significantly lower than Caucasian youth on Digit Span even after accounting for socioeconomic status. Additionally, bilingual youth perform better on verbal working memory tasks when tested in their native tongue (Kaushanskaya & Yoo, 2013). Studies have also found that comorbidity affects performance on tasks of working memory (Katz, Brown, Roth & Beers, 2011). Youth who meet criteria for more than one mental health diagnosis often perform lower on performance based measures of executive function (Katz, Brown, Roth & Beers, 2011; Zhang, Liu & Song, 2010). Overall, numerous studies confirm that Digit Span and Letter-Number sequencing are adequate differentiators of children with and without working memory deficits. Although the Working Memory index differentiates between individuals with ADHD and other diagnoses involving poor working memory, such as anxiety and depression, only one study has looked at working memory in relation to ethnic differences (Jensen & Figueroa, 1975).

**Working memory: Rating scale assessments.** The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) assesses working memory in relation to everyday activities. In the area of working memory, 10 items ask about difficulties remembering things, losing things, and the ability to hold information while completing a task. At least thirty-five studies have examined the working memory subscale of the BRIEF in children (e.g., Faridi et al., 2015; Minnes et al., 2014). Studies found that individuals with attention difficulties, language impairments (Vugs, Hendriks, Cuperus & Verhoeven, 2014), and medical diagnoses such as neurofibromatosis (Gilboa, Rosenblum, Fattal-Valevski, Toledano-Alhadeef & Josman, 2014), have more difficulty on everyday tasks involving working memory. In summary, the working memory subscale of the BRIEF is able to differentiate between youth with and without every-day difficulties in the area of working memory; however, no studies have examined ethnic differences on this subscale.

### **Cognitive Flexibility/Switching**

Cognitive flexibility or task switching is the ability to transition from one activity or situation to the next without disruption or difficulty (Logue & Gould, 2013). It is also the ability to shift perspective on a situation (Miyake et al., 2000). Cognitive flexibility deficits can include shifting too easily or demonstrating rigidity and an inability to switch. For example, resisting or having trouble accepting a different way to solve a problem with schoolwork, becoming upset with new situations, or trying the same approach to a problem over and over when it does not work. Jacques and Zelazo (2001) examined a group of 2-5 year old

children on a two dimensional task of cognitive flexibility. Age-related differences were evident, with younger children unable to understand task demands. Cognitive flexibility was evident starting at age three; however, flexibility improves with age (Anderson, 2002; Cepeda, Kramer, & Gonzales de Sather, 2001; Garon et al., 2008). Younger children resort to simpler and more concrete flexibility strategies, such as matching by colors rather than size (Zelazo, 2001). Younger children have more difficulty correctly detecting dimensions and abstracting irrelevant information. By age four, children perform well on abstraction tests but continue to struggle on two-dimensional tasks. By middle childhood, cognitive flexibility develops into a three dimensional concept, where children can organize information into varying levels (e.g., sorting items in different ways according to color, size, or shape) (Luciana & Nelson, 1998).

**Cognitive flexibility: performance-based assessments.** Many tasks in performance-based assessments involve cognitive flexibility and shifting. The Trail-Making Test (Army Individual Test Battery, 1944) requires participants to alternate responses between two sets (numbers and letters). The Wisconsin Card Sorting Task (Grant & Berg, 1981) is another task assessing cognitive flexibility. Participants are presented with a number of stimulus cards and they are required to match the cards without being told how to do so. Variations of the WCST (e.g., NEPSY: Animal sorting, Korkman, Kirk & Kemp, 2007a; DKEFS: Sorting test, Delis, Kaplan, & Kramer, 2001a) have been developed and are often used to assess cognitive flexibility. The current study will use the Card Sorting Task of the D-KEFS to assess Cognitive Flexibility/Shifting. Other common cognitive

flexibility/shifting tasks include Verbal Fluency tasks, and the Oral Trail Making test (Axelrod & Lamberty, 2006). The Verbal fluency and Oral Trail Making Tasks are less preferred since they require higher receptive and expressive language skills. Overall, sorting tasks are preferred when assessing cognitive flexibility because the task requires fewer verbal demands and they make them more appropriate for assessment with children.

Twenty studies have examined the Wisconsin Card Sort Task in relation to child diagnoses (Fitzpatrick, Darcy, Colborn, Gudorf & Lock, 2012) and age (Piper et al., 2012). Barkley, Grodzinsky and DuPaul, (1992) determined that the perseveration score of the WCST (which assesses cognitive flexibility/shifting) is more sensitive to differences between controls and children diagnosed with ADHD; however, other studies have found differences between ADHD and controls in the failure to maintain set performance scores. Mullane and Corkum (2007) assessed cognitive flexibility in a sample of 30 children between the ages of 6-11. Children were divided into two groups: those with ADHD and matched controls. Each group consisted of 15 children. Children completed the Wisconsin Card Sort Task. Results revealed children in the ADHD group made more “Failure to Maintain Set” errors, indicating they lost the correct sorting rules during performance and were less able to think flexibly. In summary, the WCST differentiates between children with executive difficulties, particularly in the areas of switching and cognitive flexibility; however, few studies have looked at cognitive flexibility in relation to ethnic differences.



**Cognitive flexibility: rating scale assessments.** The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and the Comprehensive Executive Function Inventory (CEFI; Naglieri & Goldstein, 2012) are currently the only two measures that assess cognitive flexibility/switching in relation to everyday activities in youth. The current study used the BRIEF shifting scale to measure every-day cognitive flexibility. In the area of shifting, 10 items assess one's ability to switch from one task to another (behavioral shift), and shift appropriately between emotions (emotional shift). The BRIEF has found differences in cognitive flexibility between individuals diagnosed with ADHD compared to controls (Toplak, Bucciarelli, Jain & Tannock, 2009). Sorensen and colleagues (2012) examined cognitive flexibility in a sample of 241 children between the ages of 8 and 11. Parents completed the BRIEF parent-report measure. Parents of children meeting criteria for ADHD reported significantly more difficulties in the Shift subscale of the BRIEF. The BRIEF has also found significant differences in cognitive flexibility between individuals with and without Autism Spectrum Disorder (Blijd-Hoogewys, Bezemer & Van Geert, 2014), comorbid ADHD and anxiety (Sorensen, Plessen, Nicholas & Lundervold, 2011) and Anorexia Nervosa (Dahlgren, Lask, Landro, & Ro, 2014). In summary, the shifting subscale of the BRIEF is able to differentiate between youth with and without every-day difficulties in the area of shifting; however, no studies have examined ethnic differences on this subscale.

### **Executive Function, Socioeconomic Status, and Ethnic Minority Status**

Research suggests ethnic minority children of lower socio-economic status

perform less successfully on cognitive and academic measures (Hickman & Reynolds, 1986). It is well documented that low-income minority families often present with limited means such as living in disadvantaged neighborhoods and attending low-achieving schools, increased stressors such as substance abuse and community violence, and few resources such as fewer parks and youth activities (Buckner, Mezzacappa & Beardslee, 2003). Research on EF suggests that SES, as measured by annual income as well as by parental occupation and educational status, is strongly associated with the development of EF skills such as working memory inhibition, and planning (Hackman, Farah, & Meaney, 2010) as well as organization and cognitive flexibility tasks (Blair et al. 2011; Farah et al., 2006; Noble, Norman & Farah, 2005; Raver, Blair, & Willoughby, 2013; Sarsour et al., 2011). The ethnic composition of the above-cited studies is mixed. Hackman, Gallop, Evans and Farah (2015) examined the impact of socioeconomic status across developmental stages and found that income and maternal education predicted performance on tests of executive functions. Socioeconomic status predicted performance on tasks of working memory at age five and was stable over time. The study also found that changes in income were consistent with changes in executive functions, respectively.

With regards to ethnicity, studies show that African American children score lower than Caucasians on IQ and executive function tasks; however, this study did not control for socioeconomic status (Blair et al., 2011). While there is evidence to suggest a low-income environment has a negative impact on executive functioning skills, only one study has teased apart the relationship

between income and ethnic minority status in relation to executive function. It is important to note, however, that the correlation between ethnic minority status and socioeconomic status is strong, with ethnic minority youth being three times more likely to live in poverty than their non-minority counterparts (Costello, Keeler, & Angold, 2001; National Center for Education Statistics, 2007).

Additionally, ethnic minority youth are more likely to be diagnosed with a mental health disorder (Chow et al., 2003; Dubow, Edwards & Ippolito, 1997). This study assessed the unique contribution of ethnic minority status in three executive functions and explored other variables that better account for these differences in youth who are referred for neuropsychological evaluations.

### **Inhibition**

**Research on ethnic minority children.** Only one study has examined ethnic minority differences on inhibitory control in children. Mezzacappa (2004) assessed a group of 249 ethnically diverse children (24% African American, 22% Caucasian and 54% Hispanic) between the ages of four and seven on a measure of inhibition (computerized go/no go task). Socioeconomic status was measured by combining educational status, occupational status, and highest income achieved by the primary caregiver. Ethnicity was only related to changes in reaction times. African American and Hispanic children resisted interference, or were more inhibited when there were competing demands and performed faster when competing demands were present than did Caucasian children. It is important to note, however, that most Hispanic participants were of low SES and most Caucasian participants were of high SES, which limits the generalizability of the

results. More socioeconomically advantaged children made fewer errors and were more inhibited than less advantaged children. The current study addressed the current gap in the literature by examining whether ethnic differences in inhibition are present when controlling for socio economic status, gender, and other demographic variables.

**Research on ethnic minority adults.** To date, there is limited child research in this area therefore information will be drawn from research on adults and will be focused on the Stroop task. Two studies have examined ethnic differences on inhibitory control in adults. Norman et al. (2011) examined the effects of ethnicity of Stroop Task performance in a sample of 246 African American and Caucasian adults. African Americans scored lower on inhibitory control while controlling for age, education, and gender. Razani et al. (2007) examined ethnic differences of 123 adult Hispanic-American, Asian-American, and Middle Eastern-American bilinguals and monolingual White Americans using the Stroop task. The White American group performed significantly better on the Stroop task. Raziani's results have limited generalizability given the added linguistic piece of bilinguals being tested in their non-native language. Overall, both of these studies suggest that Caucasians perform better on tasks on inhibition; however, findings from these studies are limited because socioeconomic status was not controlled for.

### **Working Memory**

**Research on ethnic minority children and adults.** To date, no research has examined the relationship between ethnic minority status and working

memory in children or adults. Studies have examined socioeconomic status and working memory in children and found no significant differences across groups (Noble, Norman & Farah, 2005). Thus, research is needed to better understand how ethnicity might impact working memory abilities and performance. Ethnicity may impact working memory depending on the amount of cultural loaded material included in each assessment tool.

### **Cognitive Flexibility**

**Research on Ethnic Minority Children.** To date, no research has examined the direct relationship between ethnic minority status and cognitive flexibility in children. Mezzacappa (2004) examined inhibition in a sample of Caucasian, Hispanic, and African American children. Although inhibitory differences were not found, results of the study suggest that African American and Hispanic children demonstrate higher flexibility than Caucasians by being able to respond to stimuli on the go/no go task faster and more accurately when more than one demand was present. However, the go/no go task is not designed to assess flexibility therefore more research is needed to further understand these results. Studies have examined socioeconomic status and cognitive flexibility in children and found no significant differences across groups (Noble, Norman & Farah, 2005). Noble and colleagues (2005) examined socioeconomic differences in a group of 60 African American kindergarten children of middle and low socioeconomic status. They were administered a card sorting task to assess task shifting. The young age of participants as well as using only low and middle income families are limitations of this study and limit the generalizability of the

results.

**Research on ethnic minority adults.** Two studies have examined the relationship between cognitive flexibility and ethnic minority status in adults. Proctor and Zhang (2008) examined a sample of 149 healthy college participants between the ages of 18-24. Participants were Caucasian, African American and Latino. No significant ethnic differences were found on the Wisconsin Card Sort Task (categories achieved and perseverative responses scores), a task assessing cognitive flexibility and shifting. Conversely, Niemeier and colleagues (2007) found significant ethnic differences on the Wisconsin Card Sort in a sample of adults following traumatic brain injury (TBI). Participants were recruited from Level I trauma centers. Preliminary analyses examining demographic group differences revealed no significant differences between ethnic groups on severity of injury or educational levels; however, 25% of the total sample (ethnic and non-ethnic) had been expelled from high school. Results on the WCST indicate that participants of ethnic minority background (33% of the overall sample) were twice as likely to score in the impaired range than their non-minority counterparts on the number of categories achieved and on the number of perseverative responses, indicating difficulties with switching and flexibility. Findings suggest that ethnic differences on tests of cognitive flexibility may not be present in healthy adults (Proctor & Zhang, 2008); however, following TBI, ethnic minorities may be at heightened risk for deficits in cognitive flexibility, as measured by the Wisconsin Card Sort Test. It is also important to consider that the second study examined adults who were experiencing more stressors and were

less educated than the first study. This supports the importance of controlling for socioeconomic status and education level when studying executive function differences in ethnic minorities. In summary, the relationship between cognitive flexibility and minority status in adults is mixed, although there is evidence to suggest that ethnic differences may be present following significant brain insult or other variables such as socioeconomic status and educational level may influence performance on executive function tasks.

### **Ethnic Minority Differences in Rating Scale Measures**

There is a dearth of research examining parent, teacher, and child ratings of executive functions based on ethnic minority group. Studies using behavioral rating scales have found differences between Black and White youth on externalizing and internalizing behaviors. DuPaul and colleagues (1998) found that African American parents reported more symptoms of externalizing behaviors than White parents, even when controlling for socioeconomic status. DuPaul's study used the ADHD Rating Scale, which has similar items to the BRIEF inhibition subscale. Teachers often rate African American students higher on externalizing and antisocial behaviors than European Americans students (Epstein, March, Conners & Jackson, 1998; Langsdorf et al., 1979; Youngstrom, Loeber & Stouthamer-Loeber, 2000). Studies of teacher rating scales have used the Conner's Teacher Rating Scale and the Achenbach Scales, which have similar items to the BRIEF inhibition subscale. Data also show that Latinos report higher symptoms of depression than White and African American youth (Wight et. al, 2005). Overall, behavioral ratings vary as a function of the reporter and race of

the child being assessed.

To date, no study has examined or reported ethnic minority differences in everyday behaviors of executive function. Ethnic groups are included in standardization norms but are represented in small percentages and minority groups are not looked at separately. Studying every-day behaviors might be influenced by cultural factors given the appropriateness of some behaviors based on the environment the child is exposed to. The current study examined whether ethnicity moderated the relationship between rating scale scores and performance-based scores.

### **Relationship Between Performance and Rating Scale Measures**

Full neuropsychological assessments typically include performance and rating scale measures, but it is unclear whether performance-based measures and informant ratings of executive function assess the same underlying constructs. Studies with adult populations have shown that rating scales and objective performance measures do not correlate strongly (Burgess, Alderman, Evans, Emslie & Wilson, 1998). Performance-based scores predicted some of the scores on rating scales but each test loaded onto multiple ratings on questionnaires and correlations depended on the rater completing the scale. For example, the Wisconsin Card Sort Test scores were predictive of family members' reports of inhibition and cognitive flexibility; however, correlations were stronger between the WCST and cognitive flexibility than the inhibition scores. Interestingly, scores on performance-based assessments were not correlated with self-report ratings of everyday executive functions. This study shows that performance-based tests can



assess multiple constructs of executive function and that performance is predictive of everyday function depending on raters.

Several studies were reviewed by Toplak, West and Staovich (2013) testing the association between performance-based and rating measures of executive function in both clinical and nonclinical samples. Twelve studies examined the BRIEF in relation to performance-based assessments in youth and findings are mixed. Anderson and colleagues (2002) found significant correlations between a task assessing shifting and the BRIEF shift scale. Parrish and colleagues (2007) examined the relationship between the D-KEFS and the BRIEF in a sample of children and found that performance tasks assessing cognitive flexibility were strongly correlated with the total score on the BRIEF. However, they did not directly compare the BRIEF shifting score to the D-KEFS cognitive flexibility/shifting score. Toplak and colleagues (2009) found positive correlations between informant reports and performance-based assessments in the areas of cognitive flexibility/shifting, inhibition, and working memory in adolescents with and without ADHD. Similar to Parrish's (2007) study, this study did not find unique associations between specific components; for example, the "Stop Task" was not correlated with the inhibit subscale of the BRIEF. The construct validity and clinical utility of these different measures of the same construct is difficult to determine when they do not correspond. Overall, the literature on the relationship between rating scales and performance-based measures suggests performance-based scores correlate with overall or total rating scale scores but do not correlate with the specific, corresponding subscale.

### **Executive Functioning and Academic Achievement**

Research shows a relationship between several executive functions and academic achievement (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Blair & Razza, 2007; Kim, Nordling, Yoon, Boldt & Kochanska, 2013; Liew, Chen & Hughes, 2010; Vitiello, Greenfield, Munis & George, 2011). In the area of inhibition, studies have shown that inhibitory control and positive teacher-student relationships significantly predicted academic achievement and future child-behavior. Inhibition has also been associated with reading and math grades one year later. Studies in this area highlight that inhibition and the ability of children to regulate responses in a classroom setting is essential in predicting academic success. In the area of working memory, studies have shown that children with lower scores on working memory tasks demonstrate poorer academic performance (Aronen, Vuontela, Steenari, Salmi, & Carlson, 2005; Gathercole & Pickering, 2000). Results of these studies provide further support regarding the importance of identifying at-risk youth with working memory deficits early in school. In the area of cognitive flexibility, studies have shown that cognitive flexibility is associated with children's future reading and math skills (Bull, Espy, & Wiebe, 2008). Although the literature suggests inhibition, working memory, and cognitive flexibility influence academic performance, these studies have been mainly conducted with predominantly Caucasian samples and have not examined ethnic differences in children.

## **Rationale**

Extensive research supports the finding that ethnic minority children perform lower on test of academic achievement and cognitive measures; however, it is unknown whether ethnic differences exist on measures of executive function. Executive function should be better understood among ethnic minority groups. Research examining executive functions and ethnicity is limited and often confounds ethnicity and socioeconomic status. Research also supports executive functions (inhibition, working memory, and cognitive flexibility) as important predictors of academic success. It is necessary to better understand the factors that may account for differences in measures of EF in youth who are referred for neuropsychological evaluations. The current study will begin to address gaps in the current literature by examining ethnic differences, SES, age, child diagnoses, comorbidity, and gender on performance-based and rating scales of executive functions (inhibition, working memory, and cognitive flexibility).

There is a dearth of research examining the relationship between rating scales and performance-based assessments of executive function. Examining the relationship between these variables is important in order to determine the role that rating scales and performance assessments should play in neuropsychological evaluations. Understanding ratings from parent reports can provide guidance to neuropsychologists and test administrators regarding the child's pattern of neuropsychological strengths and weaknesses. In summary, it is anticipated that results of this study will contribute to understanding executive function in ethnic minority youth.

## **Research Questions**

Research Question I. Does ethnicity alone predict performance on performance-based measures of executive functions?

Research Question II: Does ethnicity alone predict performance on parent-report measures of executive functions?

Research Question III: Are socioeconomic status, age, gender, comorbidity, and diagnosis, stronger predictors of executive functions than ethnicity on performance-based measures of executive functions?

Research Question IV: Are socioeconomic status, age, gender, comorbidity, and diagnosis, stronger predictors of executive functions than ethnicity on parent-report measures of executive functions?

Research Question V: Does ethnicity moderate the relationship between rating scale scores and performance-based scores?

## CHAPTER II: METHODS

This section presents information on participants, setting, measurement tools, and study procedures.

### **Participants**

Youth were assessed by the Pediatric Neuropsychology Service at the University of Chicago. Referral sources included schools, pediatricians, neurologists, clinicians, psychiatrists, and self-referrals. Data for 1231 youth between the ages of three and 24 were collected over an eight-year period (2005-2012). Data for this study had been previously collected from all youth and parents as part of typical clinical evaluations, where acknowledgement was given for use of the data for later research purposes. Latino, bi-racial, and Asian youth were excluded due to the small sample size therefore the current study examined ethnic differences between African American and Caucasian youth. Additionally, only participants between the ages of 11-17 due to the age requirement needed to complete the DKEFS and BRIEF. Participants who did not have socioeconomic data available were excluded. SES data were not available for all participants because they did not complete the background questionnaire that provided information about occupation and educational level or did not directly answer these two questions. A total of 134 youth were included in the study. Out of those 134 youth, 116 had complete data (both performance-based scores and rating scales) and 18 had rating scales only and no performance-based scores. Table two presents demographic information for each ethnic group.

Table 2

*Demographic Information for African American and Caucasian Youth*

Variable	African American (n = 38)	Caucasian (n = 96)
<b>Gender</b>		
Male	65.80%	63.40%
Female	34.20%	36.60%
<b>Comorbidity</b>		
No diagnosis	5.30%	5.40%
1 Diagnosis	31.60%	50.90%
2 Diagnoses	34.20%	24.10%
3 or more diagnoses	28.90%	19.60%
<b>Age</b>		
11-12 years	23.70%	19.60%
13-15 years	44.70%	47.30%
16-17 years	31.60%	33.00%
<b>SES</b>		
Low	44.70%	8.00%
Middle	55.30%	72.30%
High	0%	19.60%

*Note.* SES = socioeconomic status.

**Performance-based Measures.** One hundred and sixteen youth (mean age of 14.40, SD = 3.25) between the ages of 11 and 17 completed Working Memory, Inhibition, and Cognitive Flexibility performance-based assessments. Youth in this group were 61.6% males. Youth ethnicity was 74.7% Caucasian and 25.3% African American. Youth primary diagnoses included Attention Deficit Hyperactivity Disorder (37.4%), Learning Disabilities (35.4%), Mood Disorder (6.1%), Autism Spectrum Disorder (6.1%), No Diagnosis (6.1%), and other DSM-IV Axis I diagnoses (2%). Six percent of youth had no diagnosis, 42.4% had one

diagnosis, 27.3% had two diagnoses, 22.2% had three diagnoses, and 2% had four or more diagnoses.

**Rating Scales.** A sample of 134 youth between the ages of 11 and 17 (mean age of 14.36, SD = 2.24) and their caregivers completed the Inhibition, Working Memory, and Cognitive Flexibility scales of the BRIEF parent report. Youth in this group consisted of 64.2% males. Youth ethnicity was 74.6% Caucasian and 25.4% African American. Youth primary diagnoses included Attention Deficit Hyperactivity Disorder (44.8%), Learning Disabilities (29.9%), Mood Disorder (6%), Autism Spectrum Disorder (5.2%), and other DSM-IV Axis I diagnoses (1.5%). Six percent of youth had no diagnosis, 45.5% had only one diagnosis, 26.1% had two diagnoses, 20.9% had three diagnoses, and 1.4% had four or more diagnoses.

### **Setting**

The outpatient Pediatric Neuropsychology service, which also serves as a training site for doctoral clinical psychology students, employs full-time staff members as well as student neuropsychology externs and technicians. The site serves clients who receive public aid and clients who have private insurance. Neuropsychology externs and technicians are thoroughly trained during a two-week period on administration and scoring. Training involves learning how to deliver assessments, practicing with other students, and scoring sample assessments. After training concludes, neuropsychology externs are observed by trained technicians during assessments to ensure accurate administration and scoring. In addition, all externs receive weekly group and individual supervision.

## Measures

As part of the neuropsychology evaluation, youth complete several objective measures of performance including but not limited to cognitive functioning, academic achievement, executive functioning, memory, and language assessments. In addition, parents, teachers, and youth complete several paper-and-pencil measures of child functioning. For the purposes of this study, only the executive functioning data (objective and rating scales) will be examined. Family demographics were obtained from intake records and socio economic status was calculated using Hollingshead Index. Demographic information includes parental marital status, occupation, educational level of parents and children, diagnoses, services received, birth history, and medical history.

### **Socioeconomic Status**

Socioeconomic status was calculated using the Hollingshead Two-Factor Index (HTFI). The HTFI was based on weighted values of occupation and education level of each parent living in the home (Hollingshead, 1957). The index did not include the education and occupation for unemployed individuals, students, and homemakers. Occupations were ranked on a 9-point scale, which was categorized from the 1970 United States Census. Education was rated on a 7-point scale based on the number of years of schooling. In order to calculate a family index, the education and occupation scores were weighted and added. The education score was multiplied by three and the occupation score was multiplied by five. For families with two income-earners, an average score was derived. Total scores ranged from 8 to 66.



### **Comorbidity**

Comorbidity was defined as number of DSM-IV diagnoses. Comorbidities were dummy coded by number of DSM-IV diagnoses. No DSM-IV diagnosis was coded as 1, one diagnosis was coded as 2, two diagnoses were coded as 3, three diagnoses were coded as 4, and four or more diagnoses were coded as 5. These diagnoses were given at the end of the neuropsychological evaluation by the neuropsychologist on service and diagnoses were based on their overall neuropsychological pattern and evaluation results.

### **The Delis-Kaplan Executive Function System**

The Delis-Kaplan Executive Function System (Delis, Kaplan & Kramer, 2001; D-KEFS) is a neuropsychological battery used to assess areas of verbal and nonverbal executive function for both children and adults ranging from eight to 89 years of age. The D-KEFS is comprised of nine subtests assessing inhibition, planning, cognitive flexibility/shifting, among other executive processes. Subtests yield achievement scores and other optional scores such as errors, contrast, accuracy, and time-interval scores. The D-KEFS is normed on a stratified sample of 1,750 individuals, including 700 non-clinical children and adolescents between the ages of eight and 18. Norms included at least 75 individuals in each age group. The sample was equally proportioned with regards to sex, and ethnic breakdown was proportionate to the 2000 U.S. Census data. The D-KEFS has adequate validity and reliability.

**Color-Word Interference subtest (CWIT).** The CWIT was used to assess inhibition and inclination to respond to stimuli in a certain order. The task

was divided into four trials. The first trial required the child to name the color of a set of squares. The second trial required the child to read a set of words denoting colors (words are printed in black ink). The third trial required the child to inhibit previously learned responses and requires the child to name the color of the ink, and not read the word. The fourth and final trial assessed cognitive flexibility by requiring the child to switch back and forth between reading the word if the word was inside a box and naming the ink color if the word was not inside a box. The third and fourth trials were the only trials assessing inhibition; however, the fourth trial also assessed switching. For this reason, only scores from the third trial (inhibition only) were used in this study. The total score was calculated by the number of seconds taken to complete the trial. A computerized scoring program converted raw scores to scaled scores, which ranged between 1-19. Scaled scores 1-3 fell in the impaired range, scores 4-5 fell in the borderline range, scores 6-7 fell in the low average range, scores 8-12 fell in the average range, scores 12-14 fell in the high average and scores 15-19 fell in the superior range. Internal consistency values of the Color-Word Interference test ranged from .62 to .77 for ages 11-17. Test-retest correlation for ages 8-19 was high (.90). A number of studies have used the CWIT subtest and demonstrated the test has adequate validity in its use with different populations such as Parkinson's (Beatty & Monson, 1990), Dysexecutive syndrome (Bondi, Kaszniak, Bayles, and Vance, 1993), and patients with right temporal lobectomy (Crouch, Greve, & Brooks, 1996). Although the overall D-KEFS sample was ethnically representative of the U.S. population (approximately 13% African American, 10% Hispanic, 70%

White and 7% other, there are no studies assessing the validity of the CWIT with ethnic minority populations.

**Sorting Test.** The Sorting Test was used to assess cognitive flexibility and shifting. The child was presented with six cards and was asked to sort them into two groups of three cards each. The cards in each group had to be similar in some way. The child was asked to sort the cards in as many different ways as possible. The task was discontinued after four minutes or after the child stated he/she could not create any more categories. The total raw score was calculated by adding the number of correct sorts created by the child. Raw scores ranged from 0-8. A computerized scoring program converted raw scores to scaled scores, which ranged between 1-19. Scaled scores 1-3 fell in the impaired range, scores 4-5 fell in the borderline range, scores 6-7 fell in the low average, scores 8-12 fell in the average range, scores 12-14 fell in the high average and scores 15-19 fell in the superior range. Internal consistency values of the Sorting test ranged from .62 to .82 for ages 11-17. Test-retest correlation for ages 8-19 was moderate (.67). Currently, there are no studies assessing the validity of the Sorting Test with ethnic minority populations.

### **Wechsler Intelligence Scales (for children and adults)**

The Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003a), and the Wechsler Adult Intelligence Scale, Fourth Edition (WAIS-IV; Wechsler, 2008) are measures of cognitive functioning in adults and children. The WISC-IV assesses functioning in children between the ages of 6-16 and the WAIS-IV assesses functioning in adults ages 17 and above. The Wechsler

scales are comprised of ten subtests corresponding to four indices (Verbal Comprehension, Perceptual Reasoning, Working Memory, and Processing Speed), which yield a Full Scale Intelligence Quotient. Subtests yield scaled scores and indices yield standard scores.

The WISC-IV was normed on a stratified sample of 2,200 children between the ages of 6-16. Each age group had a sample size of approximately 200 children. Age, sex, race, parent education, and geographic region were based on 2000 census data. The WISC-IV has been validated with a number of cognitive, achievement, and measures of memory. Internal consistency reliability of the WISC-IV was used through the split-half method. Split half reliability for the full Scale IQ is high (.97). Reliability across other indices ranges between .88 and .97. Test-retest reliability was obtained from a sample of 243 children and scores indicate high test-retest reliability (.93). The validity of the WISC-IV was assessed by examining correlations with the WAIS and demonstrated high validity (.89) across the FSIQ indices.

The WAIS-IV is normed on a stratified sample of 2,200 adults between the ages of 16-90. Each age group between the ages of 16-69 had a sample size of approximately 200 and each age group between the ages of 70-90 had a sample size of 100. The sample was stratified based on age, sex, race, parent education, and geographic region corresponding to the 2005 census data. Like the WISC-IV, the WAIS-IV has been validated with a number of cognitive and achievement measures. Internal consistency reliability of the WAIS-IV was used through the split-half method. Split half reliability ranged from .97-.98 for the Full Scale IQ.

Test-retest reliability was obtained from a sample of 298 adults from four age groups and scores indicate high test-retest reliability for the Full Scale IQ. Inter score agreement ranged from .98-.99. The validity of the WAIS-IV was assessed by examining correlations with the WISC-IV and demonstrates high validity (.89) across the FSIQ indices. Convergent validity examinations indicated that subtests within the same domain correlate more strongly than those from different domains.

**Working Memory Index.** The WMI assessed one's ability to hold new information in short-term memory. The WMI also assessed the ability to manipulate that information in order to produce a desired result. The WMI in the WISC-IV was comprised of two subtests: Digit Span and Letter-Number Sequencing. On the WAIS-IV, the two WM subtests were Digit Span and Arithmetic.

On the Digit Span subtest, individuals were asked to repeat a group of numbers read aloud by the examiner. The first trial started with two numbers and increased in difficulty with up to ten numbers being presented on the last trial. The second trial required individuals to repeat the numbers backwards. For example, if the examiner says "5-7-8" the examinee responded "8-7-5". Both the forward and backwards digit span were discontinued after two incorrect responses in each set. Scores ranged between 0-16 for the forward and backwards trials, separately and scores were summed to create one total Digit Span score (0-32). On the WAIS-IV, digit span scores ranged from 0 to 48. The letter-number sequencing subtest required the examinee to listen to randomly presented numbers

and letters. The individual was then asked to sequence the numbers and letters and recall the numbers in ascending order and then the letters in alphabetical order.

Individuals received one point for each correct response and the subtest was discontinued after two incorrect responses in one set. Total scores on this subtest ranged from 0-30. The arithmetic subtest of the WAIS-IV required individuals to mentally solve a series of simple problems presented verbally. Individuals received one point for each correct response and the subtest was discontinued after two incorrect responses. Total scores on this subtest ranged from 0-22.

On the WISC-IV, split half reliability for the WMI was high (.92). Test-retest reliability was obtained from a sample of 243 children and scores indicate high test-retest reliability (.89). The validity of the WISC-IV WMI was assessed by examining correlations with the WISC-III and demonstrates moderate validity (.72). On the WAIS-IV split half reliability for the WMI was moderate (.80) and test-retest reliability was moderate (.85).

### **Behavior Rating Inventory of Executive Function**

The Behavior Rating Inventory of Executive Function (Gioia et al., 2000; BRIEF) is an 86-item questionnaire designed to assess executive function in youth ages 5-18. Areas of assessment include inhibition, cognitive flexibility/shifting, emotional control, initiation, working memory, planning, organization, and self-monitoring. Informants include parents, teachers, and a self-informant report for adolescents between the ages of 11-18. Reporters rated statements on a Likert scale ranging from 1 “never” to 3 “often.” Raw scores were entered into a computerized scoring program and raw scores were converted to t-

scores. T-scores of 65 and higher were considered “clinically significant.” To assess validity, the BRIEF includes a negativity scale and an inconsistency scale.

The BRIEF was normed based on a sample of 1,419 parent-ratings and 720 teacher ratings. The sample was stratified based on the 1999 U.S. census data for socioeconomic status, ethnicity, and gender. The ethnic composition of the normative sample was 80.5% White, 11.9% African American, 3.1% Latino, 3.8% Asian, and 0.5% Native American. The BRIEF has high internal consistency ( $\alpha = .80-.98$ ) and high test-retest reliability ( $r = .82$  for parents and  $.88$  for teachers). Inter-rater reliability between parent and teacher reports was moderate ( $.32-.34$ ). Convergent validity has been established with other measures of inattention and impulsivity. Divergent validity has been demonstrated by comparing the BRIEF against other emotional and behavioral scales.

**Inhibition.** The inhibition subscale of the BRIEF was used to determine the child’s ability to control impulses and stop behavior. The parent report scales were comprised of ten items. Sample items on the parent report scale included “acts wilder or sillier than others in groups”, “interrupts others” and “gets out of seat at the wrong times.” The Inhibit scale had good internal consistency for parent, self, and teacher reports ( $\alpha = .91-.96$ ) and adequate test-retest reliability ( $r = .76-.91$ ).

**Working Memory.** The inhibition subscale of the BRIEF was used to determine the child’s ability to hold information in mind with regard to goal-directed behavior. The parent-report working memory scale was comprised of ten items. Sample items on the parent report include, “when given three things to do,

remembers only the first or last”, “has a short attention span”, and “has trouble concentrating on chores, schoolwork, etc.” The Working Memory scale had good internal consistency for parent, self, and teacher reports ( $\alpha = .89-.93$ ) and adequate test-retest reliability ( $r = .82-.86$ ).

**Cognitive Flexibility/Shifting.** The shifting subscale of the BRIEF was used to determine the child’s ability to move from one situation to another and problem solve flexibly. The parent-report shifting scale was comprised of eight items. Sample items on the parent report included “resists or has trouble accepting a different way to solve a problem with schoolwork, friends, or chores”, “becomes upset with new situations”, and “tries the same approach to a problem over and over even when it does not work.” The Shift scale had moderate internal consistency for parent, self, and teacher reports ( $r = .72-.83$ ).

## **Procedure**

### **Pre-Assessment**

Prior to the assessment session, parents and youth reviewed and signed informed consent form regarding the research, participated in a clinical interview, and completed several standardized measures regarding child behavior. Patients were able to undergo testing even if they did not consent to the research, and were not included in the research database. The number of families that chose not to participate is unknown.

### **Testing**

Testing sessions were conducted in a small, distraction-free testing room, which included a table and two chairs. Trained psychometrists and graduate



students technician administered the assessments. Testing sessions were conducted during how many hours in a day of testing with a one-hour break half way through the assessment. The morning session included cognitive assessments and academic achievement measures. Then, youth and parents completed rating forms in the waiting room during the youth's lunch break. After lunch, youth returned to the testing room and completed measures of executive function, language, and memory, among other tasks. Teacher rating forms were given to the parents with a self-addressed and stamped envelope for the teachers to send back after they completed the questionnaires. Following the testing sessions, examiners scored the assessments. After scoring was completed, technicians reviewed scoring and corrected any mistakes. Once scores were finalized, a trained undergraduate research assistant entered the data in SPSS.

## CHAPTER III

### RESULTS AND ANALYSES

Cross-sectional analyses were used to examine demographic variables and their relationship to objective measures and questionnaires of executive functions. The current chapter describes the statistical analyses used for each research question. Preliminary analyses are also discussed.

#### **Preliminary Analyses**

In order to examine whether the data met all of the necessary assumptions for the intended analyses, preliminary analyses were conducted. Wilks-Shapiro test of normality was used to test the normality of the data. The working memory and cognitive flexibility performance measures were normally distributed. All parent report measures and the DKEFS inhibition scores were scattered and not normally distributed. Parent-report measures and DKEFS inhibition scores were transformed to create a normal distribution. Levene's test for homogeneity of variance was conducted to assess the equality of variance across executive functions. Values for all executive functions were above .05, indicating that the variability between the African American and Caucasian groups were the same. Table 3 presents the means and standard deviations across all subjects in each of the three executive function domains assessed for both performance measures and parent report measures. Participants scored generally within the average range on all three objective measures of executive functions. On parent rating scales, parents rated participants within the average range on day-to-day tasks of cognitive flexibility and inhibition; however, on average, they rated participants in

the clinical range on everyday tasks of working memory. Scores on parent-report measures fell in the clinically significant range for 20.1% of youth on cognitive flexibility tasks, 23.1% on tasks of inhibition and 45.5% on tasks of working memory. On performance-based tasks 26.1% of youth scored below the average range on tasks of working memory, 31% scored below the average range on tasks of inhibition, and 26.8% scored below the average range on tasks of cognitive flexibility.

Table 3

*Mean Scores and Standard Deviations for Executive Functions*

Executive Function	BRIEF			WISC/DKEFS		
	n	<i>M</i>	<i>SD</i>	n	<i>M</i>	<i>SD</i>
Cognitive Flexibility	134	59.98	13.76	116	9.03	2.70
Working Memory	134	69.26	13.62	116	97.14	14.49
Inhibition	134	59.20	15.52	116	9.031	3.25

Table 4 presents the means and standard deviations between ethnic groups in each of the three executive function domains assessed for both performance measures and parent report measures. Although overall patterns for each group are similar (e.g., generally average performance on objective tasks), t-tests revealed mean differences on both performance-based and parent-report measures. Specifically, African American participants scored significantly lower on performance-based measures of cognitive flexibility ( $t = 2.47, p = .02$ ). Parents of African American youth reported significantly higher impairment in parent-reported working memory ( $t = -2.70, p = .01$ ) and parent-reported inhibition ( $t = -2.29, p = .02$ ). Scores on parent-report measures of cognitive flexibility fell in the

clinically significant range for 17.6% of African American youth and 40% of Caucasian youth. Scores on parent-report measures of working memory fell in the clinically significant range for 61.8% of African American youth and 20.7% of Caucasian youth. Scores on parent-report measures of inhibition fell in the clinically significant range for 35.3% of African American youth and 19% of Caucasian youth. Scores on performance-based measures of working memory fell in the clinically significant range for 40.6% of African American youth and 20.7% of Caucasian youth. Scores on performance-based measures of inhibition fell in the clinically significant range for 30.3% of African American youth and 31.3% of Caucasian youth. Scores on performance-based measures of cognitive flexibility fell in the clinically significant range for 44.1% of African American youth and 21.2% of Caucasian youth.

Table 4

*Mean scores and Standard Deviations for Executive Functions across Ethnic Groups*

Variable	African American		Caucasian	
	BRIEF Mean (SD)	DKEFS/WISC Mean (SD)	BRIEF Mean (SD)	DKEFS/WISC Mean (SD)
Cog. Flexibility	61.09 (14.57)	8.06 (2.93)	59.6 (13.53)	9.35 (2.55)
Working Memory	74.59 (12.51)	93.16 (15.56)	67.45 (13.60)	98.61 (13.88)
Inhibition	64.38 (16.50)	8.48 (3.25)	57.44 (14.85)	9.22 (3.25)

Prior to testing each hypothesis and research question, Pearson correlations were run to examine relationships among study variables. Pearson correlations were used to compare ethnicity, socioeconomic status, age,

comorbidity, gender, and primary diagnosis to the study variables (Table 5). Ethnicity was coded as 0 for Caucasian youth and 1 for African American youth. There was a significant negative correlation between socioeconomic status and ethnicity, indicating that Caucasian ethnicity is related to higher socioeconomic status in this sample. Ethnicity was positively correlated with parent-reported inhibition and working memory, indicating Caucasian ethnicity is related to better ratings on parent-reported scores. Ethnicity was negatively correlated with performance-based cognitive flexibility, indicating Caucasian ethnicity is related to better performance. Socioeconomic status was positively correlated with all three performance-based executive functions. Socioeconomic status was also positively correlated with parent-reported inhibition; however, it was negatively correlated with parent reported working memory.

Comorbidity was determined by number of diagnoses and ranged from 0 (no diagnosis) to 5 (4 or more diagnoses). Comorbidity was positively correlated with a primary diagnosis of ADHD and negatively correlated with no diagnosis. On parent report measures, inhibition was significantly positively correlated with, comorbidity and negatively correlated with age and no diagnosis. Cognitive flexibility was significantly positively correlated with parent reported inhibition, working memory, and comorbidity. Working memory was significantly positively correlated with age, and comorbidity. On performance measures of executive function, inhibition was significantly positively associated with performance measures of working memory and significantly negatively correlated with youth gender and comorbidity. Cognitive flexibility was significantly positively

correlated objective measures of working memory and inhibition and significantly negatively correlated with parent reported inhibition. Working memory was significantly negatively correlated with parent reported working memory.

Table 5

*Intercorrelations Among Demographics Variables, Youth's Primary Diagnoses, Parent-Report and Performance Measures*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. DKEFS Shifting		.34**	.29**	-.09	-.18*	-.11	-.21*	.25**	-.15	-.16	-.17	-.01	.02	.11	-.05	.16
2. DKEFS Inhibition			.47**	.08	.00	-.09	-.10	.18*	-.27**	-.09	-.24**	.11	-.16	.13	-.16	.08
3. WISC Working Memory				-.02	-.15	-.30**	-.17	.27*	-.07	-.11	-.41	-.07	.02	.12	-.04	.04
4. BRIEF Shifting					.52**	.46**	.05	-.15	-.08	-.03	.23**	.03	-.15	.03	.20*	.06
5. BRIEF Inhibition						.48**	.20*	.21*	-.04	-.19*	.29**	.12	-.04	.02	-.01	.02
6. BRIEF Working Memory							.23**	-.27**	.04	.20*	.37**	.34**	-.09*	-.13	-.08	-.02
7. Ethnicity								.50**	-.02	-.04	.12	.06	.02	-.08	-.11	.07
8. Socioeconomic Status									-.03	-.01	-.12	-.01	-.03	.14	-.03	-.09
9. Gender										-.03	.03	-.09	.12	-.13	-.05	-.09
10. Age											-.01	.05	-.09	-.08	.04	.07
11. Comorbidity												.17*	.12	-.09	-.04	-.08
12. ADHD													-.57**	-.22**	-.24**	-.10
13. Learning Disability														-.17*	-.18*	-.08
14. Mood Disorder															-.07	-.03
15. Autism Spectrum Disorder																-.03
16. Cognitive Disorder																

*Note.* Variables 12-18 are youth's primary diagnoses. ADHD = Attention Deficit Hyperactivity Disorder.

\* $p < .05$ . \*\* $p < .01$ .

### Research Question Testing

*Research Question I.* Does ethnicity alone predict performance on performance-based measures of executive functions?

Linear regression was used to analyze whether ethnicity significantly predicted performance on all three performance-based executive function domains. Regression coefficients for performance measures of cognitive flexibility, working memory, and inhibition are shown in Table 6. Ethnicity significantly predicted scores on cognitive flexibility ( $F(1,126) = -6.07, p = .02$ ) and accounted for 4.3% of the variance explained (Table 4) without controlling for socioeconomic status, comorbidity, age, gender, or diagnosis. Ethnicity did not predict scores on working memory ( $F(1,107) = 3.38, p = .07$ ) and only explained 2.8% of the variance (Table 5). Ethnicity did not predict performance on tasks of inhibition ( $F(1,117) = 1.26, p = .27$ ) and only explained 0.2% of the variance.



Table 6

*Hierarchical Multiple Regression Analyses Predicting Performance on Executive Function Tasks Based on Ethnicity*

Predictors	Working Memory <sup>a</sup>			Inhibition <sup>b</sup>			Cognitive Flexibility <sup>c</sup>		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Step 1									
Ethnicity	-5.45	2.97	-0.17	-0.73	0.66	-0.1	-1.29	0.52	-0.21 <sup>**</sup>
Step 2									
Ethnicity	-1.18	3.37	-0.04	-0.33	0.71	-0.04	-0.69	0.59	-0.11
SES	0.16	0.10	0.16	0.03	0.02	0.12	0.03	0.02	0.16
Gender	-1.36	2.57	-0.05	-1.59	0.57	-0.24 <sup>**</sup>	-0.80	0.46	-0.14
Age	-0.56	0.72	-0.07	-0.16	0.15	-0.09	-0.24	0.12	-0.16 <sup>*</sup>
Severity	-5.93	1.44	-0.39 <sup>**</sup>	-0.67	0.33	-0.19 <sup>**</sup>	-0.62	0.26	-0.22 <sup>*</sup>
ADHD	-4.83	7.04	-0.17	-1.11	1.84	-0.17	-0.85	1.53	-0.16
LD	-3.32	7.12	-0.11	-2.05	1.85	-0.29	-0.77	1.55	-0.13
Mood	-0.42	8.80	-0.01	-0.99	2.12	-0.07	-0.77	1.75	-0.07
ASD	-6.41	8.62	-0.10	-3.53	2.02	-0.29	-1.58	1.69	-0.15
Medical	13.71	8.50	-0.22	-1.74	2.05	-0.14	-0.56	1.75	-0.05
Total R2	0.25			0.13			0.18		
<i>n</i>	116			116			116		

Note. <sup>a</sup>Step 1 F change = .07; Step 2 F change = .00. <sup>b</sup>Cognitive Flexibility Step 1 F change = .02; Step 2 F change = .04. <sup>c</sup>Inhibition Step 1 F change = .27; Step 2 F change = .00.

\* $p < .05$ . \*\* $p < .01$ .

*Research Question II.* Does ethnicity predict performance on parent-report measures of executive functions?

Linear regression was used to analyze whether ethnicity significantly predicts parent report on all three EF domains. Regression coefficients for parent report of cognitive flexibility, working memory, and inhibition are shown in Table 7. Without controlling for socioeconomic status, gender, age, comorbidity, or diagnosis, ethnicity significantly predicted parent reported inhibition ( $F(1,122) = 3.38, p = .02$ ) and accounted for 3.8% of the variance explained (Table 5). Ethnicity was no longer a significant predictor when socioeconomic status, gender, age, comorbidity, and diagnoses were entered on the second block. The second block was a stronger predictor of performance ( $F(1,122) = 2.39, p = .01$ ) and explained 17.7% of the variance. Comorbidity ( $B = 4.38, t = 2.48 p = .02$ ) and age ( $B = 1.26, t = -2.37 p = .02$ ) were the most significant predictors of parent reported inhibition.

Ethnicity predicted parent reported working memory ( $F(1,122) = 7.28, p = .01$ ) and accounted for 5.2% of the variance explained (Table 6). Ethnicity was no longer a significant predictor when socioeconomic status, gender, age, comorbidity, and diagnoses were entered on the second block. The second block was a stronger predictor of performance ( $F(1,122) = 5.07, p = .000$ ) and explained 31.4% of the variance. Comorbidity ( $B = 3.81, t = 3.50 p = .001$ ), socioeconomic status ( $B = -.17, t = -2.01 p = .05$ ) and age ( $B = -1.71, t = 2.17 p = .03$ ) were the most significant predictors of parent reported working memory.

Ethnicity did not predict parent reported cognitive flexibility ( $F(1,122) = .30, p = .59$ ) and only accounted for 20% of the variance explained (Table 7). Ethnicity was no longer a significant predictor when socioeconomic status, gender, age, comorbidity, and diagnoses were entered on the second block. The second block was a stronger predictor of performance ( $F(1,122) = 2.34, p = .01$ ) and explained 17.4% of the variance. Comorbidity was the most significant predictor of parent reported working memory ( $B = 2.90, t = 2.11, p = .04$ ).

Table 7

*Hierarchical Multiple Regression Analyses Predicting Parent-Report of Youth's Executive Functions Based on Ethnicity*

Predictors	Working Memory <sup>a</sup>			Inhibition <sup>b</sup>			Cognitive Flexibility <sup>c</sup>		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Step 1									
Ethnicity	7.14	2.65	0.23**	6.94	3.03	0.20*	1.49	2.74	0.05
Step 2									
Ethnicity	3.27	2.73	0.11	2.89	3.40	0.08	-1.03	3.02	-0.03
SES	-0.17	0.09	-0.18*	-0.18	0.11	-1.16	-0.13	0.09	-0.14
Gender	1.40	2.18	0.05	-0.91	2.72	-0.03	-2.0	2.41	-0.07
Age	1.26	0.58	0.17*	-1.71	1.54	-0.20*	-0.7	0.64	-0.04
Severity	4.38	1.24	0.30**	3.81	9.06	0.23*	2.90	1.37	0.20**
ADHD	10.87	7.28	0.4	6.95	9.13	0.22	-4.8	8.05	-0.17
LD	2.22	7.33	0.08	3.49	9.13	0.10	-8.18	8.11	-0.27
Mood	3.99	8.39	0.07	7.26	10.45	0.11	-2.13	9.28	-0.04
ASD	3.78	8.38	0.06	5.52	10.44	0.08	7.12	9.27	0.17
Medical	6.94	8.23	0.12	6.37	10.25	0.10	4.22	9.10	0.07
Total R2	0.31			0.17			0.17		
<i>n</i>	134			134			134		

Note. <sup>a</sup>Step 1 F change = .01; Step 2 F change = .00. <sup>b</sup>Step 1 F change = .02; Step 2 F change = .03. <sup>c</sup>Step 1 F change = .59; Step 2 F change = .01.

\*  $p < .05$ . \*\* $p < .01$ .

*Research Question III.* Are socioeconomic status, age, gender, comorbidity, and diagnosis, stronger predictors of executive functions than ethnicity on performance-based measures of executive functions?

Hierarchical linear regression was performed to test how well ethnicity predicted performance on performance measures of executive function after controlling for socioeconomic status, age, gender, comorbidity, and diagnosis. Socioeconomic status, age, gender, comorbidity, and diagnosis were entered in the first step, and ethnicity was entered in the second step. On performance measures of cognitive flexibility, ethnicity did not predict performance after controlling for other demographic variables ( $B = -.69, p = .24$ ) (See Table 8). On performance measures of inhibition, ethnicity did not predict performance after controlling for socioeconomic status, gender, age, comorbidity, and diagnoses ( $B = .03, p = .64$ ). On performance measures of working memory, ethnicity did not predict performance after controlling for demographic variables ( $B = -.18, p = .73$ ). The first step of the regression, which did not include ethnicity, explained 24.6% of the variance. When ethnicity was entered into the second step, the model accounted for 24.7% of the variance.

Table 8

*Hierarchical Multiple Regression Analyses Examining Ethnicity as a Predictor of Performance on Executive Functions After Controlling for Other Variables*

Predictors	Working Memory <sup>a</sup>			Inhibition <sup>b</sup>			Cognitive Flexibility <sup>c</sup>		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Step 1									
SES	0.18	0.08	0.18*	0.03	0.02	0.14	0.04	0.02	0.21*
Gender	-1.23	2.53	-0.04	-1.57	0.57	-0.23**	-0.73	0.46	-0.13
Age	-0.57	0.71	-0.07	-0.16	0.15	-0.09	-0.23	0.12	-0.16*
Severity	-5.93	1.44	-0.39**	-0.68	0.32	-0.19*	-0.64	0.26	-0.22*
ADHD	-5.09	6.98	-0.17	-1.23	1.81	-0.19	-1.06	1.53	-0.20
LD	-3.63	7.04	-0.12	-2.16	1.83	-0.31	-1.00	1.54	-0.17
Mood	-0.49	8.76	-0.01	-1.07	2.10	-0.08	-0.96	1.74	-0.09
ASD	-6.52	8.58	-0.10	-3.58	2.01	-0.30	-1.68	1.69	-0.16
Medical	-14.2	8.35	-0.23	-1.87	2.03	-0.15	-0.84	1.74	-0.07
Step 2									
SES	0.16	0.10	0.16	0.03	0.02	0.12	0.03	0.02	0.16
Gender	-1.36	2.57	-0.05	-1.59	0.57	-0.23**	-0.76	0.46	-0.14
Age	-0.56	0.72	-0.07	-0.16	0.15	-0.09	-0.24	0.12	-0.16*
Severity	-5.93	1.44	-0.39**	-0.67	0.33	-0.19*	-0.62	0.26	-0.22*
ADHD	-4.83	7.04	-0.17	-1.11	1.84	-0.17	-0.85	1.53	-0.16
LD	-3.32	7.12	-0.11	-2.05	1.85	-0.29	-0.77	1.55	-0.13
Mood	-0.42	8.80	-0.01	-0.99	2.12	-0.07	-0.77	1.75	-0.07
ASD	-6.41	8.62	-0.10	-3.53	2.02	-0.29	-1.58	1.69	-0.15

Medical	-13.71	8.50	-0.22	-1.74	2.05	-0.14	-0.56	1.75	-0.05
Ethnicity	-1.18	3.37	-0.04	-0.33	0.71	-0.04	-0.69	0.59	-0.11
Total R <sup>2</sup>	0.07			0.11			0.08		
<i>n</i>	116			116			116		

*Note.* SES = Socioeconomic status. Severity = Comorbidity (number of diagnoses). ADHD = Attention Deficit Hyperactivity Disorder. LD = Learning Disability. Mood = Mood Disorder. ASD = Autism Spectrum Disorder. Medical = Primary medical diagnosis. Cognitive Flexibility: Step 1 F change = .01; Step 2 F change = .24; Inhibition: Step 1 F change = .00. Step 2 F change = .64; Working Memory: Step 1 F change = .00; Step 2 F change = .73.

\* $p < .05$ . \*\* $p < .01$ .

*Research Question IV.* Are socioeconomic status, age, gender, and diagnosis, stronger predictors of executive functions than ethnicity on parent-report measures of executive functions?

Hierarchical linear regression was performed to test how well ethnicity predicted performance on parent report of executive function after controlling for socioeconomic status, age, gender, comorbidity, and diagnoses. Socioeconomic status, age, gender, comorbidity, and diagnoses were entered in the first step, and ethnicity was entered in the second step. On parent report measures of cognitive flexibility, ethnicity did not predict performance after controlling for demographic variables ( $B = -1.03, p = .73$ ) (See Table 9). The first step of the regression, which did not include ethnicity, explained 7.4% of the variance. When ethnicity was entered into the second step, the variance explained remained the same. On parent report measures of working memory, ethnicity did not predict performance after controlling for demographic variables ( $B = 3.27, p = .23$ ). The first step of the regression, which did not include ethnicity, explained 30.5% of the variance. When ethnicity was entered into the second step, the model accounted for 31.4% of the variance. On parent report measures of inhibition, ethnicity did not predict performance after controlling for demographic variables ( $B = 2.89, p = .40$ ). The first step of the regression, which did not include ethnicity, explained 17.2% of the variance. When ethnicity was entered into the second step, the model accounted for 17.7% of the variance.



Table 9

*Hierarchical Multiple Regression Analyses Examining Ethnicity as a Predictor of Parent Reported Executive Functions After Controlling for Other Variables*

Predictors	Working Memory <sup>a</sup>			Inhibition <sup>b</sup>			Cognitive Flexibility <sup>c</sup>		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
Step 1									
SES	-0.22	0.08	-0.23**	-0.22	0.09	-0.2	-0.12	0.08	-0.12
Gender	1.22	2.18	0.04	-1.08	2.71	-0.03*	-1.94	2.4	-0.07
Age	1.21	0.58	0.16*	-1.75	0.72	-0.20*	-0.25	0.64	-0.03
Severity	4.46	1.24	0.31**	3.91	1.54	0.23*	2.86	1.36	0.20*
ADHD	11.71	7.26	0.43	7.69	9.01	0.25	-5.06	7.98	-0.18
LD	3.09	7.31	0.1	4.26	9.07	0.13	-8.46	8.04	-0.28
Mood	4.67	8.38	0.08	7.86	10.41	0.12	-2.35	9.22	-0.04
ASD	4.27	8.39	0.07	5.95	10.41	0.09	6.97	9.22	0.11
Medical	7.75	8.22	0.14	7.09	10.2	0.11	3.97	9.04	0.07
Step 2									
SES	-0.17	0.09	-0.18*	-0.18	0.11	-0.16	-0.13	0.09	-0.14
Gender	1.4	2.18	0.05	-0.91	2.72	-0.03	-2.00	2.41	-0.07
Age	1.26	0.58	0.16*	-1.71	0.72	-0.19*	-0.27	0.64	-0.04
Severity	4.34	1.24	0.30**	3.81	1.54	0.23*	2.9	1.37	0.20*
ADHD	10.87	7.28	0.4	6.95	9.06	0.22	-4.8	8.05	-0.17
LD	2.22	7.33	0.08	3.49	9.13	0.1	-8.18	8.11	-0.27
Mood	3.99	8.39	0.07	7.26	10.45	0.11	-2.13	9.28	-0.04
ASD	3.78	8.38	0.06	5.52	10.44	0.08	7.12	9.27	0.12

Medical	6.94	8.23	0.12	6.38	10.25	0.1	4.22	9.1	0.07
Ethnicity	3.27	2.73	0.11	2.89	3.04	0.08	-1.03	3.02	-0.03
Total R <sup>2</sup>	0.31			0.18			0.17		
<i>n</i>	134			134			134		

*Note.* SES = Socioeconomic status. Severity = Comorbidity (number of diagnoses). ADHD = Attention Deficit Hyperactivity Disorder. LD = Learning Disability. Mood = Mood Disorder. ASD = Autism Spectrum Disorder. Medical = Primary medical diagnosis. Cognitive Flexibility: Step 1 F change = .01. Step 2 F change = .73; Working Memory: Step 1 F change = .00. Step 2 F change = .23; Inhibition: Step 1 F change = .01. Step 2 F change = .40.

\* $p < .05$ . \*\* $p < .01$ .

*Research Question V.* Does ethnicity moderate the relationship between rating scale scores and performance-based scores?

Hierarchical logistic regression was performed to test whether ethnicity moderated the relationship between parent-report measures and performance-based scores. Prior to testing the moderation, the independent variables (DKEFS scores) were centered. Ethnicity and parent reported scores were entered in the first step, and the interaction was entered in the second step (See Table 10). The interactions between ethnicity and parent-reported executive functions were not significant for working memory ( $B = .23, p = .16$ ), inhibition ( $B = -.56, p = .59$ ), or cognitive flexibility ( $B = -.50, p = .63$ ).

Table 10

*Hierarchical Multiple Regression Analyses Predicting Parent Report of Executive Function From Ethnicity and Performance-Based Measures*

Predictors	Working Memory <sup>a</sup>		Inhibition <sup>b</sup>		Cognitive Flexibility <sup>c</sup>	
	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$	$\Delta R^2$	$\beta$
Step 1	0.13*		0.02		0.01	
Ethnicity		-0.04		-0.12		-0.20*
DKEFS		-0.30*		0.01		-0.08
Step 2	0.02		0.00		0.00	
Ethnicity		-0.06		-0.11		-0.19*
DKEFS		-0.57		0.16		0.06
Ethnicity x DKEFS		0.29		-0.15		-0.15
Total R <sup>2</sup>	0.15		0.03		0.01	
<i>n</i>	116		116		116	

*Note.* <sup>a</sup> Step 1 F change = .01. Step 2 F change = .34. <sup>b</sup> Step 1 F change = .47. Step 2 F change = .60. <sup>c</sup> Step 1 F change = .06. Step 2 F change = .58.

\* $p < .01$ .

**Exploratory Analyses.** Exploratory analyses examined whether ethnicity, comorbidity, gender, socioeconomic status, or age moderated the relationship between parent rating scale scores and performance-based scores. Hierarchical logistic regression was performed to test whether these variables moderated the relationship between parent-report measures and performance-based scores. The independent variables and parent reported scores were entered in the first step, and the interaction was entered in the second step. Comorbidity (Working Memory:  $B = -.01, p = .95$ ; Inhibition:  $B = .01, p = .98$ ; Cognitive Flexibility:  $B = -.45, p = .34$ ), socioeconomic status (Working Memory:  $B = -.01, p = .21$ ; Inhibition:  $B = .01, p = .99$ ; Cognitive Flexibility:  $B = .03, p = .38$ ), gender (Working Memory:  $B = .26, p = .15$ ; Inhibition:  $B = -.03, p = .98$ ; Cognitive Flexibility:  $B = .72, p = .48$ ), and ethnicity (Working Memory:  $B = .25, p = .16$ ; Inhibition:  $B = -.55, p = .59$ ; Cognitive Flexibility:  $B = -.50, p = .63$ ) did not moderate the relationship between parent-report and performance-based scores on any of the three executive functions.

Age significantly moderated the relationship between parent-report and performance-based measures of inhibition. Greater age and lower performance-based scores was related to higher impairment in parent-report ratings ( $B = 0.62, p = .02$ ), explaining 7.6% of the variance in parent-reported scores of inhibition (See Table 11). Simple slopes for the association between performance and parent reports were tested for low (11-12 years), moderate (13-15 years), and high (16-17 years) levels of age. Simple slopes test revealed a significant positive association between moderate age and executive functions and a significant

negative association between younger age and executive functions. Figure 1 plots the simple slopes for the interaction.

Table 11

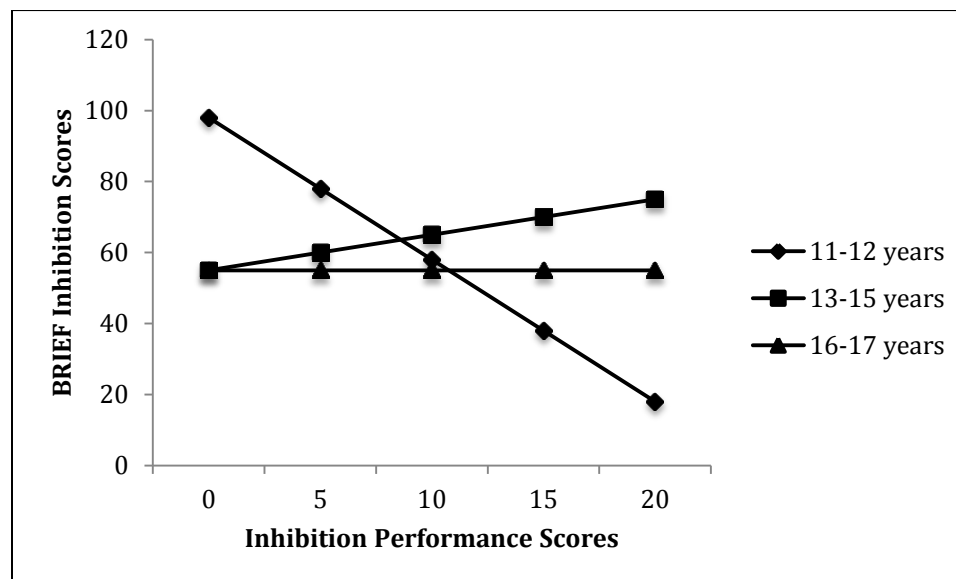
*Hierarchical Multiple Regression Analyses Predicting Performance on Inhibition Tasks From Age and Parent-Report Measures*

Predictors	Inhibition	
	$\Delta R^2$	$\beta$
Step 1	0.03	
Ethnicity		-0.18
DKEFS		-0.02
Step 2	0.05**	
Ethnicity		-0.23*
DKEFS		-0.05
Ethnicity x DKEFS		0.22*
Total $R^2$	0.08	
$n$	116	

\* $p < .05$ . \*\*  $p < .01$ .

Figure 1

Interaction Between Age and Color Word Interference (Inhibition) Scores as Related to BRIEF Inhibition Parent-Report Scores



Socioeconomic status significantly moderated the relationship between self-report and performance-based measures of working memory. The interaction between socioeconomic status and performance-based working memory was significant ( $B = 0.01, p = .02$ ), explaining 6% of the variance in self-reported scores of working memory (See Table 12).

Table 12

*Hierarchical Multiple Regression Analyses Predicting Performance on Working Memory Tasks From Socioeconomic Status and Self-Report Measures*

Predictors	Working Memory	
	$\Delta R^2$	$\beta$
Step 1	0.01	
SES		-0.03
DKEFS		-0.1
Step 2	0.05*	
SES		0.04
DKEFS		-0.13
SES x DKEFS		0.23*
Total $R^2$	0.06	
$n$	116	

\* $p < .05$ . \*\*  $p < .01$ .

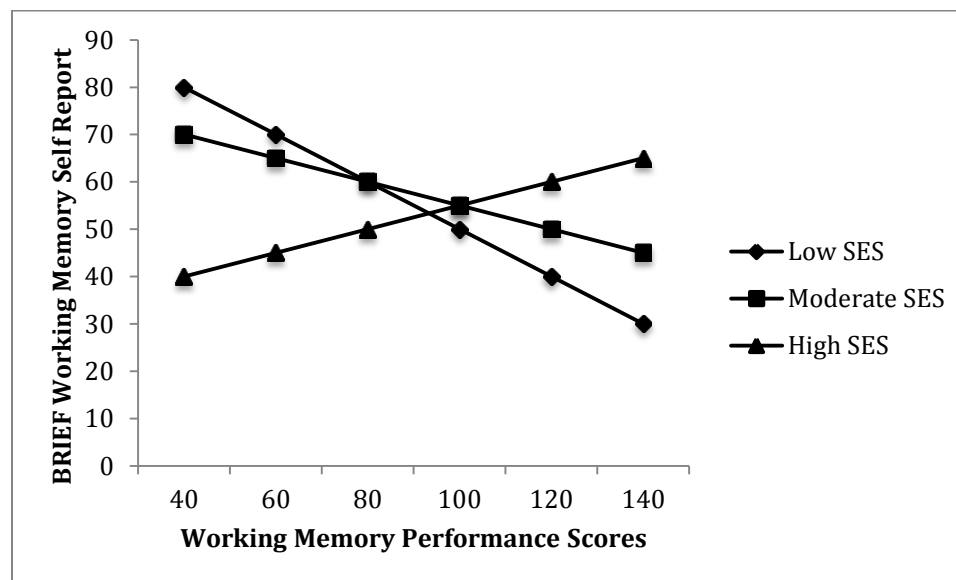
Socioeconomic status was examined as a moderator of the relation between self-reported working memory and performance measures of working memory. Socioeconomic status and performance scores of working memory were entered in the first step of the regression analysis. Results indicated that socioeconomic status ( $B = -.02, p = .77$ ) and performance-based working memory ( $B = -0.09, p = .30$ ) were not associated with self-report scores. The interaction between socioeconomic status and performance-based scores was entered in the second step and it was significant ( $B = -.01, p = .001$ ), suggesting that the effect

of performance scores depended on the level of socioeconomic status. Thus, socioeconomic status was a significant moderator of the relationship between self-report and performance measures of working memory.

Simple slopes for the association between self-report and performance-based executive functions were tested for low (-1 SD below the mean), moderate (mean), and high (+1 SD above the mean) levels of socioeconomic status. Simple slopes test revealed a significant negative association between low and moderate socioeconomic status and executive functions and a significant positive association between high socioeconomic status and executive functions. Performance-based scores were more strongly related to self-report scores for high socioeconomic status. Figure 2 plots the simple slopes for the interaction.

Figure 2

Interaction Between Socioeconomic Status and WISC/WAIS Working Memory Scores as Related to BRIEF Working Memory Self-Report Scores



Age was examined as a moderator of the relation between self-reported working memory and performance measures of working memory. Age and

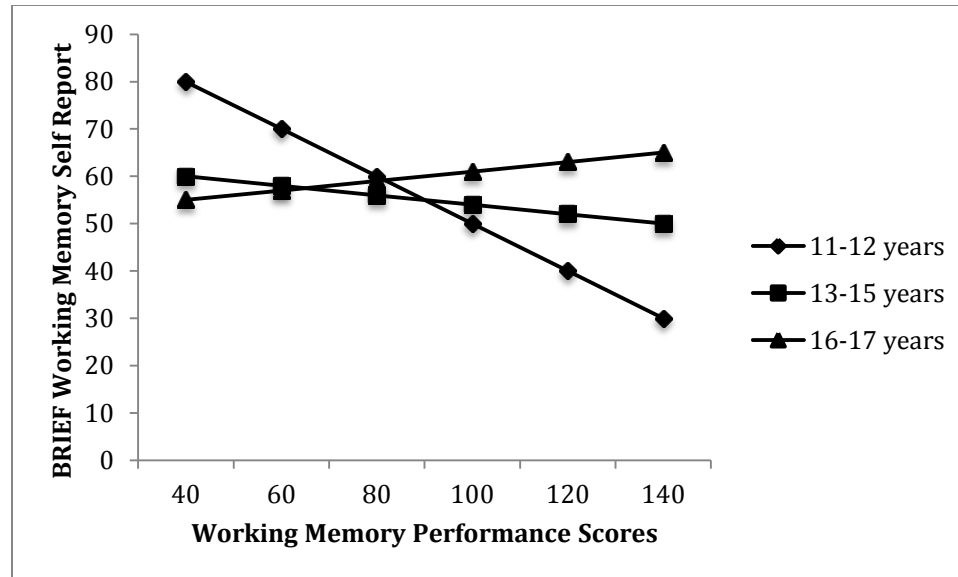


performance scores of working memory were entered in the first step of the regression analysis. Results indicated that age ( $B = 1.00, p = .16$ ) and performance-based working memory ( $B = -.08, p = .32$ ) were not associated with self-report scores. The interaction between socioeconomic status and performance-based scores was entered in the second step and it was significant ( $B = .10, p = .03$ ), suggesting that the effect of performance scores depended on the level of age. Thus, age status was a significant moderator of the relationship between self-report and performance measures of working memory.

Simple slopes for the association between self-report and performance-based executive functions were tested for low (11-12 years), moderate (13-15 years), and high (16-17 years) levels of age. Simple slopes test revealed a significant negative association between youngest and moderate age and executive functions and a significant positive association between older age and executive functions. Figure 3 plots the simple slopes for the interaction.

Figure 3

Interaction Between Age and Working Memory WISC/WAIS Scores as Related to BRIEF Working Memory Self-Report Scores



## CHAPTER IV DISCUSSION

Executive functions contribute to an individual's ability to succeed across a number of different settings, including school. The literature on executive functions is extensive. Some studies have determined the developmental markers for each specific executive skill while other studies have examined the impact of specific variables (e.g., language ability) on executive functions. Despite the vast amount of research in this area, relatively little is known about executive skills in ethnic minority children. Ethnicity is a variable that has been examined in countless studies in the mental health field. Time and time again, research suggests ethnic minorities are often at a disadvantage across multiple areas of performance (e.g., cognitive abilities, academic performance, higher risk for specific mental health disorders like schizophrenia). Additionally, research has found that ethnic minority youth receive more impaired ratings on behavioral scales completed by parents and teachers. The overall goal of this study was to examine the role of ethnicity in three executive skills and determine whether other factors explain ethnic differences in executive functions.

This study is important to the field for several reasons. First, this study provides new information to the executive literature by explaining the role of ethnicity in three executive skills in both performance-based and parent-ratings. Second, this study controlled for factors that are often confounded with ethnicity. Learning more about the specific variables that contribute to ethnic differences (e.g. socioeconomic status) can help decrease these generalizations about the effects of ethnicity. Third, this study provides new information about

the relationship between performance-based measures and parent-report measures of executive functions and whether these relationships differ according to ethnicity.

Results of this study provide important information about executive function in youth and yield three main contributions to the literature. First, although there were significant differences in performance across ethnic groups, ethnicity did not predict performance on any tasks of executive function and did not predict scores on parent-ratings after controlling for other variables. Second, socioeconomic status and age moderated the relationship between performance-based and parent/self-report measures. Finally, comorbidity, or number of diagnoses, was the most significant predictor of both performance-based measures and parent-report scores. Each of these findings will be described in further detail along with implications.

### **Ethnicity**

The first aim of this study was to determine whether there were ethnic differences on executive functions between African American and Caucasian youth who presented for neuropsychological evaluations in an outpatient hospital setting. Results indicated that without controlling for other variables, there were significant ethnic differences on performance measures of cognitive flexibility. African American youth performed worse on this task than Caucasian youth. Consistent with this finding, previous adult research suggests ethnic minority adults with traumatic brain injuries score lower on cognitive flexibility tasks than do Caucasians. Results of the current study also revealed significant ethnic

differences on parent reports of working memory and inhibition. Overall, African American youth were rated as more impaired than Caucasian youth on both of these executive functions. These results are consistent with previous research that suggests that African American parents report higher symptoms of externalizing behaviors than Caucasian parents (DuPaul et al., 1998). DuPaul and colleagues found that parents and teachers most often rate ethnic minorities as more impaired on scales of externalizing behaviors (e.g. conduct problems, aggression, impulsivity). When comparing behavioral rating scales that assess externalizing behavior, the items on the inhibition and working memory subscales of the BRIEF are similar in that the items reflect externalizing behaviors (e.g., interrupts, is often moving). The working memory and inhibition items are more easily observed than the items on the cognitive flexibility scale, which may explain why both Caucasian and African American parents did not rate cognitive flexibility as more impaired.

Interestingly, when control variables were added, ethnicity did not predict performance on any tasks and did not predict scores on parent-ratings. This finding serves as a major contribution to the literature because it suggests that initially, it can appear as though ethnicity accounts for differences in executive functions; however, other variables such as socioeconomic status, comorbidity, and age serve as more significant predictors of performance across three major executive functions. In our study, there were no significant ethnic differences on tasks of inhibition or working memory, which is consistent with previous research on youth (Mezzacappa, 2004). Unfortunately, Mezzacappa's study is the only one

that has examined both ethnicity and socioeconomic status in executive functions. Other studies have examined ethnicity as a predictor of executive function while controlling for age, gender, and education and have found that ethnicity is a significant predictor of performance (Norman et al., 2011), with African American participants scoring lower on inhibition tasks. The latter finding is not consistent with the results of this study since ethnicity was not a significant predictor of performance after adding control variables.

**Ethnicity as a moderator.** Another major goal of the current study was to determine whether ethnicity moderated the relationship between performance-based and parent-report measures of executive function. Neuropsychological assessments often include both performance and parent report measures as part of a complete assessment; however, the relationship between the two is unclear. Also, studies have found that ethnic minority parents often rate their children as more impaired than Caucasian parents. Ethnicity was used as a moderator to help determine whether the relationship between parent-report and performance scores changed depending on the youth's ethnic group. For example, do Caucasian parent rate their child's behavior more positively regardless of how they score on performance tasks? Do African American parents rate their child's behavior more negatively even when the child performs in the average range on performance tasks? In the current study, ethnicity did not moderate the relationship between parent and performance-based measures on any of the three executive functions. Exploratory analyses examined whether ethnicity moderated the relationship

between performance-based and self-reports of executive function as well as performance-based measures and teacher-reports of executive functions.

Overall, ethnicity did not moderate any of these relationships. Ethnicity does not affect the relationship between self, parent, or teacher reports and performance-based measures. These findings demonstrate that the relationship between observer-report and performance-based scores was similar for both Caucasian and African American parents, teachers, and youth. The relationship between the two is negative, meaning that youth who scored worse on performance-based tasks were scored as more impaired across parent, self, and teacher-report measures. This is an interesting finding that has not been studied to date. Previous research has examined parent, self, and teacher reports of youth behavior; however, their scores were not compared to performance-based assessments. The current finding may suggest that youth as well as their parents and teachers, have similar (and accurate) insight into youth's executive challenges regardless of the child's ethnic background. Youth ethnicity does not appear to bias the observer's perception of the child's executive function skills.

### **Socioeconomic Status**

Ethnicity and socioeconomic status are often confounded. This study aimed to differentiate between the two variables and see whether SES was a stronger predictor of performance on executive function tasks as well as parent-report measures. Interestingly, socioeconomic status only predicted performance on working memory tasks. Although it was not a significant predictor, socioeconomic status significantly moderated the relationship between self-report

scores and performance-based scores of working memory. Youth of lower socioeconomic status who scored low on performance measures reported greater impairment on self-reports of working memory and those who scored high on performance measures reported less impairment on self-reports. This finding reflects appropriate insight and self-awareness and/or willingness to disclose information about challenges in working memory for African American youth. Youth of middle class income who scored worse on performance measures rated themselves in the “at-risk” category on self-reports of working memory and those who scored higher on performance measures reported little to no impairment on self-report measures. Finally, youth of higher SES rated themselves under the clinical cut-off regardless of how they performed on performance-based tasks of inhibition. Perhaps youth of higher socioeconomic status are underreporting difficulties in working memory.

### **Age**

Age was also a significant predictor of performance on performance-based tasks of cognitive flexibility. The finding on age is consistent with developmental literature on cognitive flexibility supporting that cognitive flexibility improves with age (Anderson, 2002; Cepeda, Kramer, & Gonzales de Sather, 2001; Garon et al., 2008). Garon and colleagues (2008) suggested that improvements in cognitive flexibility continue through adulthood. Also consistent with the developmental literature on executive function, age was not a significant predictor for tasks of inhibition, which is consistent with some research stating that inhibition is fully developed by ten years of age (Klenberg et al., 2001; Lehto et



al., 2003). In contrast with previous literature, age was not a significant predictor of performance-based working memory tasks. Perhaps the fact that different working memory tasks were used depending on participant age (i.e., letter number sequencing for youth 11-15 and Arithmetic for youth 16-17) influenced the results. Age was a significant predictor of parent reported working memory, which is consistent with previous literature noting that working memory improves with age (Conklin et al., 2007; Luciana & Nelson, 1998; Huizinga, Dolan, & Van der Molen, 2006).

Inhibitory control develops steadily throughout early childhood; however, there are mixed findings regarding the development of inhibitory control past the age of twelve. In the area of inhibition some research using performance-based measures suggests that inhibitory control is fully developed between 10 and 12 years of age (Klenberg, Korkman & Lahti-Nuutila, 2001; Lehto, Juujarvi, Kooistra, & Pulkkinen, 2003) while others suggest inhibitory control increases from early adolescence through adulthood (Brocki & Bohlin, 2004; Cragg & Nation, 2008). In the area of working memory, research on performance-based tasks suggests that working memory improves throughout the life span, or as the prefrontal cortex continues to develop (Garon et al., 2008). Parent report research using the BRIEF found that working memory and cognitive flexibility develop before eleven years of age while inhibition continues to develop through adulthood (Huizinga & Smidt, 2011). Age was used as a moderator to help determine whether the relationship between parent-report and performance scores changed depending on the youth's age group.

Age significantly moderated the relationship between parent report and performance-based scores of inhibition. Younger youth (11-12 years) who scored low on performance measures were scored as clinically impaired on parent-reports of inhibition and those who scored well on performance measures were scored in the non-clinical range. This finding reflects adequate parental knowledge about their child's ability to inhibit responses. Parental monitoring and guidance are often typical for youth of this age. Parents may be in frequent communication with school about their child's performance or they may help their child complete homework and other day-to-day tasks, giving them insight into their strengths and challenges. In contrast, youth between 13-15 years of age who scored worse on performance measures were scored as less impaired on parent-reports of inhibition and those who scored higher, or better, on performance measures were scored as more impaired. Interestingly, this age group's scores on parent-report mostly fell in the at-risk and clinically significant range, indicating that most parents of youth in this age group endorsed concerns about inhibitory control in day-to-day life. Parents often associate teenage years with poor decision-making and poor inhibitory control (e.g. slamming doors, talking back). Scores on the parent-report measure may have been a reflection of emerging behaviors associated with adolescence. Additionally, youth in this age group have an increased desire for independence and may withhold information about academic performance, strengths, and challenges from their parents. Finally, youth between 16-17 years of age were generally rated under the clinical cut-off regardless of how they performed on performance-based tasks of

inhibition. Perhaps older youth are more independent and communication with parents may be more limited. Youth of this age also spend more time in social setting and may be exhibiting difficulties with inhibitory control in settings outside the home; for example, with friends or at school. Age also significantly moderated the relationship between self-report and performance-based measures of working memory. Younger youth (11-12 years) who scored low on performance measures reported greater impairment on self-report measures of working memory and those who scored high on performance measures reported less impairment. This finding reflects adequate insight about working memory abilities. Youth between 13-15 years of age who scored worse on performance measures also reported impairment in working memory but rated themselves below the clinical cutoff. Finally, youth between 16-17 years of age rated themselves below the clinical cut-off regardless of how they performed on performance-based tasks of inhibition. Perhaps older youth are more likely to underreport impairment in working memory.

### **Comorbidity**

Comorbidity was a significant predictor of performance on all performance-based measures. This finding is consistent with previous research on executive functions and comorbidities stating that more than one diagnosis leads to poorer performance across tasks of shifting and inhibition (Dolan & Lennox, 2013). Studies of comorbidities have examined ADHD and other behavioral disorders, ADHD and reading disorder (Poon & Ho, 2014), OCD and hoarding disorder (Morein-Zamir et al, 2014) and all conclude that comorbidity predicts

poorer performance across performance-based tasks of executive functions.

Comorbidity was also a significant predictor of performance on all parent report measures. This finding is consistent with Sorensen, Plessen, Nicholas and Lundervold's (2011) study which showed that children with comorbid ADHD and anxiety disorders were rated as more impaired across subscales of the BRIEF than those with an ADHD-only or anxiety-only diagnosis. Lawson and colleagues (2014) also found that more impaired scores on the BRIEF shifting and inhibition scales predicted more comorbidities between ASD and Aggression and ADHD and anxiety and depressive symptoms.

### **Gender**

Gender was a significant predictor of performance on both performance-based and parent-report measures of inhibition. The current results suggest that females scored higher of performance-based measures of inhibition and were rated as less impaired by parents. Consistent with our findings, research suggests males have more difficulty inhibiting responses than females and are rated higher on scales of hyperactivity and impulse control disorders (Campbell and Muncer, 2009; Papageorgiou, Kalyva, Dafoulis & Vostanis, 2008). Further, males are more commonly diagnosed with disorders associated with impulse-control difficulties (Newman, MacCoon, Vaughn & Sadeh, 2005). Individuals with impulse control difficulties often perform worse on tasks on inhibition (Rubia, 2011).

### **Limitations**

There are a number of limitations that should be noted. The current study looked at three executive functions separately. By examining each function

individually, we were able to find differences in which functions are more sensitive to predicting performance and ratings. However, it is important to note that each executive function is a small sample of an individual's overall ability and may not accurately describe youth's full pattern of strengths and weaknesses. A second important limitation of the study is the exclusion of Asian, Latino, and Bi-racial participants due to their small sample size. Including a broader ethnic sample (e.g., Latino and Asian youth) would help understand cultural variables that were not assessed in this study. For example, language has been studied in relation to executive functions and studies suggest that early bilinguals perform equally as well as monolinguals on working memory tasks while late bilinguals perform worse (Kalia, Wilbourn, & Ghio, 2014). Another study found that bilinguals with reading difficulties have more pronounced executive difficulties in inhibition and working memory than monolinguals with reading difficulties (Jalali-Moghadam & Kormi-Nouri, 2015). Acculturative stress is another cultural variable related to youth's ability to succeed academically. Studies show that higher acculturative stress predicts poor academic performance (DeCarlo Santiago, Gudiño, Baweja & Nadeem, 2014). No studies have examined the relationship between executive functions and acculturative stress. Other cultural variables that may play a role in the development of youth's executive functions include immigrant status, cultural mistrust, and familism. As a third limitation, the majority of youth in the study were Caucasian (75%). Future studies should aim to include youth of equal ethnic compositions.

There are also limitations regarding the measures that were used. First, the

inhibition task scaled score is calculated based on the measured time to complete the task and not the number of errors committed. For example, two youths may have completed the task in 30 seconds and both obtained a scaled score of 10, but youth #1 committed 10 errors and youth #2 committed 1 error. Perhaps number of errors committed during inhibition tasks is a better determinant of performance; however, the scaled score functions under the assumption that if a mistake is made it will take longer to complete the task because you have to correct your mistake. This method of calculating the scaled score is the most common across Stroop tasks, although few have based the scale score on the number of errors made. The performance-based working memory measures differed depending on the age group. Younger youth completed a letter number-sequencing task and older youth completed an arithmetic task. The arithmetic task may tap different constructs than the letter number-sequencing tasks and may be more culturally loaded than the task designed for younger youth. Ideally, researchers should use a single measure across all ages. Most analyses on parent report measures were significant only for working memory and inhibition and not for cognitive flexibility. The literature suggests that parents often report higher scores on the behavioral regulation index of the BRIEF while teachers often report higher scores on the metacognitive index (McCandless & O'Laughlin, 2007). These findings suggest parents may be better attuned to their child's behavioral deficits and teachers are more attuned to cognitive deficits. Overall, the literature on informant report highlights the need for multiple informant reports including, parent, self, and teacher reports, in order to obtain a complete assessment of the

child's behavior across settings (De Los Reyes, 2013). Often, having only one rater results in over or under-reporting of behavior (Collishaw, Goodman, Ford, Rabe-Hesketh, & Pickles, 2009; Rosnati, Montiroso, & Barni 2008).

### **Clinical Implications**

The current study has important implications that warrant discussion. Ethnicity did not predict performance on any tasks of executive function and did not predict scores on parent-ratings after controlling for other variables. This finding supports the need to gather and control for additional demographic information when completing assessments of executive functions. Information about socioeconomic status, diagnoses, parental education, and other variables can better explain differences in performance.

The current study also found that youth of middle and high socioeconomic status and, separately, youths between the ages of 13 and 17 report less symptomatology on self-report measures. These findings are extremely important and highlight the need to use multiple informants and/or performance-based measures to assess executive functions when working with middle/high income youth and youth 13 years and above. Using self-report measures as screeners or indicators of dysfunction may not be accurate when working with these populations. Surprisingly, youth of lower socioeconomic status and youth between the ages of 11 and 12 were more accurate reporters of their executive skills compared to their performance-based measures (working memory and inhibition, respectively). Self-report measures can be a simple way to assess progress over time rather than completing performance-based assessments and

parent-report measures, which can be expensive and time consuming. Using self-report measures would be particularly helpful when tracking progress with youth of low socioeconomic status and youth between the ages of 11 and 12 who are receiving interventions in schools.

Finally, comorbidity, or number of diagnoses, was the most significant predictor of both performance-based measures and parent-report scores. Youth with more than one mental health diagnosis performed worse on tasks and were rated as more impaired by parents. This finding highlights the need for educators to be informed of youths' diagnoses in order to implement the necessary recommendations in an academic setting. Communication between outside agencies and schools can help identify these youth. Youth with more than one mental health diagnosis may benefit from direct interventions that address executive skills either at school or through outside agencies that provide services on improving executive skills. Direct interventions in executive functions are important given the strong relationship between executive skills and academic success. Previous studies demonstrate that classroom inhibition predicts academic achievement, specifically in the areas of reading and mathematics (Gathercole & Pickering, 2000). Research also demonstrates that youth with poor working memory skills have poor academic outcomes (Aronen, Vuontela, Steenari, Salmi, & Carlson, 2005). Targeting youth with multiple diagnoses may be an appropriate prevention or intervention strategy that can help improve academic outcomes.

## **Conclusion**



Although controversial, ethnicity has been identified as a strong predictor of performance on studies examining academic performance and intellectual abilities (Marks, 2011). Unfortunately, studies examining the effects of ethnicity do not control for factors that are often compounded. Examples of variables associated with ethnic background include socioeconomic status, educational level, and access to resources and care. Studies examining academic performance and intellectual abilities neglect to control for these important demographic variables, sometimes resulting in ethnicity being a significant predictor of outcomes. Ethnic minorities living in the US often present with limited means and are of lower socioeconomic background. Further, they have limited access to care and resources and present with more barriers to accessing appropriate services. Disparities in education show that ethnic minorities are less likely to receive a high school education and attend college and are more likely to score lower across academic areas. Given these disadvantages, ethnic minorities, do in fact, look different than non-minority counterparts on research studies, especially when working with inner-city minority youth. Other variables such as age, gender, comorbidity, and socioeconomic status need to be included when examining ethnicity in any area of study. Additionally, there may be bias in both assessment and diagnosis that accounts for differences in ethnic groups. Assessments are sometimes culturally loaded and biased, which results in poor performance by ethnic minorities. Examples of biased/culturally-loaded assessments include testing participants in their non-native language and presenting testing materials that are not familiar to the participant's cultural background. The strength of this

study is the ability to demonstrate that without controlling for socioeconomic status, ethnicity is a significant predictor of performance; however, effects disappear when adding variables that are often confounded with ethnic background.

In conclusion, the current study provides important information about executive functions in youth and ethnic minorities. To date, no study has differentiated the effects of ethnic minority status and its confounding variables in executive function. The main contribution of this study is demonstrating that ethnicity initially appears to predict performance on some tasks; however, after adding other variables often confounded with ethnicity, it does not predict performance or parent-report on any executive function. This finding highlights the need to include other variables often confounded with ethnicity in order to determine the specific agents driving group differences. Other strong contributions to the literature are demonstrating the moderating effects of socioeconomic status and age on the relationship between rating scales and performance-based measures. Youths over the age of 13 and youths of higher socioeconomic status under-report deficits in executive functions. This finding provides strong support for the need of multi-rater assessment and performance-based measures when working with youth of higher socioeconomic status and youth above the age of 13. Executive functions are an integral part of success in academic settings. There is a continued need to identify variables that impact executive functions in order to implement appropriate interventions.



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