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The Role and Implications of Executive Functions During the Transition to Middle School

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Abstract

The current study analyzed the relationship between executive functions and academic performance in middle school. In particular, this study analyzed the relationship between BRIEF Index and Scale scores that were compiled on a group (N = 54) of seventh graders by two seventh-grade ELA teachers and the students' final grades in ELA, Math, Science, and Social Studies. The results showed statistically significant correlations between most of the BRIEF Indexes and Scales and the final grades, with the Metacognitive Scales showing the highest correlations. In contrast, the results showed much higher incongruence index values than expected, given the high correlations that were found. Possible explanations include the level of support afforded to the students, student motivation, and student-teacher relationships. Future research on executive functions and middle school students should use larger sample sizes that include a wider range of students, such as those in advanced classes, general education, and learning disabilities classes, as well as more teacher ratings of executive functions.

CHAPTER 1

Introduction

Statement of the Problem

The transition from elementary to middle school is a significant milestone that has the potential to impose long-term consequences on students due to the various changes that they face at this pivotal juncture. Middle school is significantly different from elementary school in many ways. For example, the curriculum becomes more difficult and the work load increases, as well as the overall expectations of students' performance both academically and behaviorally (Bailey, et al., 2015; Cook, et al., 2008). In addition, students are afforded far less support in middle school yet expected to demonstrate more independence (Boller, 2008; Kingery, et al., 2011). For many students, middle school entails navigating a much larger building, adjusting to multiple teachers, and interacting with many new peers (Cook, et al., 2008). Middle school students are expected to move through multiple classes each day, all taught by a different teacher, keep track of homework assignments and projects, study for tests and quizzes, and keep materials organized, all of which require the use of executive functions (Boller, 2008).

Executive functions is an umbrella term that refers to neurocognitive processes that cue and guide behavior. They are considered necessary for daily life, as well as the attainment of long-term goals (Diamond, 2013; Lezak, 1982). Executive functions are linked to academic success, and difficulties with executive function can lead to academic problems at all educational levels from preschool to college. The continued development of executive functions is critical as students transition from the elementary to the middle school setting, due to the decrease in support that occurs at this point (Boller, 2008; Jacobson, et al., 2011).

Purpose of the Study

The transition to middle school can be a tumultuous experience for students. This change is characterized by an increase in academic expectations and a decrease in academic support. In many districts, multiple elementary schools merge into a single middle school. The developmental stage of adolescence, which coincides with the transition to middle school, further complicates this transition, as students are also experiencing biological changes and often experience psychosocial stressors. Indeed, moving from elementary school to middle school is likely the most difficult transition that children experience. Even students who achieved success in elementary school are at risk during this critical juncture. Although many students successfully navigate this transition, some struggle significantly. Students who struggle with this transition may experience significant negative consequences, such as a decrease in motivation and a decline in academic achievement, as well as psychological distress and a decrease in overall self-esteem.

The purpose of this study is to examine the relationship between teacher perceptions of the frequency of behaviors indicative of the use of executive functions and adjustment to middle school in the form of final grades in two subjects at the end of the 7^{th} grade school year.

Research Question

What is the relationship between teacher ratings of executive functions using the *BRIEF* and students' ELA and Social Studies course grades at the end of 7^{th} grade?

CHAPTER 2

Review of the Literature

Introduction

The general concept of executive functions dates to the 1840s and the case of Phineas Gage, which sparked research on the frontal lobes (Goldstein et al., 2014). In the 1950s, interest in the prefrontal cortex increased, and by the 1970s, the construct of executive function had been formulated. Since then, multiple definitions have been proposed.

In the past several years, psychologists' and educators' interest in executive functions has increased significantly. For example, a search through *Psych INFO* using the terms "Executive functions" and "Children" discovered just five sources for 1985, and the same search revealed only 14 sources for 1995 (Bernstein & Waber, 2018). Using the term "development of executive function," search results increased to 501 sources for 2005, and this same search yielded 3,288 sources in 2015 (Bernstein & Waber, 2018). Research has revealed that executive functions play an integral role in learning, and that they are critical to school readiness and early school achievement (Blair 2002; Blair & Raver, 2015). Evidence also indicates that executive functions in childhood are indicative of school performance and social competence in adolescence (Mischel et al., 1989).

Conceptualizing Executive Functions

A formal universal definition of executive functions remains under debate by professionals across disciplines; however, multiple definitions have been proposed. Dawson and Guare (2010) assert that "executive skills allow us to organize our behavior over time and override immediate demands in favor of longer-term goals" (p.1). The authors of the *Behavioral Rating Inventory of Executive Function* (BRIEF), Gioia et al. (2000), describe executive functions as "a collection of processes that are responsible for guiding, directing, and managing cognitive, emotional and behavioral functions, particularly during active novel problem solving" (p.1). Muriel Lezak (1982) explains that "executive functions comprise those mental capacities necessary for formulating goals, planning how to achieve them, and carrying out the plans effectively" (p. 281). McCloskey et al. (2009) define executive functions as:

> directive capacities that are responsible for a person's ability to engage in purposeful, organized, strategic, self-regulated, goal-directed processing of perceptions, emotions, thoughts, and actions. As a collection of directive capacities, executive functions cue the use of other mental capacities such as reasoning, language, and visuospatial representation (p. 15).

In essence, executive function is an umbrella term applied to neurocognitive processes that cue and guide behavior. They are considered necessary for daily life, as well as the attainment of long-term goals (Diamond, 2013; Lezak, 1982). They play a critical role in academic success (Borella et al., 2010; Duckworth et al., 2005; Duncan et al., 2007; Gathercole et al., 2004), as well as academic readiness (Blair & Razza, 2007). However, they are also important in all aspects of life, including mental health (Taylor-Tavares et al., 2007; Watkins et al., 2005), physical health (Crescioni et al., 2011), job success (Bailey, 2007), personal relationships (Eakin, et al., 2004), and overall quality of life (Davis et al., 2010). Moreover, Lezak (1982) asserts that "executive functions are part and parcel of everything we do" (p. 283).

Although varying conceptualizations of executive functions have been proposed over the years, a consensus has emerged that executive functions are a multidimensional set of constructs responsible for self-directed behavior and involved in higher level cognitive capacities, including decision making and problem solving (Lezak, 1982). They perform a critical role in intentional and goal-directed behavior and are crucial to daily functioning (Banich, 2009; Diamond, 2013). They are also described as “top down” cognitive processes and considered vital to recruit when performing a task that requires sustained attention and concentration (Diamond, 2013). Executive functions are engaged in every task an individual performs and are particularly critical to learning something new (Duncan & Owen 2000; Poldrack et al., 2005). The more difficult or novel the task, the greater the need to recruit executive functions. On the other hand, as a task becomes more familiar, the need to recruit executive functions decreases (Chein & Schneider, 2005; Milham et al., 2003; Poldrack et al., 2005).

Executive functions have been metaphorically compared to the CEO (Goldberg, 2001) or the conductor of the brain (Brown, 2005, 2006; Wasserstein & Lynn, 2001). Just as a conductor cues and directs the performance of multiple musicians playing various instruments, executive functions cue and guide other cognitive processes (Brown, 2005, 2006; Wasserstein & Lynn, 2001). McCloskey (2016), however, asserts that this musical metaphor may oversimplify and misrepresent the very nature of executive functions. In terms of metaphor, rather than thinking of executive functions as the CEO of the brain, it is better to view executive functions more broadly as the management structure of a multinational corporation that includes the CEO and many other managers at different levels reflecting varying types of executive control.

Models of Executive Function

Many researchers have converged on a tripartite model of executive functions, which includes three core executive functions: working memory, inhibition, and cognitive flexibility (Blair & Diamond, 2008; Diamond, 2013; Hughes, 2011; Lehto et al., 2003; Meuwissen & Zelazo, 2014; Miyake et al., 2000). Working memory comprises the phonological loop, which temporarily holds and rehearses verbal information; the visuospatial sketchpad; which temporarily holds and rehearses visuospatial information; and the central executive, which processes and manipulates information from the different memory systems (Baddeley & Hitch, 1994; Diamond, 2013). Inhibition refers to both cognitive and behavioral inhibition (Bari & Robbins, 2013; Diamond, 2013; Garon et al., 2008). Cognitive inhibition is the ability to focus on relevant stimuli while ignoring irrelevant stimuli; behavioral inhibition is the ability to refrain from engaging in a dominant or automatic response (Bari & Robbins, 2013; Diamond, 2013; Garon et al., 2008). Cognitive flexibility is the ability to shift between different cognitive sets (Diamond, 2013; Garon et al., 2008).

Some researchers have also distinguished two distinct categories of executive functions: *cool* and *hot*. Cool executive functions are the cognitive control aspects of executive functions, and hot executive functions are the affective control aspects of executive functions recruited in situations that are emotionally and motivationally charged (Happaney et al., 2004; Zelazo & Carlson, 2012). Moreover, the lateral prefrontal cortex tends to be associated with cool executive functions, whereas the orbitofrontal cortex and the ventromedial regions are linked to hot executive functions (Happaney et al., 2004; Hongwanishkul et al., 2005; Zelazo et al., 2012)

Stuss and Alexander (2000) describe a multi-componential framework of executive function, which includes a tiered framework of self-awareness. They describe four hierarchical levels of functioning: *arousal-attention*, *perceptual-motor*, *executive mediation*, and *self-awareness*. Neural processing flows in both directions between the different levels. Direct contact with the outside environment exists only at the perceptual-motor level. Planning, inhibition and working memory skills become more active at the executive mediation level. The self-awareness level is considered the highest level of activity in this model and develops through the connections of emotions and memories of previous experiences.

McCloskey et al. (2009) developed a *holarchical* model of executive functions. This comprehensive model organizes executive functions into five different levels. Daily self-control functions are the primary focus of the first three tiers, and the fourth and fifth tiers involve higher level, deeper questions about one's sense of purpose, moral and ethical stances, and sense of connection with forms of consciousness beyond the self..

The first tier, *self-activation*, describes the physiological processes that are experienced during the waking state. When one first awakes, one's executive capacities often tend to be deficient, but gradually improve to typical levels as sleep inertia fades. The second tier, *self-regulation,* comprises at least thirty-three specific and separate self-regulation executive functions. Each of these executive functions cue and direct functioning within four different general domains--perception, cognition, emotion, and action--and work in an integrated manner to enable executive control on a moment-to-moment basis. It is important to note that the effectiveness of executive functions may vary across the four domains. For example, an individual might demonstrate the ability to effectively cue for inhibition within the perception and cognition domains, but struggle with cueing for inhibition within the emotion and action domains.

The third tier consists of *self-realization* and s*elf-determination*, two distinct forms of executive control. These two forms of executive control occupy the same level, because they both develop direct connections to self-regulation as a person enters adolescence. Self-realization refers to an increase in self-awareness and self-analysis. Through self-reflection, an individual develops a better understanding of whom he or she is, including greater knowledge of personal strengths and weaknesses. Self-determination involves planning for the future and the development of long-term goals. This includes monitoring and revising plans as needed, delaying gratification, and suppressing urges that might interfere with achieving one's goals.

Self-generation, the fourth tier, involves the development of a sense of purpose and an ethical and moral core that can be used to guide goal selection and self-realization. Activation at this level enables reflection on one's life in a more philosophical manner. In the self-generation tier, one ponders such questions as "Why do I exist?" and "Does life have a purpose?" and "Is it right to pursue goals that may negatively impact others and the environment?"

Trans-self-integration, the fifth tier, represents states of consciousness that involve the experience of sensing a connection with all beings and all things.

In this model, it is not necessary for an individual to have developed fully at one level before moving on to develop at higher tiers. In addition, development at lower tiers continues as a person has begunto develop at higher tiers.

Another component of this model is the concept of four arenas of involvement, which are *intrapersonal*, *interpersonal*, *environmental*, and *symbol system.* The intrapersonal arena involves executive control of how one perceives, feels, thinks, and acts with respect to oneself. The interpersonal arena comprises executive control of a person's perceptions, feelings, thoughts, and actions in relation to interactions with other persons. The environmental arena encompasses perceptions, feelings, thoughts, and actions in relation to natural and man-made environments (e.g., use of tools, sustainability issues, avoidance of accidents). The symbol system arena pertains to executive control of perceptions, feelings, thoughts, and actions related to reading, writing, using mathematics, and all means of communication. As with the domains of functioning, the effectiveness of executive functions can vary across each arena of involvement.

Executive Functions and Intelligence

It is important to note that although executive functions and intelligence are related, they are two distinct constructs (Brown et al., 2011; Crinella & Yu, 2000; Delis et al., 2007; Schuck & Crinella, 2005). Intelligence refers to the knowledge that one possesses and the strengths and weaknesses of one's cognitive ability. In contrast, executive functions refer to knowing when and how to recruit the knowledge and cognitive abilities necessary to complete a task and the ability to carry through the task to completion (Lezak, 1982). For example, Denckla (1996) discusses patients who, despite high intelligence, demonstrate chronic difficulties in effectively completing tasks. To better explain this, she presents the example of an individual trying to cook a meal. Despite the ability to read a cookbook and having all the necessary equipment and ingredients at hand, as well as motivation to cook the meal, difficulty with executive functions involving planning and organization would hinder this individual from having the meal ready on time. *Fluid intelligence*, which refers to reasoning and problem-solving skills, has been claimed to be more closely related to executive functions (Diamond, 2013; Kane et al., 2005). However, some researchers contend that fluid intelligence is a separate construct from executive functions (Crinella & Yu, 2000; Schuck & Crinella, 2005).

Neurological Implications of Executive Functions

As previously noted, executive functions are associated with the frontal lobes. Moreover, different structures within the frontal lobes are linked to different executive functions. For example, the dorsolateral area of the prefrontal cortex is linked to problem solving, working memory, planning, organization, attention, and cognitive flexibility (Fuster, 2001; Happaney et al., 2004; Stuss & Knight, 2002), and the ventromedial area is implicated in behavioral inhibition and emotional regulation (Fuster, 2001, 2002; Happaney, et al., 2004). Furthermore, although the frontal lobes are primarily implicated in executive functions, they are closely interconnected to other areas of the brain through complex neural networks. Thus, when a particular executive function is recruited, not only those specific areas within the frontal lobes are involved, but other areas of the brain are also activated (Elliot, 2003; McCloskey et al., 2009).

Neural Plasticity

Executive functions are gained primarily through experience and the repetitive use of these skills in problem solving. Through practice, executive functions are strengthened, the efficiency of the neural circuitry involved improves, and the probability that the skills will be activated in the future increases (Zelazo et al., 2016). Earlier theories tended to describe executive functions as static, and the orthodox position was that interventions targeted at improving them would have little impact. More recent research, however, has revealed that executive functions are much more malleable than once thought, and that they possess the potential to improve through interventions (Zelazo et al., 2016).

Experience also has a significant impact on the neural connections that regulate executive functions (Posner & Rothbart, 2007). The impact on these neural connections can be either positive or negative. For example, high levels of stress tend to impair executive functions. Exposure to chronic stress results in an increase in cortisol, which also negatively impacts executive functions. Moreover, impaired executive functions can contribute to more stress (Evans & Schamburg, 2009). On the other hand, due to the plasticity of the brain, this damage is not necessarily permanent, and removal of the stressor can reduce levels of cortisol, and executive functions may improve (Fisher et al., 2006; Liston et al., 2009).

Development of Executive Functions in Children and Adolescents

Executive functions begin to develop as early as infancy (Isquith et al., 2004), with development continuing into early adulthood (Anderson et al., 2001; Romine & Reynolds, 2005). Overall, the most rapid period of development of executive function skills occurs between six and eight years of age (Romine & Reynolds, 2005), with modest gains continuing between ages nine and twelve, and continuing at a more gradual pace through adolescence into early adulthood (Anderson et al., 2001; Romine & Reynolds, 2005). However, individual executive functions progress at different times in different ways (Romine & Reynolds, 2005). For example, inhibition emerges as early as seven to twelve months of age and tends to develop rapidly in early childhood (Best & Miller, 2010; Garon et al., 2008) with continued improvement from ages five to eight and more gradual improvement through adolescence (Romine & Reynolds, 2005). Working memory is observed as early as seven to twelve months of age and tends to show improvement through preschool years (Garon et al., 2008; Gathercole et al., 2004) and continues to improve through adolescence (Best & Miller, 2010). The ability to shift between two simple response sets is evident in children as young as three to four years-old (Rennie & Bull, 2004). The ability to successfully shift between two or more complex response sets emerges in late childhood and continues to improve through adolescence (Anderson, 2002; Best & Miller, 2010; Davidson, 2006; Garon et al., 2008).

Disorders Involving Executive Functions Deficits

Executive dysfunction is manifested in various acquired and developmental disorders, with each disorder exhibiting a unique profile in relation to executive function deficits (Gioia et al., 2002; Ozonoff & Jenson, 1999). For example, executive dysfunction is a core feature of ADHD (Barkley, 1997; Roberts et al., 2017). Although both the primarily inattentive and combined subtypes of ADHD have been linked to difficulties with working memory and most other metacognitive executive functions, including initiation, planning, organization, and self-monitoring, the combined type is also linked to significant difficulty with inhibition (Gioia et al., 2002). In contrast, autism is associated with difficulties with planning and flexibility (Kleinhans et al., 2005; Ozonoff & Jenson, 1999; Ozonoff, et al., 2004). Traumatic brain injury has been associated with deficits with metacognitive skills and behavioral regulation (Gioia et al., 2002).

Executive functions are also implicated in various other disorders, including Tourette's syndrome and obsessive-compulsive disorder (Watkins et al., 2005), major depressive disorder (Taylor-Tavares et al., 2007), bipolar disorder (Torres et al., 2007), and schizophrenia (Barch, 2005).

Executive Functions in Academic Functioning

Much research has been conducted on the role of executive functions in school, and evidence has emerged that executive functions are associated with academic performance as early as the preschool years, extending through college. In the early years, executive functions are linked to school readiness (Blair & Diamond, 2008), as well as academic achievement in children (Checa & Rueda 2011; Clark et al., 2002; Hughes & Ensor 2011; Lan et al., 2011) and adolescents (Berman et al., 2009; Kotsopoul & Lee,; Latzman et al., 2010; Waber, 2006).

Even as early as preschool years, intact executive functions are necessary for children to learn. The ability to inhibit and regulate one's behavior is important for developing and maintaining relationships with peers and adults (Blair & Diamond, 2008; McClelland et al., 2006), and the ability to sustain attention and working memory are critical during instructional time (Gathercole & Alloway, 2008). Numerous studies have linked executive functions in preschool with early math and reading skills in kindergarten (Blair & Razza, 2007; Espy et al., 2004; McClelland et al., 2007; Shaul & Schwartz, 2013). Further, executive functions in kindergarten are linked to math and literacy skills at the end of first grade (Monette et al., 2011). More recent research has linked science achievement skills to executive functions in these early years as well (Nayfield et al., 2013). More important, early executive function skills may be an indicator of academic achievement throughout elementary school. For example, a study conducted by McClelland et al. (2006) linked executive functions in kindergarten to math and literacy performance from kindergarten through sixth grade. Evidence exists that executive functions intact in early childhood can have long-term implications that extend into adolescence and even adulthood. The well-known "Marshmallow Test" conducted by Mischel et al. (1989) demonstrates this relationship. Those children who participated in the study and who had refrained from eating the marshmallow in order to receive a larger reward were also described by their parents as more interpersonally competent, exhibited better self-control and frustration tolerance, and demonstrated better concentration (Mischel et al., 1989). In addition, these children scored higher on the SAT and were less likely to engage in substance abuse (Mischel et al., 1989).

Research has also linked executive functions in early middle school to academic achievement in all areas, in both middle school and high school. Samuels et al. (2016) conducted a longitudinal study of the relationship between executive functions and academic performance among adolescents in a low-income, urban middle school. The BRIEF, which was used to assess executive functions, was administered by teachers at the end of each grade from sixth through ninth. The results revealed that the *General Executive Composite* (GEC) scores were stable throughout the four years and that the GEC predicted grades in Mathematics, English, Social Studies, Science, and Spanish consistently, regardless of gender and income level, as well as the status of special education services. (Samuels et al., 2016).

Overall, executive functions tend to predict school achievement (Clark et al., 2010; Mazacco & Kover, 2007), grades (Duckworth & Seligman, 2005), high school graduation (Vitaro et al., 2005), and college graduation (McClelland et al., 2013). In many cases, executive functions were found to be a better predictor of academic success than IQ (Brown et al., 2011; Duckworth & Seligman, 2005).

Executive functions play both direct and indirect roles in learning (Zelazo et al., 2016). For example, intact executive functions enable students to remain seated and on task, sustain attention, and follow rules and directions, which all directly impact their ability to learn (Zelazo et al., 2016). Children who possess good executive skills and do well academically may exhibit a positive attitude toward school and demonstrate motivation to do well, which may be considered indirect impacts of executive function skill (Zelazo et al., 2016). In contrast, poor or absent executive function skills may have a direct negative impact on a child's ability to learn (Zelazo et al., 2016). Executive function deficits may be manifested in various ways, such as difficulty keeping materials organized, failing to hand in homework despite having completed it, and inaccurately estimating the amount of time a task will take (Boller, 2008). Poor executive functions may also impact social, emotional, and behavioral functioning (Hughes & Ensor, 2011). Impairment in these areas of functioning is observed even in students who evince strong abilities (Dawson & Guare, 2010).

McCloskey et al., (2009) discusses how children with executive function deficits tend to have production difficulties. He describes three types of students who struggle academically: those with a learning disability but no production difficulties, those with production difficulties but no learning disability, and those with both a learning disability and production difficulties. Children who display difficulties with both learning disabilities and production difficulties tend to be identified by teachers, evaluated, and classified with a learning disability rather quickly, but students who display only learning difficulties are less likely to be identified and referred for evaluations and services, at least in the elementary school years. This is because the latter group possess and demonstrate adequate executive functions, enabling them to produce work that meets expectations through executively generated and guided compensatory strategies. The third group, students who do not have a learning disability but demonstrate deficits in one or more executive function capacities, also tend to be referred by teachers early in their education because of their lack of or inadequate production. In this group of students, some might be mislabeled as learning disabled and some might receive a diagnosis of ADHD, both classifications that would enable these students to access more support in school. And for some, if a learning disability is not identified and they do not meet the diagnostic criteria for ADHD, their lack of production is often attributed to laziness, a lack of motivation, or other negative traits. Without interventions targeted at improving the executive function deficits that are impairing their academic performance, these students often face the most risk of failing in school.

Executive functions and mathematics. Mathematics encompasses a variety of skills and topics, including number sense, arithmetic, algebra, and geometry. The foundational number sense skills that children possess upon entering school has been linked to mathematical skills in the early years (Bull et al., 2011; Jordan et al., 2010). For example, Jordan et al. (2010) found that children's number sense in the beginning of first grade was a predictor of both calculation and problem-solving skills at the end of third grade. In addition, executive functions play a critical role in mathematical achievement. A relationship has been well established between executive functions and children's math skills from preschool through adolescence (Bull et al., 2011), and that children who exhibit difficulties in mathematics also demonstrate difficulties with working memory, inhibition and shifting (Bull & Scerif, 2001).

In a study of young children, Bull et al. (2011) found that executive functions in preschool are linked to emerging mathematical skills. Longitudinal studies reflect the long-term relationship between early executive function skills and later mathematical achievement. For example, in a study following children from the age of four through the end of third grade, Bull et al. (2008) found that working memory, inhibition, planning, and monitoring were all linked to mathematical skills at the end of first grade. By the end of third grade, working memory continued to predict mathematical performance. Clark et al. (2010) found that children who exhibited better inhibitory control, shifting, and planning skills at age four also demonstrated stronger mathematical performance two years later. In another longitudinal study, Mazzocco and Kover (2007) found a link between inhibition and math skills in early elementary school through late elementary school.

McCloskey et al. (2009) describes how executive functions are necessary for each of the various skills involved in mathematics. Multiple executive functions are critical for directing and integrating the processes, abilities, skills and knowledge bases required to perform any math task from basic computation skills to more complex novel problem-solving, and deficits in executive functions therefore can cause or contribute to mathematical difficulties (Berninger & Richards, 2002; McCloskey et al., 2009; McCloskey & Perkins, 2013).

Executive functions and reading comprehension Reading comprehension is a complex cognitive task that requires multiple skills and cognitive capacities, including such basic reading skills as word recognition, word decoding, and reading rate, as well as verbal reasoning, language abilities, visuospatial translation of language, and word and general knowledge lexicons (Berninger & Richards, 2002; McCloskey et al., 2009; McCloskey & Perkins, 2012). In addition, executive functions play an important role in reading comprehension. Although research in this area is still developing , a strong relationship between working memory and reading comprehension has emerged as a consistent finding (Berninger & Richards, 2002; Ehrlich, 2005; Scheff et al., 2018; Seigneuric et al., 2007).

Cutting et al. (2009) found that children with reading comprehension difficulties also exhibit difficulties with tasks requiring planning, organization and monitoring. A similar study conducted by Locascio et al. also revealed a relationship between deficits in strategic planning and organization and reading comprehension difficulties. In another study conducted by Sesma et al. (2009), working memory and planning were linked to reading comprehension, although not to word recognition skills.

In young children, executive functions seem to play a role in the acquisition of letter identification and phonemic awareness; however, as these skills become more automatic, the need to recruit executive functions decreases (Blair & Razza, 2007). Although research in this area is still somewhat new, current studies suggest that a primary executive function deficit may be linked to comprehension difficulties in children with a specific reading comprehension deficit. For children diagnosed with both dyslexia and a reading comprehension deficit, the primary deficit contributing to poor reading comprehension may be phonological or lexical, with executive function deficits secondary (Scheff et al., 2018).

Overall, reading comprehension requires specific self-regulation executive functions to cue and guide the use of various skills and cognitive capacities, as well as additional executive functions that cue and coordinate the use of the different mental capacities necessary for reading comprehension (McCloskey et al., 2009, 2014; McCloskey & Perkins, 2013). Due to its complexity, deficits in any of the multiple skills required could result in difficulty with reading comprehension.

Executive function and writing. Writing is a complex process that requires multiple steps, including planning, drafting, reviewing, and revising, as well as multiple skills, including reading, spelling, language, fine motor skills, short-term memory, anlong-term memory (Hooper et al., 2011; Harris et al., 2018). Successful writing also requires multiple executive functions, including attention, inhibition, planning, organization, flexibility, monitoring, and evaluating (Harris et al., 2018).

In the recent years, multiple studies have looked at the role of executive functions and writing in children of various ages. For example, Hooper et al. (2011), examined the role of executive functions in writing among first-grade students. They found that attention, planning, verbal working memory, visual working memory, and long-term retrieval were all linked to written expression and spelling. In a study by Dribooms et al., (2015), which involved fourth graders writing a narrative based on pictures they were shown, inhibition and working memory were linked to the length of written text but not planning. They speculated that this finding emerged because planning is a higher level executive function, and the children in the study might not have developed those skills at that point (Dribooms et al., 2015). In another study of upper grade elementary school children, Dribooms et al. (2017) found that inhibition and planning were linked to narrative writing.

The specific executive functions involved vary depending on the type of writing task. For example, in a study conducted by Altemeier et al. (2006) that involved third and fifth graders reading a paragraph and taking notes, then using their notes to write a report, inhibition was found to be the most important function for the task of note-taking, while verbal fluency was most important for the report-writing task.

Each step of the writing process involves various executive functions. In addition, because skilled writing requires reading and rereading the text, the executive functions involved in reading are also needed for the writing process (McCloskey et al., 2009). It is understandable why many students who struggle with reading also struggle with the writing process. Executive functions are clearly critical to the multitasking and coordination of the various cognitive capacities that are required for successful writing. Indeed, this is the academic area most affected by executive function deficits.

Middle School

There are various transitions that students experience while in school, from beginning school to moving from high school to college or the adult world. One significant transition for students is moving from elementary school to middle school (Cooke et al., 2008). Middle school is significantly different from elementary school in various ways. The curriculum becomes more difficult and the workload increases, as well as the overall expectations of students both academically and behaviorally (Bailey et al., 2015; Cook et al., 2008). At the same time, the supports afforded to students decrease in middle school compared to elementary school (Boller, 2008). In essence, students are expected to function with greater independence while managing more responsibilities (Boller, 2008; Kingery, et al., 2011).

In addition to the increased academic demands, the environment itself tends to be quite different from elementary school. In elementary school, students have one teacher with whom they spend most of the day, which allows the opportunity for a more intimate relationship to develop (Cook et al., 2008). In addition, students in elementary school are typically with the same group of peers all day, and in many cases, these students have known each other for several years. In many districts, more than one elementary school feeds into a middle school, so the transition involves a larger building and new peers (Bailey et al., 2015; Cook et al., 2008). Another difference is the number of teachers a student will have. In middle school, students are assigned a different teacher for each subject. resulting in multiple teachers. This dynamic affects the student-teacher relationship, which is far less intimate in middle school than elementary school (Cook et al., 2008). In addition, students are often with a different group of peers in each class (Cook et al., 2008). The middle school transition requires students to navigate a much larger building, move between multiple classrooms throughout the day, adjust to multiple teachers, and interact with many new peers (Cook et al., 2008).

At this point, students also transition from being the oldest children in the school to the youngest, which may increase their risk of victimization to bullying, or at the very least, induce anxiety about potential bullying (Bailey, et al., 2015). With all the changes that are presented to students at this transition, it is not surprising that many children experience anxiety about beginning middle school (Bailey, et al., 2015). Specific concerns reported by students at this juncture include changing for physical education, bullying, exposure to peer pressure, making friends, difficulty with schoolwork, using a locker, navigating a larger building, having enough time to eat lunch, encountering teachers who are not nice, and using the bathrooms (Bailey et al., 2015).

Parents and teachers tend to expect that upon entering middle school, students will become more independent (Boller, 2008). During their last year of elementary school, teachers attempt to prepare their students for middle school by informing them of some of the changes that they may expect, as well as changes expected of them in the future (Boller, 2008). When students begin middle school, they are presented with the rules and expectations by middle school teachers and administrators. At that point, teachers and parents tend to assume that middle school students are capable of successfully meeting those expectation because of their age (Boller, 2008).

In a typical day in a middle school, a student sits through several classes, each taught by a different teacher, have homework assigned for each class, and receive notification of a test next week in one class and a project in another. Adults expect middle school students to be able to write their assignments down in their assignment book, bring home all necessary books and materials, complete homework daily, and undertake larger projects independently (Boller, 2008). For some students, these tasks are not difficult, and they demonstrate success; however, some middle school students do not possess these skills, and as a result they begin to struggle academically (Boller, 2008). As noted, executive functions are important for academic success at all levels, but the acquisition of these skills is more critical as students transition from the elementary setting to middle school (Boller, 2008; Jacobson et al., 2011).

Further complicating the transition is the developmental stage of adolescence, whose early phase coincides with the transition to middle school. The biological changes of puberty (hormone production and brain changes), as well as psychosocial changes and the development of one's self-concept, makes this a vulnerable period for children (Wigfield et al., 2005). Although not all adolescents experience difficulties during this stage, it is worth noting that many do and that for those individuals, these difficulties could have long-term implications extending far beyond the middle school experience (Blackwell, 2007). Some students successfully navigate the transition to middle school. For those students, middle school has the potential to be a positive time, as they are afforded new opportunities and experiences. On the other hand, those students who struggle with the transition may endure significant negative consequences, such as a decrease in motivation and a decline in academic achievement (Alspaugh, 2001; Anderman & Maehr, 1994). Furthermore, students who struggle with this transition may also suffer psychological distress, a decrease in their overall self-worth, disengagement from school, and an increased risk of engaging in risky behavior (Eccles et al., 1989).

Overall, the transition to middle school is a pivotal developmental trajectory that has the potential to impose long-term consequences on students, thus it is important for schools to facilitate a successful transition for these youth. As previously noted, executive functions have been linked to academic success. Furthermore, executive functions are even more critical at this academic juncture, due to the increased level of independence that is characteristic of middle school coupled with the various challenges that students face at this time. Therefore, intact executive functions may serve as a protective factor for students transitioning to middle school.

Executive Function Interventions

Executive functions, including the ability to manage time, organize and prioritize information, and monitor progress, are all critical for completing homework, taking notes, completing long-term projects, and studying for tests. Students who can easily understand even complex concepts but struggle with the processes of goal setting, initiating tasks, and organizing materials and information often have difficulty demonstrating what they know (Meltzer, Pollica & Barzillai, 2007). Strategy instruction, which teaches students how to learn, is an effective way to address executive function weaknesses (Meltzer et al., 2007).

Through strategy instruction, students can identify their individual strengths and weaknesses and develop strategies to address those critical executive functions, which enables them to utilize their strengths to become more efficient learners (Meltzer et al., 2007).

Important components of strategy instruction are:

- Strategy instruction should be directly linked to the curriculum.
- Metacognitive strategies should be taught explicitly.
- Strategies should be taught in a structured, systematic way, using scaffolding and modeling and providing time for practice.
- Students' motivation and self-understanding should be addressed to ensure generalized use of strategies. (Meltzer et al., 2007, p. 168)

Through the implementation of classroom-based strategy instruction, the executive function processes of planning, goal setting, organization, cognitive flexibility, and self-monitoring can also be addressed.

Planning and Goal Setting. Planning and goal setting are key aspects of self-regulated learning yet typically not taught in schools. Teachers can teach these skills by modeling the process of planning through schedules, the use of weekly and monthly calendars, and imparting time management strategies.

Organization and Prioritizing. Instruction needs to include helping students to develop strategies for organizing materials, information, and ideas, and how to incorporate these strategies when taking notes, studying and writing.

Shifting Flexibly. Cognitive flexibility is critical for reading, writing, math, and test taking. In regard to reading, students can be taught to ask themselves questions to help them shift more flexibly while reading. When writing, teaching students to shift roles when editing their work, such as pretending they are the teacher, may help them view their writing from a different perspective, enabling them to better assess whether they have clearly explained the information and provided enough details. For math, teachers can instruct students to ask themselves questions when solving problems, such as “Do I know more than one way to solve this problem?”

Self-Monitoring and Checking. Many students struggle with monitoring and checking their work, because they often do not know what to check for. Providing checklists for assignments is helpful. Teaching students to make their own personalized checklists for each subject, which include mistakes they often make, is even more beneficial.

In addition to incorporating these skills into the curriculum, some students might need more intensive interventions. For example, students with ADHD tend to struggle with executive functions. Organizational skills, which include both organization of materials and time management and planning, (Langberg et al., 2012) are often less developed in students with ADHD. In addition, students with ADHD also tend to struggle with homework completion, because the task requires both organization of materials and time management skills (Langberg et al., 2011). In order to successfully complete homework, students must accurately record the assignment, bring all essential materials home, set aside time to complete the assignment, and bring the completed work back to school and turn it in (Langberg et al., 2011).Tasks that require more long-term planning, such as projects and studying for tests, tend to be even more difficult for students with ADHD (Langberg et al., 2011). The problems associated with homework fall into two categories. The first is inattention/avoidance of homework, which refers to problems associated with focusing and sustaining attention and working independently and efficiently (Power et al., 2006). The other category is poor productivity/nonadherence with homework rules, which refers to problems related to the input and output of homework, such as failure to accurately record homework and to complete and turn in homework (Power et al., 2006). These difficulties tend to become more apparent when students transition to middle school (Langberg et al., 2010). Because successful homework completion is linked to grades, particularly at the middle school and high school levels, it is important to implement interventions to teach these necessary skills.

The *Homework, Organization, and Planning Skills* (HOPS) program was a structured intervention program that was designed for middle school students diagnosed with ADHD. The program was developed by Langberg et al. (2008) to address the organization and planning difficulties that children with ADHD experience. The program was initially delivered twice a week in 75-minute sessions in after-school program staffed by undergraduate psychology students (Langberg et al., 2008). Although the students demonstrated an improvement in their GPA in core classes, (Langberg et al., 2008) an important limitation was that the interventions were implemented in an after-school program by research staff rather than school staff. The HOPS program was modified to be delivered during the school day by school counselors, school psychologists, and other school mental health providers in order to create a more collaborative environment, more conducive to implementing the organization and planning interventions (Langberg et al., 2011). The program was implemented over eleven weeks, with twenty-minute sessions twice a week for five weeks, decreasing to once a week for the final six weeks. Skills addressed in the program included organization of school materials, accurately recording homework, projects, and tests, short- and long-term planning, and time management. Studies of the HOPS program have revealed its effectiveness. For example, in one study of 47 middle school students, participants showed significant improvement in parent ratings of organizational skills, as well as an improvement in GPAs, which were both maintained at the three-month postintervention period (Langberg et al., 2012).

A Blueprint for Success, which was developed by Rush NeuroBehavioral Center, is another executive function program. The program, which focuses on self-regulation, self-awareness, goal-directed behavior, self-monitoring, problem solving, time-management and planning skills, was incorporated into the curriculum and was taught by classroom teachers (Bozeday et al., 2011).

The program consists of three different units. The *Foundations* Unit includes structuring the learning environment, organizing materials, and time-management skills (Bozeday et al., 2011). The use of a planner was part of the time-management lesson.

During the second Unit, *Study Strategies and Academic Support*, higher order skills were introduced (Bozeday et al., 2011). These include following directions, memory techniques, note-taking/organizing information, test preparation, and reflection (Bozeday et al., 2011). The third Unit, *Personal Growth*, addressed self-awareness, including learning strengths, goal setting, and decision making (Bozeday et al., 2011).

The program is flexible and can be implemented in the order suggested by the sequence of the lessons, or teachers may select lessons based on students' needs at any given time (Bozeday et al., 2011). The program may be implemented as a Tier I or Tier II intervention. There are also three versions of the program, each with lessons tailored to three different age categories: Intermediate, (Grades 3, 4, and 5), Middle School (Grades 6, 7 and 8), and High School (Bozeday et al., 2011). Materials included with each age level are the teacher's Curriculum Notebook, which includes Teacher Resources, Lesson Plans, Progress-Monitoring Charts, and Assessment Tools, and the Student Guide, which includes short lessons, activities to reinforce skills learned, worksheets with graphic organizers, templates, and charts to enhance learning, and self-assessments (Bozeday et al., 2011).

In addition to utilizing a specific program such as HOPS or the Blueprint for Success, difficulties with executive functions can also be addressed through other therapeutic interventions such as *Cognitive-Behavioral Therapy*, *Mindfulness* techniques, and problem-solving training (McCloskey et al., 2009). It is important to remember that executive functions are multidimensional in nature, and so are the interventions that address executive function deficits as well. No universal treatment approach is effective at improving executive functions for all individuals (McCloskey et al., 2009). However, an intervention plan should include modeling and cueing, as well as helping the student become more cognizant of which specific functions are required to accomplish a specific goal. (McCloskey et al., 2009).

Assessing Executive Functions

Direct Formal Methods There are multiple neuropsychological tests that assess various executive functions. Two well-known tests are the Delis Kaplan Executive *Function System* (D-KEFS) and the *NEPSY-II*.

The D-KEFS is a standardized assessment designed to assess various executive functions in individuals from 8 to 89 years of age (Delis et al., 2001). It comprises nine different tests, which can be administered independently or in combination with other D-KEFS tests.

Word-Context Test. This test presented the examinee with a pseudoword and encouraged him or her to try to discover its meaning by interpreting a series of clues that are initially broad and general, then narrow in specificity. Executive functions tapped by this subtest include verbal modality, as well as skills like deductive reasoning, integration of multiple bits of information, hypothesis testing, and flexible thinking.

Sorting Test. This test presented the examinee with six different cards varying in perceptual features and printed words, and instructed him or her to sort the cards into two groups of three according to as many categories as possible, such as shape, color, etc. This test assessed several areas of executive functioning, including initiation of problem-solving behavior, verbal and nonverbal concept-formation skills, transfer of concepts into action, and flexible thinking.

Twenty Questions Test. This test presented the examinee a page displaying 30 common objects and instructed him or her to guess which of the objects the examiner is thinking of by asking as few *yes* or *no* questions as he or she can. Key areas of executive functioning tapped into by this subtest included the ability to recognize categories and subcategories, abstract question formation, and efficiency in problem-solving.

*Tower Test***.** In this test, the examinee was presented with *n* number of discs of varying sizes in a specific array and are asked to arrange the discs on the board so that they match the stimulus picture presented, and to do so in as few moves as possible. The examinee must follow a number of rules as well. In each subsequent part, the number of rings and the complexity of the moves required to successfully complete the task increased. This test taps into spatial planning, rule learning, inhibition of impulsive responses, inhibition of perseverative responses, and establishing and maintaining instructional set.

*Color-Word Interference Test***.** This test consisted of four individual test conditions. Conditions 1 and 2 served as lower `level assessments of color naming and word reading. Condition 3 introduced a distracter by displaying the names of colors across the page printed in the ink of a different color. For example, the word *red* would be printed in blue ink. The subject must then say the name of the ink color while inhibiting responses of saying the word. Condition 4 builds upon Condition 3 by introducing a switching response. Here again, color word names were printed in a different ink color, but random words were outlined with a black box. The examinee was told to name the color of the ink unless the word is within a box, at which point they are instructed to read the word but not name the color of the ink. Executive functions employed in this test are response inhibition and cognitive flexibility.

Verbal Fluency Test. This test required the individual to randomly generate words based upon established parameters, such as words beginning with a particular letter or a specific category, such as boys' names. A switching task was also included, in which the respondent alternates between giving the name of a fruit and a piece of furniture. This task assesses cognitive flexibility, response inhibition, and verbal fluency.

Trail Making Test. This test required the examinee to create a trail with their pencil by connecting numbers and letters, then alternating numbers and letters. The task measures cognitive switching, the ability to inhibit, and maintaining a cognitive set and working memory.

Proverb Test. (Ages 16 +) This test presented the examinee with different proverbs, requiring them to interpret them. The task measures abstract verbal thinking.

The NEPSY-II is another neuropsychological assessment. The NEPSY-II is a comprehensive neuropsychological battery designed to assess neuropsychological development in children and adolescents (Korkman et al., 2007). The test comprised thirty-two subtests that are divided into six different domains. The domains included in the NEPSY-II are attention and executive functioning, language, memory and learning, sensorimotor, and visuospatial processing. The entire assessment can be administered, or a specific set of subtests, depending on the presenting problem. Within the attention and executive function domain, there are six different subtests (Korkman et al., 2007).

Animal Sorting. (Ages 7-16) The examinee was given eight cards and instructed to sort the cards into two groups of four, using different categorical criteria. The task is designed to assess concept-formation skills, the transfer of concepts into action, and flexibility of thinking.

Auditory Attention and Response Set. (Ages 5-16) This subtest comprised two parts. In both tasks, the examinee listens to an auditory recording of a list of words, and when he or she hears the target word, touches the appropriate circle in the stimulus book. Auditory Attention assesses selective auditory attention and sustaining attention. (The Response Set assesses the ability to shift and maintain a new and complex set involving both inhibition of previously learned responses and correct responses to matching or contrasting stimuli.)

Clocks. (Ages 7-16) This subtest included items that required the examinee to draw an analog clock that reflects the specific time that the examiner indicates and visual items that require the examinee to indicate the time shown on the clock, which may or may not have numbers. This task assesses the examinee's understanding of time using an analog clock, as well as planning and organization and visuoperceptual and visuospatial skills.

Design Fluency. (Ages 5-12) The examinee was instructed to rapidly draw unique designs that connect up to five dots, which are presented in structured and random arrays. This task assessed the child's behavioral productivity, visual attention, motor speed, and visual-perceptual skills.

Inhibition. (Ages 5-16) The examinee was instructed to view rows of black and white shapes or arrows and asked to name the shape or the direction of an arrow, or to give an alternative response. This task assessed the examinee's ability to self-monitor, inhibit automatic responses, and cognitive switching.

Statue. (Ages 3-6) The examinee was instructed to maintain a body position with eyes closed for 75 seconds. This task assessed motor persistence and inhibition.

Although these tests provided valuable information, they did have limitations in regard to capturing an individual's executive function skills. The nature of the standardized assessment tool creates a less natural, more structured setting, in which the examiner cued the examinee. Although important information may still be obtained with these assessments, the examinee's performance on such tests may not be consistent with how they perform everyday tasks (Banich, 2009; Lezak, 1982). For example, Alderman et al. (2003) assessed adults with some form of brain injury. Most of the individuals performed well on the assessments of executive functions, excluding the *Multiple Errands Test-Simplified Version* (MET-SV), which took place in a shopping center and entailed the subjects' independent completion of simple tasks, such as purchasing specific items from a list and finding specific information, all within a specified time limit. Similar studies have discovered consistent findings (Lawrence et al., 2002; Shallice and Burgess, 1991). Therefore, assessing an individual's ability to perform complex daily tasks independently in his or her natural environment may be a more accurate indicator of his or her executive function skills (Brown, 2006; Toplak et al., 2013).

Rating Scales In addition to standardized assessments, executive functions have also been assessed through behavior-rating scales. There are multiple behavior-rating scales designed to assess executive functions. One is the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al.,1996), which assesses executive functions in children. A teacher form provides information about the manifestation of a child's executive functions in school; a parent form provides information about a child's executive functions at home. The BRIEF comprised eight clinical scales, two Indices, and one *Global Executive Composite* (Gioia et al., 2000). The two Indices are the *Behavioral Regulation Index* and the *Metacognitive Index*. The Behavioral Regulation Index included the Inhibit, Shift, and Emotion Control Scales. Inhibit refers to the ability to inhibit (refrain from) acting on an impulse. Shift refers to one's ability to move from one activity or task to another as needed. Emotional Control is the ability to modulate or regulate one's emotional response to a particular situation. The Metacognitve Index includes the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor Scales. Initiate pertains to the ability to begin a task independently. Working Memory is the ability to hold information in mind temporarily in order to perform a task. Plan/Organize has two components. Plan is the ability to set goals, to break down larger tasks into steps, and to develop strategies to achieve a goal. Organize pertains to the ability to order ideas and information. Organization of Materials is the ability to keep one's materials and possessions organized. Last, Monitor refers to the ability to monitor one's performance of tasks.

Summary

Executive functions are multidimensional neurocognitive processes that cue and guide behavior. They are considered necessary for daily life, as well as the attainment of long-term goals (Diamond, 2013; Lezak, 1982). They are present in every task one performs and are particularly important when learning something new (Duncan & Owen, 2000; Poldrack et al., 2005).

Research has shown that executive functions are linked to academic performance from the preschool level through college. Intact executive functions are critical to learning in in all subject areas. Executive function deficits have been linked to specific learning disabilities in reading comprehension and mathematics. In addition, because executive functions are an integral component of reading, writing and mathematics, executive function deficits can result in difficulties with academic performance.

Middle school is significantly different from elementary school in various ways, thus the move from elementary school to middle school is likely one of the most difficult transitions for students. In middle school, the curriculum typically becomes more difficult and the workload increases (Bailey et al., 2015; Cook et al., 2008). In addition, students are expected to demonstrate much more independence and manage more responsibilities at this level (Boller 2008; Kingery et al., 2011). For many students, middle school entails navigating a much larger building, moving to and from multiple classrooms throughout the day, adjusting to multiple teachers, and interacting with many new peers (Cook et al., 2008). Although executive functions are relevant to academic achievement at every level, the significant changes that occur in the transition to middle school may make the utilization of executive functions even more critical.

Research Question

The study analyzed the BRIEF Index and Scale scores, as well as the item-level ratings of each BRIEF Scale that were completed by seventh grade teachers to explore the following research question:

What is the relationship between the BRIEF scores based on teacher ratings and ELA, Math, Science, and Social Studies grades of a sample of seventh grade students?

It is hypothesized that those students who were rated as having few if any behavior difficulties thought to reflect executive function deficits, as indicated on the

BRIEF- teacher report, will also earn better grades in ELA and Social Studies than students identified as having more extensive behavior difficulties thought to reflect executive function deficits.

CHAPTER 3

Methods

Overview

The objective of the current study is to examine the role of executive functions in academic success during middle school. The study utilized archival data to examine the relationship between teacher BRIEF ratings and end-of-year grades in English Language Arts (ELA) and Social Studies (SS) courses for a group of seventh-grade students.

Data Source

This study used archived data that was collected during the 2015-2016 school year in a suburban school district in southern New Jersey. The archival data consists of BRIEF Teacher Form Scale scores and BRIEF individual item scores and end-of-year grades in ELA and SS courses for a group of 54 seventh-grade students. The BRIEF ratings were completed by the ELA and SS course teachers.

Measures

The first edition of the Behavior Rating Inventory of Executive Functions (BRIEF; Gioia et al.,1996) Teacher Form was used to assess the executive functions of seventh-grade students in the current study. The BRIEF is a standardized questionnaire that is used to assess parent, teacher, and student perceptions of executive function difficulties in children ages five through eighteen years of age (Gioia et al., 1996). The BRIEF Teacher form consists of 86 items and takes about ten to fifteen minutes to complete. The individual items describe children's daily manifestation of behaviors thought to indicate executive function difficulties, and the teacher is required to rate each item based on his or her observation of the child. Each item is rated using a three-point scale, in which 1 = *Never*, 2 = *Sometimes*, and 3 = *Often*. The items contribute to eight different Clinical Scales, which comprise two separate Index Scores the Behavioral Regulation Index and the Metacognitive Index. There is also a Global Executive Composite. Raw scores were obtained for each of the Clinical Scales, as well as the Index Scores and Global Executive Composite and then converted to *T*-scores. A *T*-score of 65 or above indicates dysfunction of that executive function

(Gioia et al., 2000). The Behavioral Regulation Index includes the Inhibit, Shift, and Emotion Control Scales, and the Metacognitve Index includes the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor Scales (Gioia et al., 2000).

Psychometric Characteristics of the BRIEF

The BRIEF possesses strong psychometric properties in regard to internal consistency and test-retest reliability. Using Cronbach's alpha statistic, the internal consistency for the Clinical Scales ranged from .84 to .96, the Behavioral Regulation Index was .97 for both the clinical and normative sample, the Metacognition Index was .96 for the clinical sample and .98 for the normative sample, and the Global Executive Composite was .98 for both the clinical and normative sample (Gioia et al., 1996). The test-retest correlation for the clinical scales ranged from .83 to .92 over a period of three and one-half weeks. The test-retest correlation for the Behavioral Regulation Index was .92, the Metacognitive Index was .90, and the Global Executive Index was .91 (Gioia et al., 1996).

Because another executive function rating scale did not exist when the BRIEF was developed, convergent and discriminant validity were assessed by comparing the

BRIEF scales to other child behavior rating scales and examining the patterns of ratings obtained from teachers and parents of children diagnosed with specific mental disorders, including Attention Deficit Hyperactivity Disorder, learning disabilities, autism spectrum disorder, conduct disorder, and intellectual disability (Gioia et al., 1996).

Procedures

Archival data, consisting of the results of BRIEF teacher ratings, and end-of-year grades from ELA and SS classes, were accessed with permission from the school district. The BRIEF rating scales were completed by two seventh-grade special education ELA teachers during the 2015-2016 school year. One of the teachers taught only seventh grade-inclusion ELA and had been co-teaching with the same general education teacher for eight years. The other teacher, who was in her third year of teaching, taught the seventh-grade learning disabilities ELA classes. During that school year, an additional inclusion class was needed, so the second teacher taught an additional inclusion ELA class. Both teachers completed a BRIEF for each student in the in-class support classes they taught, regardless of whether the student had an IEP. The Teacher BRIEF ratings and student ELA and SS end-of-year grades were copied to a data analysis file with no specific identifiers, so that data analyses were completed in a manner that maintained student and teacher confidentiality.

Statistical Analyses

Data analyses employed descriptive and inferential statistical analysis techniques to examine the relationship between teacher ratings of executive functions and end-of-year grades in ELA and SS courses.

Parametric inferential statistical analyses will involve correlational analyses completed with the BRIEF Scale *T*-scores and the ELA and SS end-of-year course grades. Nonparametric statistical analyses will involve 2 x 2 chi-square analyses comparing two-category classification transformations (Problematic and Nonproblematic categories) of each BRIEF Scale Percentile Rank (the Problematic category is defined as percentile rank greater than or equal to 90; the Nonproblematic category is defined as percentile rank less than 90) with two-category classifications of course grades (*Good* defined as a grade of A, B, or C; *Poor* defined as a grade of D or F).

Descriptive analyses will be conducted using 3 x 2 cross-tabulation tables comparing the teacher ratings of the frequency of occurrence (*Never*, S*ometimes*, *Always*) of each item from each BRIEF Scale with the two-category classifications of course grades

Hypothesis

It is hypothesized that the seventh-grade students rated by their ELA teacher as having minimal behavioral difficulties thought to reflect executive function deficits as indicated on the BRIEF-Teacher Report will earn good grades in both ELA and Social Studies. Conversely, those students identified as exhibiting extensive behavioral difficulties thought to reflect executive function deficits as indicated on the BRIEF Teacher Report will earn poor grades.

CHAPTER 4

Results

This chapter presents the results of statistical analyses designed to examine the relationship between teacher ratings of executive functions using the BRIEF and final course grades for a sample of 55 middle school students. Table 1 shows the gender and educational classification of the sample of students that were rated by teachers. This table also includes the final grades earned by these students in four core subjects in grades 6 and 7.

Table 1.

Characteristics of the Sample of Students Rated by Teachers with the BRIEF

General Education

	Female								Male							
	Grade 6				Grade 7				Grade 6				Grade 7			
Grade	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS
A	1	5	7	3	11	5	5	10	3	5	13	9	10	7	10	8
B	13	7	11	12	8	9	12	8	13	10	5	7	6	9	9	10
C	6	4	2	4	2	4	4	3	2	2	1	3	3	4	1	2
D		2		1		3			1	1			1	1		
F		2								1			1		1	1
NG	1	1	1	1					2	2	2	2				
Total	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21

Special Education IEP or 504 Plan

	Female								Male							
	Grade 6				Grade 7				Grade 6				Grade 7			
Grade	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS	ELA	MTH	SCI	SOS
A			1		4	1		1			1		1		1	1
B	4	4	5	4	2	5	2	5	3	2	4	2	3	2	2	3
C	2	2		2			4		3	5	2	5	2	3	3	2
D									1				1	2	1	1
F																
NG																

Total	6	6	6	6	6	6	6	6	7	7	7	7	7	7	7	7

The BRIEF ratings analyzed in this study were provided by two teachers who taught the English Language Arts classes to the students whose characteristics were described in Table 1. Table 2 shows the gender and educational classification of the students rated by each teacher.

Table 2

Characteristics of the Sample of Students Rated by Each Teacher

		ELA Teacher 1	ELA Teacher 2
Female	General Education	15	6
	Special Education or 504 Plan	3	3
Male	General Education	9	12
	Special Education or 504 Plan	5	2
	Total	32	23

Research Questions

Data analyses, whose results are presented in this chapter, were conducted to answer the following research question:

Research Question: What is the relationship between teacher ratings of executive functions using the BRIEF and students' core subject final grades for 6^{th} and 7^{th} grade?

This study examined the relationship between teacher ratings of executive functions and final course grades using correlational analyses and analyses of cross-tabulation data.

Correlational Analysis. BRIEF Teacher Form *T*-scores for each Scale and Composite were correlated with sixth grade and seventh grade final course grades in four core subjects. The eight BRIEF Teacher Form Scales were Inhibition, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and

Monitor. The BRIEF Composites were the Behavior Rating Index (BRI), the Metacognitive Index (MCI), and the Global Executive Composite (GEC). The four core subjects were English Language Arts (ELA), Mathematics (MTH), Science (SCI) and Social Studies (SOC). The results of correlational analyses for all BRIEF Scales and Composites and all four core subjects are presented in Table 3.

BRIEF Scale and Composite *T*-scores ranged from 42 to 127 and final grades were expressed as percentages that ranged from 61 to 100. BRIEF scores are negatively weighted, so the higher the *T*-score, the more frequent the endorsement of behaviors indicative of executive function difficulties. Conversely, the lower the *T*-score, the less frequent the endorsement of behaviors indicative of executive function difficulties. When correlating the negatively weighted BRIEF *T*-scores with the positively weighted final course grade percentages, negative correlations reflected a positive relationship between executive functions and academic performance. The relationships between each BRIEF *T*-score and final course grades are organized and presented separately for each BRIEF Scale and Composite in the sections that follow.

Table 3

Correlations between the BRIEF Scale and Composite T-scores and Final Course Grades for 6th and 7th Grades

BRIEF SCALE/Composite		ELA Grade 6 *n* = 52	ELA Grade 7 *N* = 55	MTH Grade 6 *n* = 52	MTH Grade 7 *N* = 55	SCI Grade 6 *n* = 52	SCI Grade 7 *N* = 55	SOC Grade 6 *n* = 52	SOC7 Grade 7 N = 55
Inhibition	*r*	-.372**	-.431**	-0.244	-.266*	-.366**	-.428**	-.352*	-.505**
	Sig.	0.007	0.001	0.081	0.049	0.008	0.001	0.011	0.000
Shift	*r*	-0.255	-.344*	-0.137	-0.135	-.312*	-.407**	-.320*	-.283*
	Sig.	0.068	0.010	0.333	0.327	0.024	0.002	0.021	0.036
Emotional Control	*r*	-0.190	-.289*	-0.154	-0.145	-0.266	-.404**	-.298*	-.325*
	Sig.	0.178	0.032	0.277	0.291	0.057	0.002	0.032	0.016
Behavior	*r*	-.302*	-.388**	-0.200	-0.205	-.343*	-.449**	-.353*	-.413**
Regulation Index	Sig.	0.030	0.003	0.156	0.133	0.013	0.001	0.010	0.002
Initiate	*r*	-.620**	-.677**	-.396**	-.520**	-.578**	-.699**	-.532**	-.682**
	Sig.	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
Working Memory	*r*	-.643**	-.608**	-.418**	-.575**	-.611**	-.706**	-.552**	-.744**
	Sig.	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
Plan/Organize	*r*	-.619**	-.714**	-.389**	-.538**	-.587**	-.681**	-.481**	-.710**
	Sig.	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000
Organization of	*r*	-.575**	-.504**	-.326*	-.448**	-.404**	-.517**	-.463**	-.586**
Materials	Sig.	0.000	0.000	0.018	0.001	0.003	0.000	0.001	0.000
Monitor	*r*	-.549**	-.517**	-.381**	-.416**	-.592**	-.605**	-.542**	-.691**
	Sig.	0.000	0.000	0.005	0.002	0.000	0.000	0.000	0.000
Metacognitive	*r*	-.650**	-.663**	-.414**	-.543**	-.606**	-.705**	-.552**	-.747**

Index	Sig.	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000
Global Executive	*r*	-.553**	-.605**	-.357**	-.436**	-.542**	-.650**	-.507**	-.663**
Composite	Sig.	0.000	0.000	0.009	0.001	0.000	0.000	0.000	0.000

Note. **. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Inhibition Scale. Statistically significant correlations between the Inhibition Scale and final course grades were found for three of the four courses in 6th grade and all four courses in 7th grade. Inhibition Scale correlations with all four courses were lower in grade 6 than in grade 7. The lowest correlations were found between the Inhibition Scale *T*-scores, and the final grade for the Math course in grade 6 (r = -.244, not significant) and the Math course in grade 7 (r = -.266). The correlations between the Inhibition Scale and final grades in the ELA, Science and Social Studies courses were all in the .30 - .39 range for 6th grade. The correlations for all three of these courses increased in 7th grade; correlations in ELA and Science rose into the .40 - .49 range, and the correlation with Social Studies increased into the .50 - .59 range. The correlations between the Inhibition Scale and final course grades were among the lowest in this study.

Shift Scale. In 6th grade courses, statistically significant correlations between the Shift Scale and the final course grades were found only for Science (r = -.312) and Social Studies (r = -.320). In 7th grade, statistically significant correlations were found for all courses except Math. The lowest correlations were found between the Shift Scale *T*-score and 6th grade Math 6 (r = -0.137) and 7th grade Math (r = -0.135). The highest correlation was found between the Shift Scale and the final grade for Science in 7th grade (*r* = -.407). The correlations between the Shift Scale and the final course grades were among the lowest in this study.

Emotional Control Scale. Statistically significant correlations between the Emotional Control Scale and the final grades were found only for Social Studies in 6th grade (*r* = -.298), but in 7th grade, statistically significant correlations were found for all subjects except Math. The correlations for ELA, Science and Social Studies increased from 6th grade to 7th grade but decreased for Math. The lowest correlations for both 6th grade (*r* = -.154) and 7th grade (*r* = -.145) were also found with Math. The highest correlation for 6th grade was found with Social Studies (*r* = .298), and the highest correlation for 7th grade was found with Science (*r* = -.325). The correlations between the Emotional Control Scale and final course grades were among the lowest correlations in this study.

Behavior Regulation Index. Statistically significant correlations between the Behavior Regulation Index and the final grades were found for ELA, Science, and Social Studies in both 6th grade and 7th grade. The correlations between the Behavior Regulation Index and the final grades in the ELA, Science, and Social Studies courses were all in the .30-.39 range for 6th grade. The correlations for all three of these courses increased in 7th grade, with Science and Social Studies rising into the .40-.49 range. Correlations between the Behavior Regulation Index and the final grades in Math were not statistically significant for either 6th or 7th grade.

Initiate Scale. Statistically significant correlations between the Initiate Scale and final grades were found for all four subjects for both 6th grade and 7th grade. The correlations for all four subjects increased from 6th grade to 7th grade. For 6th grade, the highest correlation was found between the Initiate Scale and the final grades in ELA (*r* = -.620), and for 7th grade, the highest correlation was found between the Initiate Scale and Science (*r* = -.699). Although still statistically significant, the lowest correlations were found between the Initiate Scale and the final grades for Math in both 6th grade (*r* = -.396) and 7th grade (*r* = -.520). In 6th grade, the correlations for the other three subjects were .53 or above, and in 7th grade, all subjects increased into .67-.69 range.

Working Memory Scale. Statistically significant correlations between the Working Memory scale and the final grades were found for all four subjects in both 6th grade and 7th grade. The correlations for Math, Science, and Social Studies increased from 6th grade to 7th grade, while the correlations for ELA decreased from 6th grade (*r* = -.643) to 7th grade (*r* = -.608). For 6th grade, the highest correlation was found between the Working Memory Scale and the final grades in ELA (*r* = -.643), and for 7th grade, the highest correlation was with Social Studies (*r* = -.744). The lowest correlation between the Working Memory scale and Math was found in both 6th grade (*r* = -.418) and 7th grade (*r* = -.575). The correlations between the Working Memory Scale and final course grades were the highest correlations in this study.

Plan/Organize Scale. Statistically significant correlations were found between the Plan/Organize Scale and final grades for all four subjects in both 6th grade and 7th grade. Furthermore, the correlations for all four subjects increased from 6th grade to 7th grade. The highest correlations for both 6th grade and 7th grade were found between the Plan/Organize Scale and final grades for ELA (*r* = -.619 and *r* = -.714). Although still statistically significant, the correlation between the Plan/Organize Scale and Math were relatively low for both 6th grade (*r* = -.389) and 7th grade (*r* = -.538). The correlations between the Plan/Organize Scale and final course grades were among the highest in this study.

Organization of Materials Scale. Statistically significant correlations were found between the Organization of Materials Scale and the final grades for all four subjects in both 6th and 7th grades. The correlations between the Organization of Materials Scale and final grades increased from 6th to 7th grade in Math, Science, and Social Studies, but the correlation for ELA decreased slightly from 6th grade (*r* = -.575) to 7th grade (*r* = -.504). The highest correlation for 6th grade was found between the Organization of Materials Scale and the final grades in ELA (*r* = -.575), and for 7th grade, the highest correlation was found between the Organization of Materials Scale and the final grades in Science (*r* = -.586). Although still statistically significant, the correlation between Organization of Materials Scale and final grades was relatively low for Math in both 6th grade (*r* = -.326) and 7th grade (r = .448).

Monitor Scale. Statistically significant correlations were found between the Monitor Scale and the final grades for all four subjects in both 6th grade and 7th grade. The correlations between the Monitor Scale and final grades also increased from 6th grade to 7th grade in Math, Science, and Social Studies but decreased slightly in ELA from 6th grade (*r* = -549) to 7th grade (-.517). Although statistically significant, the correlation between the Monitor Scale and final grades was relatively low for Math in 6th grade (*r* = -.381) and 7th grade (*r* = -416). In contrast, the correlations with ELA, Science, and Social Studies were all in the .50-.59 range for 6th grade, with the correlation for Science and Social Studies increasing into the .60-.69 range.

Metacognition Index. Statistically significant correlations were found between the Metacognitive Index and the final grades for all four subjects for both 6th grade and 7th grade. The correlations between the Metacognitive Index and final grades increased from 6th grade to 7th grade in all four subjects. Relatively low correlations between the Metacognitive Index and final grades were found for Math for both 6th grade (r = -.414) and 7th grade (r = -.543). The highest correlation in 6th grade was found between the Metacognitive Index and the final grade in ELA (r = -.650), and for the 7th grade, the highest correlation was between the Metacognition Index and the final grade in Social Studies (r = -.747). The correlations between the Metacognitive Index and final course grades were among the highest in this study.

Global Executive Composite. Statistically significant correlations were found between the Global Executive Composite and the final grades for all four subjects in both 6th grade and 7th grade. The correlation between the Global Executive Composite and the final grades increased from 6th grade to 7th grade for all four subjects. Relatively low correlations between the Global Executive Composite and final grades were found for Math for both 6th grade (r = -.357) and 7th grade (r = -.436). The highest correlation between the Global Executive Composite and final grades for 6th grade was found with ELA (r = -.553), and for 7th grade, the highest correlation was with the Social Studies final grade (r = -.663).

Cross-tabulation Analyses. A series of cross-tabulations were constructed tabulating executive function rating levels based on BRIEF *T*-scores and academic achievement levels based on core subject final grades. Each BRIEF *T*-score was transformed into a dichotomous categorical score representing executive function rating levels as follows: *T*-scores greater than or equal to a score of 60 were categorized as reflecting low executive function ratings (EF-); *T*-scores less than or equal to a score of 59 were categorized as reflecting high executive function Ratings (EF+). Higher BRIEF *T*-scores reflected a lower executive function rating level, because the BRIEF items are all negatively weighted. High scores reflect more frequently occurring behaviors indicative of executive function deficits, and low scores reflect less frequently occurring behaviors indicative of executive function deficits. Each course grade average was transformed into a dichotomous categorical score representing a level of academic achievement as follows: Final course grades greater than or equal to 80 were categorized as reflecting high academic achievement (Aca+); final course grades less than or equal to 79 were categorized as reflecting low academic achievement (Aca-).

Cross-tabulations were calculated by crossing the BRIEF Scale and Composite executive function performance levels with the core course academic achievement levels. The frequency counts for the categories were used to calculate indices of agreement, including sensitivity, specificity, and kappa (degree of agreement beyond chance), and to calculate two indices of incongruence.

The indices of incongruence were operationally defined as follows: 1) Unexpectedly high achievement was operationally defined as the percentage of students categorized as attaining high academic achievement levels and low executive function rating levels; 2) Unexpectedly low achievement is operationally defined as the percentage of students categorized as attaining low academic achievement levels and high executive function rating levels. The results of the analyses of the cross-tabulations are organized and presented separately for each index in Tables 4.5 through 4.9.

Sensitivity. The Sensitivity Index values based on the cross-tabulation of each BRIEF Scale and Composite T-score recoded as an executive function rating level and each core subject final course grade recoded as academic achievement levels are presented in Table 4.

Table 4.

Sensitivity Index Percentages for Agreement among Dichotomous Categorization of BRIEF Scale and Composite T-Scores and Dichotomous Categorization of Final Course Grades.

BRIEF Scale or Composite	Grade 6 ELA N = 52	Grade 7 ELA N = 55	Grade 6 MTH N = 52	Grade 7 MTH N = 55	Grade 6 SCI N = 52	Grade 7 SCI N = 55	Grade 6 SOC N = 52	Grade 7 SOC N = 55
Inhibition	47	60	47	41	80	57	47	67
Shift	73	80	58	65	80	71	60	67
Emotional Control	53	40	42	47	60	64	40	56
Behavior Regulation	60	60	53	59	80	71	60	67
Initiate	60	80	53	53	100	64	60	78
Working Memory	60	80	53	59	100	64	67	89
Plan/ Organize	60	80	47	53	80	64	60	78
Organization of Materials	53	70	47	47	80	50	53	67
Monitor	60	70	47	53	100	60	53	89
Metacognition	60	80	53	55	100	64	60	78
Global Executive Composite	67	80	58	65	100	71	60	78

Sensitivity Index values represent the percentage of students categorized as having low executive function ratings that also were classified as having low academic achievement.

Working Memory Scale. The Working Memory Scale demonstrated the greatest sensitivity, with Sensitivity Index values of 100% for Grade 6 Science, 89% for Grade 7 Social Studies, and 80% for Grade 7 ELA. For the remaining 5 courses, Sensitivity Index values were less than 70% (67% for Grade 6 Social Studies, 64% for Grade 7 Science, 60% for Grade 6 ELA and 59%, and 53% for Grade 6 Math and Grade 7 Math, respectively.

Global Executive Composite. The Global Executive Composite was the second most sensitive scale to low achievement, with Index values of 100% for Grade 6 Science, 80% for Grade 7 ELA, 78% for Grade 7 Social Studies, and 71% for Grade 7 Science. For the remaining four courses, Sensitivity Index values were less than 70% (67% for Grade 6 ELA, 65% for Grade 7 Math, 60% for Grade 6 Social Studies, and 58% for Grade 6 Math.)

Shift Scale. Ratings from the Shift Scale were the third most sensitive to low achievement, with Index values of 80% for Grade 7 ELA and Grade 6 Science, 73% for Grade 6 ELA and 71% for Grade 7 Science. For the remaining four courses, Sensitivity Index values were less than 70% (67% for Grade 7 Social Studies, 65% for Grade 7 Math, 60% for Grade 6 Social Studies, and 58% for Grade 6 Math).

Initiate Scale. The Initiate Scale showed Sensitivity Index values of 100% for Grade 6 Science, 80% for Grade 7 ELA, and 78% for Grade 7 Social Studies. The Sensitivity values for the five remaining courses were all less than 70% (64% for Grade 7

Science, 60% for Grade 6 ELA, 60% for Grade 6 Social Studies, and 53% for both Grade 6 and Grade 7 Math.)

Monitor Scale. The Monitor Scale showed Sensitivity Index values of 100% for Grade 6 Science, 89% for Grade 7 Social Studies, and 70% for Grade 7 ELA. The Sensitivity values for the other five courses were all less than 70% (60% for Grade 6 ELA, 60% for Grade 7 Science, 53% for Grade 7 Math, 53 % for Grade 6 Social Studies, and 47% for Grade 6 Math).

Metacognitive Index. The Metacognitive Index showed Sensitivity Index values of 100% for Grade 6 Science, 80% for Grade 7 ELA, and 78% for Grade 7 Social Studies. The Sensitivity values for the other five courses were all less than 70% (64% for Grade 7 Science, 60% for Grade 6 ELA, 60% for Grade 6 Social Studies, and 53% and 55% for Grade 6 Math and Grade 7 Math, respectively.)

Plan/Organize Scale. Ratings from the Plan/Organize Scale were the fourth most sensitive to low achievement, with Index values of 80% for both grade 7 ELA and Grade 6 Science and 78% for Grade 7 Social Studies. The Sensitivity values for the other five courses were less than 70% (64% for Grade 7 Science, 60% for both Grade 6 ELA and Grade 6 Social Studies, 53% for Grade 7 Math, and 47% for Grade 6 Math.)

Behavior Regulation Index. Ratings from the Behavior Regulation Index showed Sensitivity Index values of 80% for Grade 6 Science and 71% for Grade 7 Science. The Sensitivity values for all other courses were less than 70% (67% for Grade 7 Social Studies, 60% for Grade 6 Social Studies, 60% for both Grade 6 and Grade 7 ELA, 59% for Grade 7 Math, and 53% for Grade 6 Math.

Organization of Materials Scale. The ratings from the Organization of Materials Scale were among the least sensitive measures, with Sensitivity Index values above 70% for only two courses, 80% for Grade 6 Science and 70% for Grade 7 ELA. The Sensitivity values for all other courses were less than 70% (67% for Grade 7 Social Studies, 53% for Grade 6 ELA, 53% for Grade 6 Social Studies, 50% for Grade 7 Science, and 47% for both Grade 6 and Grade 7 Math).

Inhibition. The ratings from the Inhibition Scale were also among the least sensitive of the BRIEF Scales or Indexes, with Sensitivity Index values above 70% for only one course, 80% for grade 6 Science. The Sensitivity values for all other courses were less than 70% (67% for Grade 7 Social Studies, 60% for Grade 7 ELA, 57% for Grade 7 Science, 47% for grade 6 ELA, Grade 6 Math, and Grade 6 Social Studies, and 41% for Grade 7 Math).

Emotional Control. The Emotional Control Scale was the least sensitive to low achievement, with Sensitivity Index values for all eight of the courses falling below 70% (64% and 60% for Grade 7 Science and Grade 6 Science, respectively, 56% for Grade 7 Social Studies, 53% for Grade 6 ELA, 47% for Grade 7 Math, 42% for Grade 6 Math, and 40% for Grade 6 Social Studies).

Specificity. The Specificity Index values based on the cross-tabulation of each BRIEF Scale and Composite executive function rating level with each core subject academic achievement level are presented in Table 5.

Table 5

Specificity Index Percentages for Agreement between Dichotomous Categorization of BRIEF Scale and Composite T-Scores and Dichotomous Categorization of Final Course Grades.

BRIEF Scale or Composite	Grade 6 ELA *N* = 52	Grade 7 ELA *N* = 55	Grade 6 MTH *N* = 52	Grade 7 MTH *N* = 55	Grade 6 SCI *N* = 52	Grade 7 SCI *N* = 55	Grade 6 SOC *N* = 52	Grade 7 SOC *N* = 55
Inhibition	73	76	76	74	65	78	73	76
Shift	65	64	61	66	57	66	58	61
Emotional Control	72	67	67	71	66	76	65	70
Behavior Regulation	68	67	67	71	64	73	68	67
Initiate	78	80	79	79	74	80	78	78
Working Memory	71	76	73	76	70	76	76	76
Plan/ Organize	70	71	67	71	66	73	70	72
Organization of Materials	84	84	85	84	79	83	84	83
Monitor	81	80	79	82	77	80	78	83
Metacognition	78	80	79	79	74	80	78	78
Global Executive Composite	73	73	73	76	68	76	70	72

Specificity Index values represent the percentage of students categorized as having a high executive function rating who were also classified as attaining high academic achievement.

Organization of Materials Scale. The Organization of Materials Scale demonstrated the greatest specificity, with Specificity Index values greater than 80% for seven courses (85% for Grade 6 Math, 84% for Grade 7 Math, 84% for ELA Grade 6 and ELA Grade 7, 84% for Grade 6 Social Studies, 83% for Grade 7 Social Studies, and 83% for Grade 7 Science). The remaining specificity value, Grade 6 Science, was 79%.

Monitor Scale. The Monitor Scale showed the second greatest specificity, with Specificity Index values greater than 80% for 3 courses (81% for Grade 6 ELA, 82% for Grade 7 Math, and 83% for Grade 7 Social Studies) and Specificity Index values of 80% for Grade 7 ELA% and Grade 7 Science. The specificity value for Grade 6 Math was 79%, Grade 6 Science was 77%, and Grade 6 Social Studies was 78%.

Initiate Scale. The Initiate Scale showed Specificity Index values of 80% for two courses, Grade 7 ELA and Grade 7 Science. The Specificity values for the other six courses were all less than 80% (79% for both Grade 6 and Grade 7 Math, 78% for both Grade 6 and Grade 7 Social Studies, 78% for Grade 6 ELA, and 74% for Grade 6 Science).

Metacognitive Index. The Metacognitive Index also showed Specificity Index values of 80% for two courses, Grade 7 ELA and Grade 7 Science. The Specificity values for the other six courses were all less than 80% (79% for both Grade 6 and Grade 7 Math, 78% for both Grade 6 and Grade 7 Social Studies, 78% for Grade 6 ELA, and 74% for Grade 6 Science).

Working Memory Scale. The Working Memory Scale showed Specificity Index values of 70% or greater for all eight of the courses, but none of the values exceeded 76%. The Specificity values for Grade 7 ELA, Grade 7 Math, Grade 7 Science, and both Grade 6 and Grade 7 Social Studies were all 76%, 71% for Grade 6 ELA, 73% for Grade 6 Math, and 70% for Grade 6 Science.

Inhibition Scale. The Inhibition Scale showed Specificity Index values of 70% or greater for 7 of the courses, but none of the values exceeded 80% (78% for Grade 7 Science, 76% for Grade 7 ELA, 76% for Grade 6 Math, 76% for Grade 7 Social Studies, 74% for Grade 7 Math, 73% for Grade 6 ELA, and 73% for Grade 6 Social Studies). The remaining Specificity value, for Grade 6 Science, was 65%.

Global Executive Composite. The Global Executive Composite showed Specificity Index values of 70% or greater for seven of the courses, but none of the values exceeded 80% (76% for Grade 7 Math, 76% for Grade 7 Science, 73% for both Grade 6 and Grade 7 ELA, 73% for Grade 7 Math, 72% for Grade 7 Social Studies, and 70% for Grade 6 Social Studies). The Specificity value for Grade 6 Science was 68%.

Plan/Organize Scale. The Plan/Organize Scale showed Specificity Index vales of 70% or greater for six of the courses, but none of the values exceeded 73% (73% for Grade 7 Science, 72% for Grade 7 Social Studies, 71% for Grade 7 ELA, 71% for Grade 7 Math, 70% for Grade 6 ELA, and 70% for Grade 6 Science). The two remaining courses, Grade 6 Math and Grade 6 Science, showed Specificity values of 67% and 66%, respectively.

Emotional Control Scale. The Emotional Control Scale showed Specificity Index values of 70% or greater for four of the courses, but none of the values exceeded 76%

(76% for Grade 7 Science, 72% for Grade 6 ELA, 71% for Grade 7 Math, and 70% for Grade 7 Social Studies). The other four courses showed Specificity values below 70% (67% for Grade 7 ELA and Grade 6 Math, 66% for Grade 6 Science, and 65% for Grade 6 Social Studies).

Behavior Regulation Index. The Behavior Regulation Index showed Specificity Index values of 70% or greater for only two courses (73% for Grade 7 Science and 71% for Grade 7 Math). The other six courses all showed Specificity values below 70% (68% for Grade 6 ELA, 68% for Grade 6 Social Studies, 67% for Grade 7 ELA, 67% for Grade 6 Math, 67% for Grade 7 Social Studies, and 64% for Grade 6 Science).

Shift Scale. The Shift Scale demonstrated the least specificity, with Specificity Index values below 70% for all eight of the courses (66% for Grade 7 Math, 66% for Grade 7 Science, 65% for Grade 6 ELA, 64% for Grade 7 ELA, 61% for Grade 6 Math, 61% for Grade 7 Social Studies, 58 % for Grade 6 Social Studies, and 57% for Grade 6 Science).

Kappa. The Kappa Index values, based on the cross-tabulation of each BRIEF Scale and Composite executive function rating level and each core subject academic achievement level, are presented in Table 6.

Table 6

Kappa Index Percentages for Agreement between Dichotomous Categorization of BRIEF Scale and Composite T-Scores and Dichotomous Categorization of Final Course Grades

BRIEF Scale or Composite	Grade 6 ELA *N* = 52	Grade 7 ELA *N* = 55	Grade 6 MTH *N* = 52	Grade 7 MTH *N* = 55	Grade 6 SCI *N* = 52	Grade 7 SCI *N* = 55	Grade 6 SOC *N* = 52	Grade 7 SOC *N* = 55
Inhibition	19	28	24	15	22	33	19	31
Shift	32	29	18	27	14	30	15	16
Emotional Control	23	5	9	18	12	36	5	17
Behavior Regulation	25	19	19	28	18	38	25	22
Initiate	37	47	32	32	36	42	37	41
Working Memory	31	41	25	34	31	36	39	45
Plan/ Organize	28	38	14	23	20	33	28	33
Organization of Materials	38	47	34	33	33	33	38	40
Monitor	40	41	27	35	39	39	31	54
Metacognition	37	47	32	32	36	42	37	41
Global Executive Composite	36	38	30	39	29	41	28	33

Kappa Index values represent the percentage of classification consistency (high EF rating level with high achievement level and low EF rating level with low achievement level) beyond chance.

Initiate Scale. The Initiate Scale demonstrated the greatest classification consistency beyond chance, with Kappa Index values greater than 40% for Grade 7 ELA (47%), Grade 7 Science (42%) and Grade 7 Social Sciences (41%), and kappa values greater than 30% for the remaining five courses (37% for Grade 6 ELA and Grade 6 Social Studies, 36% for Grade 6 Science, and 32% for Grade 6 and Grade 7 Math).

Metacognitive Index. The Metacognitive Index showed the second greatest classification consistency beyond chance with Kappa Index values greater than 40% for Grade 7 ELA (47%), Grade 7 Science (42%), and Grade 7 Social Studies (41%). Kappa Index values greater than 30% but less than 40% were found for Grade 6 ELA (37%), Grade 6 Science (37%), Grade 6 Science (36%), and Grade 6 and Grade 7 Math (both 32%).

Working Memory Scale. The Working Memory Scale showed Kappa Index values greater than 40% for Grade 7 Social Studies (45%) and Grade 7 ELA (41%). Kappa Index values greater than 30% but less than 40% were found for Grade 6 Social Studies (39%), Grade 7 Science (36%), Grade 7 Math (34%), Grade 6 ELA (31%) and Grade 6 Science (31%). The Kappa Index value for the remaining course, Grade 6 Math, was 25%.

Organization of Materials Scale. The Organization of Materials Scale showed Kappa Index values greater than or equal to 40% for Grade 7 ELA (47%) and Social Studies (40%) and Kappa values greater than 30% but less than 40% for Grade 6 Social

Studies (38%), Grade 6 ELA (38%), Grade 6 Math (34%), Grade 7 Math (33%), and Grade 6 and Grade 7 Science (both 33%).

Monitor Scale. The Monitor Scale showed Kappa Index values greater than 40% for Grade 7 Social Studies (54%) and Grade 7 ELA (41%) and kappa values greater than 30% but less than 40% for Grade 6 ELA (40%), Grade 6 and Grade 7 Science (both 39%), Grade 7 Math (35%), and Grade 6 Social Studies (31%). The Kappa Index value for the remaining course, Grade 6 Math, was 27%.

Global Executive Composite. The Global Executive Composite showed Kappa Index values greater than 40% for Grade 7 Science (41%) and kappa values greater than 30% but less than 40% for Grade 7 Math (39%), Grade 7 ELA (38%), Grade 6 ELA (36%), and Grade 7 Social Studies (33%). The kappa values for the remaining courses were 30% or below (Grade 6 Math 30%, Grade 6 Science 29%, and Grade 6 Social Studies 28%).

Plan/Organize Scale. The Plan/Organize Scale did not demonstrate any Kappa values greater than 40% but did show values greater than 30% but less than 40% for Grade 7 ELA (38%), Grade 7 Science (33%), and Grade 7 Social Studies (33%). The Kappa values for the remaining courses were all less than 30% (28% for Grade 6 ELA, 28% for Grade 6 Social Studies, 23% for Grade 7 Math, 20% for Grade 6 Science, and 14% for Grade 6 Math).

Inhibition Scale. The Inhibition Scale did not demonstrate any Kappa Index values greater than 40% but did show values greater than 30% but less than 40% for Grade 7 Science (33%) and Grade 7 Social Studies (31%). The other six courses all showed Kappa values less than 30% (28% for Grade 7 ELA, 24% for Grade 6 Math, 22%

for Grade 6 Science, 19% for Grade 6 ELA, 19% for Grade 6 Social Studies, and 15% for Grade 7 Math).

Shift Scale. The Shift Scale did not show any Kappa Index values greater than 40% but did show a value of 32% for Grade 6 ELA. Kappa values between 20% and 30% were found for Grade 7 Science (30%) and Grade 7 ELA (29%). The remaining four courses showed kappa values below 20% (18% for Grade 6 Math, 16% for Grade 7 Social Studies, 15% for Grade 6 Social Studies, and 14% for Grade 6 Science).

Behavior Regulation Index. The Behavior Regulation Index did not show any Kappa Index values greater than 40% but did show a kappa value of 38% for Grade 7 Science. A kappa value of 28% was found for Grade 7 Math, 25% for Grade 6 ELA, 25% for Grade 6 Social Studies, and 22% for Grade 7 Social Studies. The remaining 3 courses showed kappa values falling below 20% (19% for Grade 7 ELA, 19% for Grade 6 Math, and 18% for Grade 6 Science).

Emotional Control Scale. The Emotional Control Scale produced the lowest Kappa values and did not show any Kappa Index values greater than 40% but did show a Kappa value of 36% for Grade 7 Science. A kappa value of 23% was found for Grade 6 ELA. The kappa values for the remaining six courses all fell below 20% (18% for Grade 7 Math, 17% for Grade 7 Social Studies, 12% for Grade 6 Science, 9% for Grade 6 Math, and 5% for both Grade 7 ELA and Grade 6 Social Studies).

EF-/ACA+ Incongruence. The EF-/ACA+ Incongruence Index values based on the cross-tabulation of each BRIEF Scale and Composite executive function rating level and each core subject academic achievement level are presented in Table 7.

Table 7

EF-/ACA+ Incongruence Index Percentages Based on Dichotomous Categorization of BRIEF Scale and Composite T-Scores and Dichotomous Categorization of Final Course Grades

BRIEF Scale or Composite	Grade 6 ELA *N* = 52	Grade 7 ELA *N* = 55	Grade 6 MTH *N* = 52	Grade 7 MTH *N* = 55	Grade 6 SCI *N* = 52	Grade 7 SCI *N* = 55	Grade 6 SOC *N* = 52	Grade 7 SOC *N* = 55
Inhibition	59	65	47	59	76	53	59	65
Shift	54	67	54	54	83	58	64	75
Emotional Control	58	79	58	58	84	53	68	74
Behavior Regulation	57	71	52	52	81	53	57	71
Initiate	47	53	41	47	71	47	47	59
Working Memory	53	58	47	47	74	53	47	58
Plan/ Organize	55	60	55	55	80	55	55	65
Organization of Materials	43	50	36	43	71	50	43	57
Monitor	44	56	44	44	69	47	50	50
Metacognition	47	53	41	47	71	47	47	59
Global Executive Composite	50	60	45	45	75	50	55	65

The EF-/ACA+ Incongruence Index values represented the percentage of students with low EF rating levels who earned high achievement levels in academic courses. Lower EF-/ACA+ Incongruence Index values reflected greater levels of consistency between EF rating level and academic achievement level. It is important to note that all Incongruence Index values were much higher than anticipated, given the high correlations between EF ratings and course grades for many of the BRIEF Scales and composites.

Organization of Materials Scale. The Organization of Materials Scale demonstrated the least incongruence, with an EF-/ACA+ Incongruence Index value of 36% for Grade 6 Math and lower than 50% for an additional three courses (43% for Grade 6 ELA, Grade 7 Math, and Grade 6 Social Studies). Incongruence Index values for the remaining four courses were all greater than 50% (71% Grade 6 Science, 57% Grade 7 Social Science, and 50% for Grade 7 ELA and Grade 7 Science).

Monitor Scale. The Monitor Scale showed EF-/ACA+ Incongruence Index values lower than 50% for four of the courses (44% for Grade 6 ELA, 44% for both Grade 6 and Grade 7 Math, and 47% for Grade 7 Science). Incongruence Index values for the other four courses were all 50% or greater (69% for Grade 6 Science, 56% for Grade 7 ELA, and 50% for both Grade 6 and Grade 7 Social Studies).

Initiate Scale. The Initiate Scale showed EF-/ACA+ Incongruence Index values lower than 50% for five of the courses (41 % for Grade 6 Math, and 47% for Grade 6 ELA, Grade 7 Math, Grade 7 Science, and Grade 6 Social Studies). Incongruence values for the other three courses were all greater than 50% (71% for Grade 6 Science, 59% for Grade 7 Social Studies, and 53% for Grade 7 ELA).

Metacognitive Index. The Metacognitive Index showed EF-/ACA+ Incongruence Index values lower than 50% for five of the courses (41% for Grade 6 Math and 47% for Grade 6 ELA, Grade 7 Math, Grade 7 Science, and Grade 6 Social Studies). Incongruence values for the other three courses were all greater than 50% (71% for Grade 6 Science, 59% for Grade 7 Social Studies, and 53% for Grade 7 ELA).

Working Memory Scale. The Working Memory Scale showed EF-/ACA+ Incongruence Index values lower than 50% for three of the courses (47% for Grade 6 Math, Grade 7 Math, and Grade 6 Social Studies). Incongruence values for the remaining five courses were all greater than 50% (74% for Grade 6 Science, 58% for Grade 7 ELA and Grade 7 Social Studies, and 53% for Grade 6 ELA and Grade 7 Science).

Global Executive Composite. The Global Executive Composite showed EF-/ACA+ Incongruence Index values lower than 50% for 2 of the courses (45% for both Grade 6 and Grade 7 Math). Incongruence values for the other 6 courses were all 50% or greater (75% for Grade 6 Science, 65% for Grade 7 Social Studies, 60% for Grade 7 ELA, 55% for Grade 6 Social Studies, and 50% for both Grade 6 ELA and Grade 7 Science).

Plan/Organize Scale. The Plan/Organize Scale showed EF-/ACA+ Incongruence Index values greater than 50% for all of the 8 courses (80% for Grade 6 Science, 65% for Grade 7 Social Studies, 60% for Grade 7 ELA, and 55% for Grade 6 ELA, Grade 6 Math, Grade 7 Math, Grade 7 Science, and Grade 6 Social Studies).

Inhibition Scale. The Inhibition Scale showed EF-/ACA+ Incongruence Index values lower than 50% only for Grade 6 Math (47%). Incongruence values for the other seven courses were all greater than 50% (76% for Grade 6 Science, 65% for Grade 7

ELA, 65% for Grade 7 Social Studies, 59% for Grade 6 ELA, Grade 7 Math, and Grade 6 Social Studies, and 53% for Grade 7 Science).

Behavior Regulation Index. The Behavior Regulation Index showed EF-/ACA+ Incongruence Index values greater than 50% for all courses (81% for Grade 6 Science, 71% for Grade 7 ELA and Grade 7 Social Studies, 57% for Grade 6 ELA and Grade 6 Social Studies, and 53% for Grade 7 Science, and 52% for both Grade 6 and Grade 7 Math.

Shift Scale. The Shift Scale showed EF-/ACA+ Incongruence Index values greater than 50% for all courses (83% for Grade 6 Science, 75% for Grade 7 Social Studies, 67% for Grade 7 ELA, 64% for Grade 6 Social Studies, 58% for Grade 7 Science, and 54% for Grade 6 ELA, Grade 6 Math, and Grade 7 Math).

Emotional Control Scale. The Emotional Control Scale also showed EF-/ACA+ Incongruence Index values greater than 50% for all courses (84% for Grade 6 Science, 79% for Grade 7 ELA, 74% for Grade 7 Social Studies, 68% for Grade 6 Social Studies, 58% for Grade 6 ELA, Grade 6 Math, and Grade 7 Math, and 53% for Grade 7 Science).

EF+/ACA- Incongruence. The EF+/ACA- Incongruence Index values based on the cross-tabulation of each BRIEF Scale and Composite *T*-score recoded as an executive function rating level, and each core subject final course grade recoded as an academic achievement level are presented in Table 8.

Table 8.

EF+/ACA- Incongruence Index Percentages Based on Agreement between Dichotomous Categorization of BRIEF Scale and Composite T-Scores and Dichotomous Categorization of Final Course Grades

BRIEF Scale or Composite	Grade 6 ELA *N* = 52	Grade 7 ELA *N* = 55	Grade 6 MTH *N* = 52	Grade 7 MTH *N* = 55	Grade 6 SCI *N* = 52	Grade 7 SCI *N* = 55	Grade 6 SOC *N* = 52	Grade 7 SOC *N* = 55
Inhibition	23	11	29	26	4	16	23	8
Shift	14	6	29	19	4	13	21	10
Emotional Control	20	17	33	25	6	14	27	11
Behavior Regulation	19	12	29	21	3	12	19	9
Initiate	17	5	26	21	0	13	17	5
Working Memory	18	6	27	19	0	14	15	3
Plan/ Organize	19	6	31	23	3	14	19	6
Organization of Materials	18	7	26	22	3	17	18	7
Monitor	17	8	28	21	0	15	19	3
Metacognition	17	5	26	21	0	13	17	5
Global Executive Composite	16	6	25	17	0	11	19	6

The EF+/ACA- Incongruence Index values represented the percentage of students with high EF rating levels who displayed low achievement levels in academic courses. Lower EF+/ACA- Incongruence Index values reflected greater levels of consistency between EF rating levels and academic achievement levels. It is important to note that all Incongruence Index values were somewhat higher than anticipated, given the high correlations between EF ratings and course grades exhibited in many of the BRIEF Scales and composites.

Shift Scale. The Shift Scale demonstrated the least incongruence with EF+/ACA- Incongruence Index values of 10% or less for three courses (4% for Grade 6 Science, 6% for Grade 7 ELA, and 10% for Grade 7 Social Science), and values between 11 and 20% for three more courses (13% for Grade 7 Science, 14% for Grade 6 ELA, and 19% for Grade 7 Math). Incongruence Index values exceeded 20% for the remaining two courses (21% for Grade 6 Social Studies and 29% for Grade 6 Math).

Initiate Scale. The Initiate Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (0% for Grade 6 Science and 5% for Grade 7 ELA and Grade 7 Social Studies) and values between 11 and 20% for another three courses (13% for Grade 7 Science and 17% for Grade 6 ELA and Grade 6 Social Studies). The remaining two courses showed Incongruence Index values greater than 20% (21% for Grade 7 Math and 26% for Grade 6 Math).

Working Memory Scale. The Working Memory Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (0% for Grade 6 Science, 3% for Grade 7 Social Studies, and 6% for Grade 7 ELA) and values between 11 and 20% for four other courses (14% for Grade 7 Science, 15% for Grade 6 Social Studies, 18% for

Grade 6 ELA, and 19% for Grade 7 Math). The last course, Grade 6 Math, showed an Incongruence Index value of 27%.

Plan/Organize Scale. The Plan/Organize Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (3% for Grade 6 Science and 6% for Grade 7 ELA and Grade 7 Social Studies) and values between 11 and 20% for three other courses (14% for Grade 7 Science and 19% for Grade 6 ELA and Grade 6 Social Studies). Incongruence Index values exceeded 20% for Grade 7 Math (23%) and Grade 6 Math (31%).

Organization of Materials Scale. The Organization of Materials Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (3% for Grade 6 Science, and 7% for Grade 7 ELA and Grade 7 Social Studies) and values between 11 and 20% for 3 additional courses (17% for Grade 7 Science and 18% for Grade 6 ELA and Grade 6 Social Studies). The other two courses showed Incongruence Index values greater than 20% (22% for Grade 7 Math and 26% for Grade 6 math).

Monitor Scale. The Monitor Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (0% for Grade 6 Science, 3% for Grade 7 Social Studies, and 8% for Grade 7 ELA) and values between 11 and 20% for three more courses (15% for Grade 7 Science, 17% for Grade 6 ELA, and 19% for Grade 6 Social Studies). The remaining courses, Grade 6 and Grade 7 Math, showed Incongruence values greater than 20% (28% and 21%, respectively).

Metacognitive Index. The Metacognitive Index showed EF+/ACA- Incongruence Index values of 10% or less for three courses (0% for Grade 6 Science, and 5% for Grade 7 ELA and Grade 7 Social Studies) and values between 11 and 20% for three more courses (13% for Grade 7 Science, and 17% for Grade 6 ELA and Grade 6 Social Studies). Incongruence Index values exceeded 20% for Grade 7 Math (21%) and Grade 6 Math (26%).

Global Executive Composite. The Global Executive Composite showed EF+/ACA- Incongruence Index values of 10% or less for three courses (0% for Grade 6 Science, and 6% for Grade 7 ELA and Grade 7 Social Studies) and values between 11 and 20% for four courses (11% for Grade 7 Science, 16% for Grade 6 ELA, 17% for Grade 7 Math, and 19% for Grade 6 Social Studies). The remaining course, Grade 6 Math, showed an Incongruence value of 25%.

Inhibition Scale. The Inhibition Scale showed EF+/ACA- Incongruence Index values of 10% or less for two courses (4% for Grade 6 Science and 8% for Grade 7 Social Studies) and values between 11 and 20% for two courses (11% for Grade 7 ELA and 16% for Grade 7 Science). The remaining four courses showed Incongruence values greater than 20% (23% for Grade 6 ELA and Grade 6 Social Studies, 26% for Grade 7 Math, and 29% for Grade 6 Math).

Behavior Regulation Index. The Behavior Regulation Index showed EF+/ACA- Incongruence Index values of 10% or less for two courses (3% for Grade 6 Science and 9% for Grade 7 Social Studies) and values between 11 and 20% for four courses (12% for Grade 7 ELA and Grade 7 Science, and 19% for Grade 6 ELA and Grade 6 Social Studies). The other two courses showed Incongruence values greater than 20% (21% for Grade 7 Math and 29% for Grade 6 Math).

Emotional Control Scale. The Emotional Control Sale showed EF+/ACA- Incongruence Index values of 10% or less for only one course (6% for Grade 6 Science) and values between 11 and 20% for four of the courses (11% for Grade 7 Social Studies, 14% for Grade 7 Science, 17% for Grade 7 ELA, and 20% for Grade 6 ELA). The remaining courses all showed Incongruence values greater than 20% (25% for Grade 7 Math, 27% for Grade 6 Social Studies, and 33% for Grade 6 Math).

CHAPTER 5

Discussion

Executive functions are linked to academic performance from the preschool level through college. However, the significant changes that occur during the transition to middle school may make the utilization of executive functions even more critical.

The purpose of this study was to analyze the relationship between executive functions and academic performance in middle school. In particular, this study analyzed the relationship between BRIEF Index and Scale scores that were completed by seventh-grade ELA teachers and final grades in ELA, Math, Science, and Social Studies.

It was hypothesized that students who were rated as having few, if any, behavior difficulties thought to reflect executive function deficits, as indicated on the BRIEF-teacher report, will also earn better grades in the ELA Math, Science, and Social Studies courses than students identified as having more, even extensive behavior difficulties thought to reflect executive function deficits. The final grades from 7th grade, the first year of middle school in this district, as well as the final grades from 6th grade, the final year of elementary school in this district, were included in the analysis.

Discussion of Findings

Correlational Analyses. The results from this study showed statistically significant correlations between many of the BRIEF Indexes and Scales and the final grades. In regard to the Global Executive Composite, statistically significant correlations were found for all four subjects for both 6th grade and 7th grade. The correlations between the Global Executive Composite and the final grades increased from 6th grade to 7th grade in all four subjects. The Metacognitive Index also showed statistically significant correlations for all four subjects and at both grade levels. The correlations increased from grade 6 to grade 7 for all four of the subjects. Furthermore, the Scales within the Metacognitive Index also showed statistically significant correlations for all four subjects at both grade levels.

The highest correlations were observed between the Working Memory Scale and final grades. These correlations increased from grade 6 to grade 7 for Math, Science, and Social Studies but not for ELA. The Plan/Organize Scale showed the second-highest correlations. The correlations increased from 6^{th} grade to 7^{th} grade for all four subjects, which makes sense, because students typically experience an increase in workload during middle school and are required to demonstrate more independence. The third highest correlations overall were observed with the Initiate Scale. These correlations also increased from grade 6 to grade 7 for all four subjects. The next highest correlations were found between the Monitor Scale and final grades. These correlations increased from 6^{th} grade to 7^{th} grade for Math, Science, and Social Studies but not ELA. The Organization of Materials Scale showed the next highest correlations. These correlations increased from grade 6 to grade 7 for Math, Science, and Social Studies but not ELA.

The Behavioral Regulation Index showed low but statistically significant correlations with final grades for ELA, Science and Social Studies for both 6^{th} grade and 7^{th} grade and low, statistically nonsignificant correlations with both 6^{th} grade and 7^{th} grade Math. The three Scales within the Behavioral Regulation Index also showed low correlations with final grades for all courses. The Inhibition Scale showed low but statistically significant correlations for all courses except 6^{th} grade Math. The Shift Scale showed low but statistically significant correlations with grade 6 and grade 7 Science and

Social Studies and grade 7 ELA. Significant correlations were not found for the other three courses. Overall, the Emotional Control Scale showed the lowest correlations, with significant correlations found only for grade 6 and grade 7 Social Studies, grade 7 Science, and grade 7 ELA.

Overall, the correlations between the BRIEF Scores and the final grades were higher with Social Studies and Science than ELA and Math. All correlations between all BRIEF Scales and Social Studies and Science final course grades were significant at both grade levels. The correlations increased from grade 6 to grade 7 for Science and Social Studies for all scales except the Shift Scale, which decreased slightly from 6^{th} to 7^{th} grade. For grade 7 ELA, significant correlations were observed with all BRIEF Scales, although for many of the Scales, the correlations were highest for Science and Social Studies. The exception was the correlation with the Plan/Organize Scale, which was higher for ELA. It is also worth noting that with ELA, the correlations with the Working Memory, Organization of Materials, and Monitor Scales showed a decrease from grade 6 to grade 7.

The Math course showed the lowest correlations between all Scales and Indexes and final grades for both grade 6 and grade 7. Although statistically significant correlations were observed for the Global Executive Composite, the Metacognitive Index, and the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor Scales, these correlations were lower than correlations observed for the other three courses. Statistically significant correlations with Math final course grades were not found for the Behavioral Regulation Index, and the Inhibition, Shift, and Emotional Control Scales. However, all correlations increased from 6^{th} grade to 7th grade for all but the Shift Scale, which remained the same, and the Emotional Control Scale, which decreased slightly.

It is not surprising that the correlations between the Scales within the Metacognitive Index were higher than the correlations between the Scales within the Behavior Regulation Index. It was also not surprising that for the most part, an increase from grade 6 to grade 7 was observed. One interesting finding was that the correlations between the Scales and the final grades in Science and Social Studies tended to be higher than with ELA and Math. One reason for this might be because both ELA and Math are double periods. The additional time in those classes might afford the students more support.

Sensitivity Index Analyses. The Sensitivity Index values represent the percentage of students categorized as having low executive function ratings who were also classified as having low academic achievement. Overall, these values were lower than expected. The Global Executive Composite showed Sensitivity Index values greater than 70% for four of the courses (Grade 6 Science, Grade 7 ELA, Grade 7 Social Studies, and Grade 7 Science). The Metacognitive Index showed Sensitivity Index values greater than 70% in three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies). Ratings from the Behavior Regulation Index showed Sensitivity Index values greater than 70% only for Grade 6 and Grade 7 Science.

In regard to the individual Scales, the Working Memory Scale demonstrated the greatest sensitivity, with the Sensitivity Index values greater than 70% for three of the courses (Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA). Although it is not surprising that Working Memory showed the greatest sensitivity of all the individual scales, it is surprising that Sensitivity Index values greater than 70% were not found for more of the courses, as extensive research shows that Working Memory is important to academic achievement in all subject areas.

The Shift Scale was the second most sensitive to low achievement, with Sensitivity Index values greater than 70% for four of the courses (Grade 7 ELA, Grade 6 Science, Grade 6 ELA, and Grade 7 Science). The Plan/Organize Scale ratings were the next most sensitive to low achievement, with Index values greater than 70% for three of the courses (Grade 7 ELA, Grade 6 Science, and Grade 7 Social Studies).

The Initiate Scale showed Sensitivity Index values greater than 70% for three of the courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies). The Monitor Scale also showed Sensitivity Index values greater than 70% for three of the courses (Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA). Of all the Scales within the Metacognitive Index, the Organization of Materials Scale was the least sensitive to low achievement, with Sensitivity Index values greater than 70% for only two courses (Grade 6 Science and Grade 7 ELA).

The other two Scales in the Behavioral Regulation Index, Inhibition and Emotional Control, demonstrated the least sensitivity. The Inhibition Scale presented Sensitivity Index values of 80% only for Grade 6 Science, and for the Emotional Control Scale, none of the Sensitivity Index values were greater than 70%.

In terms of courses, the highest sensitivity ratings were found with Grade 6 Science; the course with the next highest sensitivity ratings was Grade 7 ELA. All BRIEF scales except Emotional Control showed sensitivity ratings greater than 70. Six of the BRIEF scales showed sensitivity ratings greater than 70%, and two of the BRIEF scales showed sensitivity ratings at 70%. Grade 7 Social Studies showed sensitivity ratings greater than 70% for six of the BRIEF scales. Grade 7 Science showed sensitivity ratings greater than 70% for only three of the BRIEF scales, and grade 6 ELA showed a sensitivity rating above 70% for only one BRIEF scale. The results did not yield any sensitivity ratings at or above 70 for both 6th and 7th grade Math and 6th grade Social Studies.

The Sensitivity Index values for ELA and Social Studies did show an increase with many of the BRIEF Scales from Grade 6 to Grade 7. These results indicate that students' executive functions impacted their academic achievement more in 7th grade than 6th grade for ELA and Social Studies. Although they exhibited poor executive functions, many students still did well academically in ELA and Social Studies while in 6th grade. However, in middle school, their academic achievement was more likely to be affected by poor executive functions in those two subjects. However, in Science the opposite pattern was observed, with the Sensitivity Index values decreasing from Grade 6 to Grade 7. These results suggest that even with the more extensive support students received in elementary school, students who did not exhibit good executive functions did not perform as well academically in 6th Grade Science, but their less developed executive functions hindered their academic achievement less in 7th Grade. The reason for this is unclear, although differing curricula may have contributed. The students may have found Grade 6 Science more challenging and the curriculum in 7th Grade Science less so.

Furthermore, poor executive functions did not appear to impact students' grades in both 6th Grade Math and 7th Grade Math. As noted, Math also showed the lowest correlations between all Scales and Indices and final grades for both grade 6 and grade 7.

The explanation for this might be the support students receive in Math at both Grade levels. Math is a double period both in elementary school and middle school. Therefore, more time is available for students to receive assistance from the teachers. In addition, although students are assigned Math homework daily, they are typically given time to begin the assignment in class, decreasing the amount of work they are expected to do outside of the classroom. Large-scale assignments and projects are typically not assigned, so less planning is required by the students.

Specificity Index Analyses. The Specificity Index values represent the percentage of students categorized as having high executive function ratings who were also were classified as having high academic achievement. Although the results of this study did not yield consistently high Sensitivity Index values, the results did reveal higher Specificity Index values overall, particularly for the Metacognitive Index and the Scales within the Metacognitive Index.

The Global Executive Composite showed Specificity Index values of 70% or greater in all courses except Grade 6 Science. The Behavior Regulation Index showed Specificity Index values greater than 70% for only two of the courses (Grade 7 Science and Grade 7 Math). The Metacognitive Index showed Specificity Index values greater than 70% for all eight courses.

In regard to the individual scales, the Organization of Materials Scale demonstrated the greatest specificity, with Specificity Index values of 79% or greater for all eight courses. The Monitor Scale showed the second highest specificity, with Specificity Index values of 77% or greater for all eight courses. The Initiate Scale showed the third highest specificity, with Specificity Index values of 74 % or greater for all eight courses. The Working Memory Scale showed Specificity Index values of 70% or greater for all eight courses. These scores are all logical, as all are important to academic achievement. It was somewhat unexpected that the Organization of Materials Scale demonstrated the greatest specificity. A plausible explanation for this finding is that students who can keep their materials organized can find necessary items more easily, but less organized students tend to lose important items. If students cannot find their homework or a study guide to study for a test, their grades would likely suffer.

The Inhibition Scale unexpectedly indicated greater specificity than the Plan/Organize Scale. The Inhibition Scale showed Specificity Index values of 70% or greater for all courses except Grade 6 Science, while the Plan/Organize Scale showed Specificity Index values of 70% or higher for six of the eight courses but values below 70% for Grade 6 Math and Grade 6 Science.

The Emotional Control Scale showed Specificity Index values of 70% or higher for four of the courses (Grade 6 ELA, Grade 7 Math, Grade 7 Science, and Grade 7 Social Studies). The Shift Scale demonstrated the least specificity, with Specificity Index values falling below 70% for all eight courses.

Regarding the courses, Grade 7 Science was the most consistent; all BRIEF Scales but the Shift Scale showed Specificity Index values of 73 or higher. In contrast, grade 6 Science was the least consistent; only five of the BRIEF Scales showed Specificity Index values of 70 or higher. Grade 7 Math was the next most consistent; all the BRIEF Scales but the Shift scale showed Specificity Index values of 71 or higher. Grade 6 Math was less consistent, with seven of the BRIEF Scales showing Specificity Index values of 73 or higher. For Grade 7 Social Studies, nine of the BRIEF Scales showed Specificity Index values of 70 or above, and for Grade 6 Social Studies, eight of the Scales showed Specificity Index values of 70 or above for eight of the Scales. For Math, Science, and Social Studies, the Specificity values increased from Grade 6 to Grade 7. For ELA, on the other hand, the Specificity values were fairly consistent across both Grades. Furthermore, in Grade 6, ELA was the most consistent, with nine of the BRIEF Scales showing Specificity Index values of 70 or greater. It is worth noting that the Emotional Control Scale Specificity values decreased slightly from 6^{th} Grade to 7^{th} Grade for ELA.

Overall, students identified as exhibiting good executive functions also demonstrated high academic achievement in Grades 6 and 7 and across all four subjects. The percentages increased from 6^{th} Grade to 7^{th} Grade in all subjects but ELA, which remained consistent across both grades.

Kappa Index Analyses. The Kappa Index values represent the percentage of classification consistency (high EF rating level with high achievement level and low EF rating level with low achievement level) beyond chance. The results revealed higher kappa values overall for the Metacognitive Index and the scales within that Index compared to the Behavioral Regulation Index and the scales within that Index.

The Global Executive Composite showed Kappa Index values greater than 40% for Grade 7 Science and kappa values greater than 30% for four more courses (Grade 7 Math, Grade 7 ELA, Grade 6 ELA, and Grade 7 Social Studies). The Metacognitive Index showed Kappa Index values higher than 40% for three courses (Grade 7 ELA, Grade 7 Science, and Grade 7 Social Studies) and higher than 30% for the other five courses. However, the Behavior Regulation Index showed a Kappa Index value higher than 30% for only one course (Grade 7 Science).

Analysis of the individual scales revealed that the Initiate Scale demonstrated the greatest classification consistency beyond chance with Kappa Index values greater than 40% for three courses (Grade 7 ELA, Grade 7 Science, and Grade 7 Social Sciences) and kappa values greater than 30% for the remaining five courses. The Working Memory Scale showed Kappa Index values higher than 40% for two courses (Grade 7 Social Studies and Grade 7 ELA), and Kappa Index values higher than 30% for five more courses (Grade 6 ELA, Grade 7 Math, Grade 6 Social Studies, and Grade 6 and Grade 7 Science). The Organization of Materials Scale revealed Kappa Index values greater than 40% for Grade 7 ELA and kappa values higher than 30% for the other seven courses. The Monitor Scale showed Kappa Index values above 40% for two courses (Grade 7 Social Studies and Grade 7 ELA) and kappa values above 30% for five more courses (Grade 6 ELA, Grade 7 Math, Grade 6 Social Studies, and Grades 6 and 7 Science). In the Metacognitive Index, the Plan/Organize Scale demonstrated the least classification consistency beyond chance, with Kappa Index values greater than 30% for only three of the courses (Grade 7 ELA, Grade 7 Science, and Grade 7 Social Studies). These scores were logical, as students are expected to become more independent in middle school and better able to plan and organize, particularly in regard to projects and more complex assignments. In 6th grade, students likely received more assistance with such assignments. In addition, the ability to plan and organize may not be as necessary for Math, as compared to such subjects as ELA, Science, and Social Studies. In Math, students are typically presented with a lesson, then practice the particular skills just learned.

Homework assignments generally are not demanding; students are afforded time to begin the assignment in class, so less time and planning are required.

Like the Behavioral Regulation Index, the Inhibition Scale, Shift Scale, and Emotional Control Scale all demonstrated less classification consistency beyond chance. The Inhibition Scale showed Kappa Index values greater than 30% for only two of the courses (Grade 7 Science and Grade 7 Social Studies). The Shift Scale showed Kappa Index values greater than 30% only for Grade 6 ELA, and the Emotional Control Scale showed a Kappa Index value greater than 30% only for Grade 7 Science.

In terms of courses, Grade 7 Science was the most consistent, with kappa values of 30% or greater for eight of the BRIEF Scales and a kappa value greater than 40% for the other three. Grade 7 Social Studies was next most consistent, with kappa values higher than 30% for three BRIEF Scales and kappa values higher than 40% for five of the BRIEF Scales. For Grade 6, ELA was the most consistent, with kappa values of 30% or higher for seven of the BRIEF Scales.

Overall, the kappa values for Math were the lowest for both grades. Grade 7 Math showed kappa values higher than 30% for six of the BRIEF Scales, and Grade 6 Math showed kappa values greater than 30% for four of the BRIEF Scales.

For Math, Science, and Social Studies, kappa values increased from Grade 6 to Grade 7, but for ELA, kappa values were mostly consistent across both grades. Grade 7 ELA showed kappa values greater than 30% for two of the BRIEF Scales and kappa values greater than 40% for five of the BRIEF Scales. The results for Grade 6 ELA were similar, with kappa values greater than 30% for six of the BRIEF Scales and a kappa value of 40% for one Scale. In an interesting result, the Shift Scale showed a Kappa

Index value of 32% for 6th Grade ELA but decreased for 7th Grade ELA. As previously noted, the Plan/Organize Scale showed Kappa Index values of 30% or greater only for Grade 7.

EF-/ACA+ Incongruence Index. The EF-/ACA+ Incongruence Index values represent the percentage of students with low EF ratings who earned high achievement levels in academic courses. Lower EF-/ACA+ Incongruence Index values reflected greater levels of consistency between EF rating level and academic achievement. It is important to note that all Incongruence Index values were much higher than anticipated, given the high correlations between EF ratings and course grades for many of the BRIEF Scales and composites.

The Organization of Materials Scale demonstrated the least incongruence, with an EF-/ACA+ Incongruence Index value of 36% for Grade 6 Math and values in the 36% to 50% range for three other courses (Grade 6 ELA, Grade 7 Math, and Grade 6 Social Studies). Organization of Materials Scale Incongruence Index values for Grade 6 Science, Grade 7 Social Studies, Grade 7 ELA, and Grade 7 Science were all greater than 50%. The Monitor Scale showed EF-/ACA+ Incongruence Index values less than 50% for four of the courses (Grade 6 ELA, Grade 6 and Grade 7 Math, and Grade 7 Science). Monitor Scale Incongruence Index values for Grade 6 Science, Grade 7 ELA, and Grade 6 and Grade 7 Social Studies were all 50% or higher.

The Initiate Scale showed EF-/ACA+ Incongruence Index values of less than 50% for five of the courses (Grade 6 Math, Grade 6 ELA, Grade 7 Math, Grade 7 Science, and Grade 6 Social Studies). The Initiate Scale incongruence values for Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA were all greater than 50%. The Metacognitive

Index showed EF-/ACA+ Incongruence Index values of less than 50% for five of the courses (Grade 6 Math, Grade 6 ELA, Grade 7 Math, Grade 7 Science, and Grade 6 Social Studies). Metacognitive Index Incongruence values for Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA were all greater than 50%. The Working Memory Scale showed EF-/ACA+ Incongruence Index values less than 50% for three of the courses (Grade 6 Math, Grade 7 Math, and Grade 6 Social Studies). Working Memory Scale Incongruence values for Grade 6 Science, Grade 7 ELA, Grade 7 Social Studies, Grade 6 ELA, and Grade 7 Science were all greater than 50%.

The Global Executive Composite showed EF-/ACA+ Incongruence Index values less than 50% for two courses (Grade 6 and Grade 7 Math). The Incongruence values for Grade 6 Science, Grade 7 Social Studies, Grade 7 ELA, Grade 6 Social Studies, Grade 6 ELA, and Grade 7 Science were all greater than 50%. The Plan/Organize Scale showed EF-/ACA+ Incongruence Index values greater than 50% for all eight courses. The Inhibition Scale showed EF-/ACA+ Incongruence Index values less than 50% for Grade 6 Math. Incongruence values for the other seven courses were all greater than 50%. The Behavior Regulation Index showed EF-/ACA+ Incongruence Index values greater than 50% for all eight courses. The Shift Scale and the Emotional Control Scale also showed EF-/ACA+ Incongruence Index values greater than 50% for all eight courses.

Overall, all Incongruence Index values were much higher than expected for Grades 6 and 7. One reason for this might be the level of support the students received in both grade levels. In 6th grade, the students were still in elementary school. In all four elementary schools that the students in this study attended for 6th grade, the students are primarily in one classroom throughout the day and only have two core teachers. They have one teacher for ELA and Social Studies and another teacher for Math and Science. The teachers can get to know the students on a more intimate level and provide them with additional support if needed. Although the 6th-grade teachers in all four of the elementary schools attempted to prepare the students for the transition to middle school, they recognized that they are still elementary-age students and treated them as such. For example, if a student cannot find a homework assignment or a study guide, the teacher might help him or her look for the former or provide another copy of the latter. In addition, it is not uncommon for 6th-grade teachers to keep students in during recess if they needed to complete missing work.

In middle school, although the responsibilities of students increase, and they are often given less support than elementary school students, the students who participated in this study may have received more support than is typical in middle school. All the students in the study attended an in-class support classroom for ELA, regardless of their educational program (general education, 504 Plan, or IEP). The in-class support model practiced by these teachers was "Team Teaching," and the approach affected all students in the classroom. Both ELA teachers who completed the BRIEFS are special education teachers with experience teaching at the middle school level. Both are kind and patient, and students tend to gravitate toward them. Both teachers also have some knowledge about executive functions. Their awareness of executive functions, coupled with their personalities and their openness to interacting with students, makes it likely that they provided additional support for students who might have been struggling.

Some of the students also attended an in-class support program for Math as well. Although the Math teachers are very different from the ELA teachers in their approach to interacting with students, attending an in-class support program does give students additional support. Some of the students might have had the support of a classroom aide for Science and Social Studies. The district does not have an in-class support program for Science and Social Studies at the middle school level, but some classes have a classroom aide. The role of the classroom aide is primarily to work with those students who have an IEP and need an in-class support program. However, in middle school, the classroom aides assigned to the Science and Social Studies classes tend to support any student who needs assistance.

EF+/ACA- Incongruence Index Analyses. The EF+/ACA- Incongruence Index values represented the percentage of students with high EF rating levels who earned low achievement levels in academic courses. Lower EF+/ACA- Incongruence Index values indicated greater consistency between EF rating levels and academic achievement levels. It is important to note that Incongruence Index values were somewhat higher than anticipated, as a result of the high correlations between EF ratings and course grades exhibited for many of the BRIEF Scales and composites.

The Shift Scale demonstrated the least incongruence, with an EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Science), and values between 11 and 20% for three other courses (Grade 7 Science, Grade 6 ELA, and Grade 7 Math). Shift Scale Incongruence Index values exceeded 20% for the remaining two courses (Grade 6 Social Studies and Grade 6 Math). The Initiate Scale showed EF+/ACA- Incongruence Index values of 10% or less for three of the courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies) and values between 11% and 20% for three other courses (Grade 7 Science, Grade 6 ELA, and Grade 6 Social Studies). The remaining two courses, Grade 6 and Grade 7 Math, showed Initiate Scale Incongruence Index values greater than 20%.

The Working Memory Scale showed EF+/ACA- Incongruence Index values of 10% or less for three of the courses (Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA) and values between 11 and 20% for an additional four courses (Grade 7 Science, Grade 6 Social Studies, Grade 6 ELA, and Grade 7 Math). Grade 6 Math showed an Incongruence Index value greater than 20%. The Plan/Organize Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies) and values between 11 and 20% for three other courses (Grade 7 Science, Grade 6 ELA, and Grade 6 Social Studies). Incongruence Index values exceeded 20% for Grade 7 Math and Grade 6 Math.

The Organization of Materials Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies) and values between 11 and 20% for three additional courses (Grade 7 Science, Grade 6 ELA, and Grade 6 Social Studies). The other two courses showed Incongruence Index values greater than 20% (Grade 7 Math and Grade 6 Math). The Monitor Scale showed EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 Social Studies, and Grade 7 ELA) and values between 11 and 20% for three other courses (Grade 7 Science, Grade 6 ELA, and Grade 6 Social Studies). Grade 6 and Grade 7 Math showed Incongruence values greater than 20%.

The Metacognitive Index showed EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies) and values between 11 and 20% for three more courses (Grade 7 Science, Grade 6 ELA, and

Grade 6 Social Studies). Incongruence Index values exceeded 20% for Grade 7 Math and Grade 6 Math. The Global Executive Composite showed EF+/ACA- Incongruence Index values of 10% or less for three courses (Grade 6 Science, Grade 7 ELA, and Grade 7 Social Studies) and values between 11% and 20% for four courses (Grade 7 Science, Grade 6 ELA, Grade 7 Math, and Grade 6 Social Studies). Grade 6 Math showed an Incongruence value greater than 20%.

The Inhibition Scale showed EF+/ACA- Incongruence Index values of 10% or less for Grade 6 Science and Grade 7 Social Studies, and values between 11% and 20% for Grade 7 ELA and Grade 7 Science. The other four courses (Grade 6 ELA, Grade 6 Social Studies, and Grade 6 and Grade 7 Math) all showed Incongruence values greater than 20%. The Behavior Regulation Index showed EF+/ACA- Incongruence Index values of 10% or less for two courses (Grade 6 Science and Grade 7 Social Studies) and values between 11 and 20% for four other courses (Grade 7 ELA, Grade 7 Science, Grade 6 ELA, and Grade 6 Social Studies). The other two courses, Grade 6 and Grade 7 Math showed Incongruence values greater than 20%. The Emotional Control Sale showed EF+/ACA- Incongruence Index values of 10% or less for only one course (Grade 6 Science) and values between 11% and 20% for four courses (Grade 7 Social Studies, Grade 7 Science, Grade 7 ELA, and Grade 6 ELA). The remaining three courses (Grade 6 and Grade 7 Math and Grade 6 Social Studies) all showed Incongruence values greater than 20%.

Analysis of the courses reveals that Grade 6 Science was the most consistent, as all BRIEF Scales showed EF+/ACA- Incongruence Index values less than 10%. Grade 7 Social Studies was the next most consistent. Except for the Emotional Control Scale, all

BRIEF Scales showed EF+/ACA- Incongruence Index values less than 10%. The only other course that showed consistency between executive function ratings and academic performance was Grade 7 ELA. For this course, all BRIEF Scales showed EF+/ACA- Incongruence Index values less than 10%, excepting the Inhibition Scale, the Emotional Control Scale, and the Behavior Regulation Index.

The explanation for the greater levels of consistency between EF rating levels and academic achievement levels for these three courses when the other five courses show far less consistency is unclear. However, one explanation may be motivation or lack thereof. Research has revealed that motivation is another factor that impacts learning and academic achievement (Stover & Hoffman, 2014). Highly motivated students tend to put forth more effort, ask for help when necessary, and remained determined even when tasks are challenging (Lin-Siegler et al., 2016). Some of the students may possess adequate executive functions but low levels of motivation. However, these three courses might have appealed more to some of these students, providing the needed motivation to engage their adequately developed executive functions.

Another possible explanation may be the students' relationships with the teachers. Research has demonstrated that positive student-teacher relationships are linked to academic achievement (Baker et al., 2008; Roorda et al., 2011; Sointu et al., 2017). In particular, supportive relationships with teachers can result in higher motivation for learning, improve school engagement, foster positive attitudes toward school, and improve academic achievement (Baker, 2006; Hughes, 2011; Roorda et al., 2011; Sointu et al., 2017). Furthermore, supportive relationships with teachers may also serve as a protective factor for at-risk students (Baker, 2006, 2008; Davis, 2003). Grade 7 ELA was one of the courses that showed greater levels of consistency; as previously noted, both ELA teachers had an exceptional ability to connect with students. That connection with their teacher might have motivated those students to perform well in ELA, despite a lack of motivation to perform as well in other subjects. One of the Grade 7 Social Studies teachers, who likely taught many of the students in the study, is also particularly well-liked by students, as evidenced by student comments made to the researcher. It is noteworthy that he is English and speaks with an accent, which tends to keep the students in his class engaged, as this researcher observed. In addition, in conversations with this researcher, many students have identified this teacher as one of their favorite teachers, but at the same time, the one they fear most . This duality of this relationship may have influenced students' motivation to do well in this class.

The greater level of consistency between the EF ratings and academic achievement in Grade 6 Science is more perplexing. In the four elementary schools, there were at least four different Grade 6 Science teachers, so a teacher's personality is unlikely to have been a consistent factor affecting student motivation. The 6^{th} Grade Science curriculum may be more interesting to students, though, and may have motivated students who tend to be less motivated by school.

Limitations of the Study

There are some characteristics of the current study that may limit the generalizability of the findings and may affect the validity of the results. One limitation is the small sample size of students. Another limitation is the restriction of the source of data to a single suburban school district. Although the district varies in racial, ethnic, and socioeconomic status, the results may not be consistent if the study were replicated in an urban or rural school district or even a different suburban school district. In addition, using archival data from two in-class support teachers decreased the chances of obtaining a representative sample of teacher perspectives. Although the sample is a mix of both general education students and students with IEPs to address educational needs, the sample excluded other students, such as students in self-contained special education classrooms, students in learning disabilities resource classrooms, and students enrolled in advanced courses.

Differences in confounding teacher variables may have impacted the study. All teachers had different levels of experience with teaching. In addition, one of the teachers usually taught seventh-grade inclusion ELA and had several years of experience. She also cotaught with the same teacher during her tenure in the district. The other teacher had taught the seventh-grade learning disabilities ELA classes. Due to the school's needs that year, she taught both learning disabilities and inclusion, which are very different. In addition, she began the year coteaching with a general education teacher, who had several years of teaching experience but had never cotaught. In the middle of the year, the general education teacher left for maternity leave, and the long-term substitute was a young teacher with no prior experience. Therefore, the dynamic of that inclusion ELA class was significantly different from the other inclusion ELA classes.

In addition, the chance always exists of unintentional rating errors that would impact the teachers' ratings of their students' use of executive functions. For example, the *central tendency bias* refers to the participant rating most items in the middle rather than choosing responses that might be favorable or unfavorable (Saal et al., 1980). *Leniency or severity error* refers to a participant choosing ratings higher or lower than warranted by an individual's behavior. Another rating error is the *halo effect*, which refers to a participant rating an individual's performance based on a particular trait (Saal et al., 1980). When completing the BRIEFS, the teachers may have rated students for whom they had a preference in a more positive manner than warranted, and students for whom they did not have a preference less favorably.

Confounding student variables that may also have affected the study include gender and ethnicity. Males and females tend to exhibit different executive function profiles, and the teachers may have rated females as having better executive functions than males. In addition, the teachers may have associated students who belonged to a specific ethnic group with a lower socioeconomic status and may have assigned lower ratings when completing those students' BRIEFS.

Future Directions

Future research on executive functions and middle school students should use larger sample sizes and a wider range of students, such as those in advanced and learning disabilities classes, as well as general education classes. A more diverse sample of students would provide more information about executive functions and their impact on academic performance in relation to various types of learners. In addition, a more diverse sample of students would necessarily include more teachers. Results for each of the courses may have been significantly different if students included in the study were taught by a wider variety of teachers. For example, the two ELA teachers who completed the executive function rating scales are very different than some of the other 7^{th} Grade

ELA teachers in the building. A student attending an ELA class with a different teacher might have had a very different experience.

Future research should also include executive function ratings from multiple teachers to obtain more than one perspective on each student's executive functions. The most important enhancement to future studies would be to incorporate interventions to improve executive functions in students who exhibit executive function difficulties. The study should begin prior to the transition to middle school, and should be a grade-wide intervention to help all students, with more intensive interventions implemented for those students who continue to struggle.

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