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The Relevance of Executive Functions in Academic Production in Middle School

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Dissertation Approval

This is to certify that the thesis presented to us by Norina Bobik on the 10th day of June, 2009, in partial fulfillment of the requirements for the degree of Doctor of Psychology, has been examined and is acceptable in both scholarship and literary quality.

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Abstract

The present study investigated the role that executive function plays on academic production in middle school from a prototype perspective. It was hypothesized that middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically successful would differ significantly from these same middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically unsuccessful. The study used archival data consisting of items from the Behavior Rating Inventory of Executive Function (BRIEF), a questionnaire that was completed by middle school teachers during a professional in-service workshop at four large urban middle schools.

The concept of academic competence was viewed as a category, structured by the similarities of successful middle school students to one another in discrete behavioral manifestations of executive functions and organized around a prototype that represents the central tendency of all the exemplars in the category of successful students, as operationally defined by the BRIEF items. A second prototype was structured in a similar manner for the unsuccessful student category. To examine differences between these two prototypical categories, *t* tests were conducted using T scores from the eight BRIEF domains. It was postulated that there would be a significant difference between the successful learner prototype and the unsuccessful learner prototype. It was expected that the successful student prototype would possess fewer executive function impairments than the unsuccessful student prototype.

Statistically significant findings were obtained, suggesting that teachers' perceptions of prototypical successful students differed from these same teachers' perceptions of prototypical unsuccessful students in their behavioral manifestations of executive function capacities in all eight domains of the BRIEF. Teachers' ratings most consistently produced the expected pattern of T score results for the Inhibit, Initiate, Plan/Organize, Monitor, and Working Memory scales. Teachers were least likely to see large differences between successful and unsuccessful students in behaviors that reflected the executive function capacities of Shift, Emotional Control, and Organization of Materials. The results of the study supported the hypothesis that successful students exhibit very few executive function difficulties, while unsuccessful students exhibit executive function difficulties in the clinically significant range.

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Chapter 1

Introduction

Statement of the Problem

Considerable concerns have been raised regarding the decline in educational outcomes among students in middle school (Anderman, Anderman, & Griesinger, 1999; Jimerson, 2001; Roderick, 1994; Rumberger, 1995). Most children successfully meet the demands of middle school, but some experience academic failure, low motivation, and negative self-beliefs about achievement. Due to increased class work and the complexity of the information presented to students at this stage of the educational process, good information processing skills are critical for achieving academic success. Borkowski and Muthukrishna (1992, p. 483) identified the following 10 major characteristics of a good information processor:

1. knows a large number of learning strategies
2. understands when, where, and why these strategies are important
3. selects and monitors strategies wisely, and is extremely reflective and planful
4. adheres to an incremental view regarding the growth of mind
5. believes in carefully deployed effort
6. is intrinsically motivated, task-oriented, and has mastery goals
7. does not fear failure, in fact realizes that failure is essential for success, hence is not anxious about tests, but sees them as learning opportunities
8. has concrete multiple images of "possible selves," both hoped-for and feared selves in the near and distant future
9. knows a great deal about many topics and has rapid access to that knowledge

10. has a history of being supported in all these characteristics by parents, schools, and society at large.

The demands of middle school require self-directed, goal-oriented, intentional, and purposeful behavior aimed at managing and producing successful academic outcomes. In essence, these are the types of behaviors commonly referred to as *executive functions* in neuropsychology. *Metacognition* and *self-regulation* are terms used by cognitive and educational psychologists to describe aspects of executive functioning necessary for academic success.

Executive function difficulties can lead to significant academic problems (Case, Pericola, & Karen, 1992; Malpass, O'Neil, & Hocevar, 1999; Miranda, Villaecusa, & Vidal-Abarca, 1997; Reid & Borkowski, 1987). These academic problems can persist despite adequate performance on psychometric measures of intelligence, no identifiable learning disabilities, and no domain-specific processing deficits in areas such as perception, memory, or language (Denckla, 1999). Underachievement can be categorized as situational in nature or chronic (Borkowski & Thorpe, 1994). *Situational underachievement* refers to poor performance that is temporary and linked to environmental conditions, such as parental divorce or death in the family. *Chronic underachievement* refers to performance that is well below expectations, considering the ability of the individual, exhibited over a long period of time and without apparent reason. Underachievement can be related to a specific subject, such as mathematics, or be more global in nature, affecting all academic domains.

A multitude of factors, both internal and external, can lead to underachievement (Jimerson, 1999; Murdock, 1999; Wigfield & Eccles, 2002). Some of these include disabling symptoms stemming from chronic physical illness, emotional disturbance, and poverty. Additionally, effective use of executive function capacities is critical during middle school, when academic challenges increase along with teacher expectations for student autonomy and self-sufficiency (Borkowski & Burke, 1999).

Good executive functions are necessary in middle school to enable students to deal with a number of challenges. Middle schools usually incorporate the populations of several elementary schools; thus, the buildings are larger and the students need to establish new friendships. The curriculum is taught departmentally and teachers are required to instruct different groups of students each day, with limited opportunity to interact socially with their students. Due to these social and physical environmental changes, students are more likely to feel anonymous and less supported by their teachers (Wigfield & Eccles, 2002).

Martha Denckla notes that "education operates on the implicit expectations of increasing independence and self-generated, if externally reinforced, productivity" (Denckla, 1999, p. 265). Productivity in middle school requires efficient use of executive function capacities. In the classrooms, middle school students must make the transition from learning specific basic skills to applying these basic skills to acquire new knowledge or expand current knowledge in specific content areas. Academic work increases in both complexity and in volume. Textbooks become a major source of information and reading in content areas often is more abstract in nature. New subject matter is presented with increased detail and complexity, and students are required to comprehend, analyze, recall facts, draw inferences, and make judgments. Reading content-area texts requires fluency and effective use of comprehension strategies, such as identifying main ideas and supporting details, linking new information to previously learned knowledge, and summarizing. There are greater demands for engaging critical higher-order thinking with abstract concepts, applying mental effort for extended periods of time, and using problem-solving skills (Levine, 1999).

There are greater demands for sustained attention during lectures while filtering out irrelevant information and noise in the classroom environment in middle school. Students must selectively focus attention while actively processing the information being presented. New information must be linked to prior knowledge while controlling or pacing the rate of information processing. Students must utilize working memory resources efficiently while monitoring incoming information in a manner that facilitates comprehension of complex material. Students are required to do multiple tasks simultaneously. They must listen to lectures that contain strings of longer and more varied clausal sentences and unfamiliar or technical vocabulary while processing concepts and taking notes, placing further demands on the coordination of working memory resources. Middle school students are expected to work independently more of the time, to possess more metacognitive awareness, and to exhibit more self-regulatory behavior than students in elementary school. These expectations are commensurate with the developing executive function capacities of many adolescents. Children who are slow in developing the executive capacities to meet these expectations, however, can experience significant academic difficulties (Hartman, 2001; Levine, 1999).

Purpose of the Study

Grade retention is a commonly used practice in dealing with academic underachievement. A position statement issued by the National Association of School Psychologists (NASP) on student grade retention and social promotion, however, states, "Through many years of research, the practice of retaining children in grade has shown to be ineffective in meeting the needs of children who are academically delayed" (1998, p.1). A meta-analysis of grade retention research revealed that students typically don't "catch up" to normally achieving peers over the course of a single year (Jimerson, 2001). Also, retained children are at greater risk for dropping out of school (Jimerson, 1999). A recent longitudinal study showed that almost half of the students who are at high risk for dropping out of high school can be identified as early as the sixth grade (Herzog & Balfanz, 2006).

A review of the literature found few research studies addressing executive function difficulties among students in middle school. Furthermore, research studies of executive functioning generally focus on individuals known to have learning disabilities. The present study attempted to contribute to current research findings by investigating teacher perceptions about the executive function capacities of students in the middle school general education population through analysis of prototypical ratings completed by teachers using the Behavior Rating Inventory of Executive Functions (BRIEF).

From the teacher ratings of the BRIEF items, prototypical profiles of academically successful and academically unsuccessful students were created. It was postulated that the unsuccessful student prototypical profile would reflect significantly more executive function ratings reflecting impairment than the prototypical profile of successful students.

Research Question

Do middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically successful differ significantly from these same middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically unsuccessful?

Chapter 2

Review of the Literature

Critical Elements of Executive Functions

Neuropsychological research has associated executive functions with the frontal lobes of the brain (Stuss, 1992). The frontal lobes are anatomical structures that are involved with many higher thought and motor processes. The prefrontal cortex (the foremost area of the frontal lobes) plays an important role in coordinating thought and actions in accordance with internally motivated intentions or goals (Lezak, 1995; Miller & Cohen, 2001). Executive functions represent a set of psychological constructs that have been linked in a very general way to the frontal lobes of the brain, but the specific delineation of executive functions varies according to theoretical models and disciplines (Barkley, 2001; Borkowski & Burke, 1999; Denckla, 1999; Lezak, 1995; Lyon & Krasnegor, 1999; Stuss, 1992;).

From a neuropsychological perspective, executive functions were initially investigated with patients who suffered injury to their frontal lobes and exhibited behavioral and personality changes (Lezak, 1995). From these studies, varying kinds of executive dysfunction were associated with damage to the prefrontal regions of the brain, as well as to subcortical, interconnected regions (Lezak, 1995). Studies showed evidence suggesting that executive functions are mainly mediated by the prefrontal cortex of the brain and associated descending neural systems (Goldman & Rosvold, 1970; Stuss & Benson, 1986). The frontal lobe brain areas begin to develop during early childhood and continue to mature in adolescence, paralleling the emergence and development of executive functions (Levin, Culhane, Hartmann, Evankovich, Mattison, et al., 1991; Welsch, Pennington, & Groisser, 1991).

Anatomically, the frontal lobes are located toward the front of the head and above the sylvian fissure (Stuss & Benson, 1984). They appear as two fairly symmetrical lobes that can be each divided into three major areas: dorsal-lateral, medial, and basilar-orbital. There are connections between the frontal lobes and almost all regions of the brain. Neural networks routed through subcortical areas convey auditory, visual, and somatosensory information to the frontal lobes. Parietal, temporal, olfactory, and occipital sensory areas connect directly to the frontal lobes. Association cortices have afferent connections to the frontal lobes, and contralateral connections allow communication between frontal lobe regions across the two hemispheres of the brain (Stuss & Benson, 1984). The frontal lobes interconnect with the three limbic systems: the cortical limbic lobe, a subcortical system called the septo-hypothalamo-mesencephalic continuum, and a peripheral viseroendocrine system that is associated with mood and motivation (Nauta, 1971; Stuss & Benson, 1984). Connections between the brain stem and the prefrontal cortex are linked to the regulation of arousal and tone (Luria, 1973). Luria stated, "the frontal lobes (and, in particular, their medial zones) constitute the cortical apparatus regulating the state of activity and that they thus play a decisive role in the maintenance of one of the most important conditions of human conscious activity – the maintenance of the required cortical tone and modification of the state of waking in accordance with the subjects immediate tasks" (1973, p. 197). He further stated, "maintenance of the optimal cortical tone is absolutely essential for the basic condition of all forms of conscious activity, mainly, the formation of plans and intentions that are stable enough to become dominate and to withstand any distracting or irrelevant stimulus" (Luria, 1973, p. 198).

Afferent neural connections from the visual, auditory, and somatic sensory areas extend from the sensory region to the frontal lobe and are considered associative chains (Stuss & Benson, 1984). The frontal cortex is connected by efferent pathways to other cortical structures, such as the anterior temporal cortex, inferior parietal lobe, cingulate and parahippocampal gyri and subcortical regions of the hypothalamus, associated mesencephalic tegmentum, ventral tegmental area, brain stem structures, striatum, subthalamic region, mesencephalic region, and red nucleus (Stuss & Benson, 1984).

According to Nauta, "the unique feature of the neural circuitry is that it places the frontal cortex in a reciprocal relationship with two great functional realms, namely: (1) parietal, occipital and temporal regions of the cerebral cortex involved in the processing of visual, auditory, and somatic sensory information, and (2) the telencephalic limbic system and its subcortical correspondents, in particular, the hypothalamus and meso -and diencephalic structures associated with the hypothalamus" (1971, p. 181). Nauta further stated that "the frontal lobe is characterized so distinctly by its multiple associations with the limbic system, and in particular by its direct connections with the hypothalamus, that it would seem justified to view the frontal cortex as the major – although not the only – neocortical representative of the limbic system. The reciprocity in the anatomical relationship suggests that the frontal cortex both monitors and modulates limbic mechanisms (Nauta, 1971, p. 182). Changes in an individual's affective and motivational responses to his surroundings following frontal lobe damage could relate to its close association with the limbic system and hypothalamus (Nauta, 1971).

Five parallel circuits link the frontal lobes with subcortical regions (Alexander & Stuss, 2000). Each circuitry involves a portion of the frontal lobe, projections to striatal regions, to globus pallidus, thalamus, and back to the frontal lobe. Two circuits relate to motor functions and three circuits, the dorsolateral, lateral orbital, and medial frontal/anterior cingulate, relate to cognitive and affective abilities (Alexander & Stuss, 2000). The frontal lobes, with their connections to other parts of the brain, play an important role in executive cognitive processes, personality, emotions, and self-awareness. Disorders affecting frontal lobe functioning have been characterized as behavioral problems, cognitive impairments, and motor deficits (Alexander & Stuss, 2000). Brain injuries affecting prefrontal circuits have been linked to clinical syndromes. Executive function deficits have been observed with lesions to the dorsolateral prefrontal circuit, disinhibition with lesions to the orbitofrontal circuit, apathy with lesions to the anterior cingulated circuit, and movement disorders to damage of the basal ganglia part of the circuitry. In addition, depression, mania, and obsessive-compulsive disorders have been associated with injury to the frontal-subcortical circuits (Cummings, 1993).

Research studies have attempted to relate anatomical findings of the prefrontal-subcortical functions to executive functions (Barde & Thompson-Schill, 2002; Cummings, 1993; Rugg, Fletcher, Chua, & Dolan, 1999; Volz, Schubotz, & Cramon, 2006). However, Stuss and Alexander emphasized that it would be misleading to attribute specific executive function difficulties to particular parts of the brain. According to Stuss and Alexander, "there is no unitary executive function. Rather, distinct processes related to the frontal lobes can be differentiated which converge on a general concept of control functions" (1992, p. 289).

According to Fuster (1980), the prefrontal cortex, the anterior portion of the frontal lobes, plays an important role in the temporal integration of behavior. He postulated that different sections of the prefrontal cortex assume various behavioral functions, and these functions become the components of a supraordinate function of temporal structuring of goal-directed behavior. The prefrontal cortex is involved during the coordination of sensory inputs with motor outputs to form novel behavioral sequences for goal-directed acts (Fuster, 1980). Automatic or well-established patterns of behavior do not require prefrontal involvement. Time is another critical factor related to prefrontal cortex use (Fuster, 1980). The prefrontal cortex is needed when sensory-motor integration occurs across time for the behavioral sequences. The role of the prefrontal cortex in temporally structuring behavior is subserved by three interactive cognitive functions: working memory, preparatory set, and interference control (Fuster, 1980). The two subordinate functions, retrospective function and prospective function, work together to support the integration of temporal events (Fuster, 1980). Retrospective function relates to temporarily stored sensory and motor sequential information that is held until the attainment of a goal. Prospective function includes preparation for anticipated events. This is also known as anticipation, foresight, or set. These functions are localized in the dorsal and lateral prefrontal convexity. The suppression of interfering external stimuli or internal influences that prevent the orderly sequences of actions from attaining its goal is a ventral cortex function (Fuster, 1980).

Fuster views (1980) all behavior as part of a hierarchical order of temporally sequenced units, with reflexive acts representing the most basic unit, progressing to the highest levels, comprising behaviors that have purpose or in pursuit of a goal. The limbic region provides the drive by which the organism initiates and completes the new, and usually complex, temporal structures toward the intended goal. Executive functions relate to attributes of initiation, intention, motivation, and vigor in the temporal integration of novel, complex behavioral structures toward its goal (Fuster, 1980).

From a theoretical perspective, executive function is best considered as an umbrella construct of central control processes (Denckla, 1999). Included under the executive function umbrella are such processes as inhibition and delay of responding, planning, organization, maintenance of anticipatory set/preparedness to act, and integration of cognitive and output processes (Denckla, 1999). Other processes that relate to the executive function domain include strategic encoding and retrieval of verbal and visuospatial information, working memory functions, directing and sustaining attention to novel situations, inhibiting attention to distraction, initiating goal-directed behaviors, and utilizing higher order organizational strategies (Barkley, 2001; Fuster, 1980; Lezak, 1995; Luria, 1973; Stuss & Benson, 1986).

Lezak (1995) identifies volition, planning, purposive action, and effective performance as the four critical components of executive functions. These are activity-related behaviors required for socially appropriate, responsible human behavior. Impaired self-regulatory behavior typically involves a cluster of deficiencies rather than one specific executive function capacity. Volition refers to:

> the complex process of determining what one needs or wants and conceptualizing some kind of future realization of that need or want. In short, it is the capacity for intentional behavior. It requires the capacity to formulate a goal or at a less well-conceptualized level, to form an intention. (Lezak, 1995, p. 651).

Lezak stated that, "the identification and organization of the steps and elements (e.g., skills, material, other persons) needed to carry out an intention or achieve a goal constitute planning and involve a number of capacities" (1995, p. 653). He further stated that, "in order to plan, one must be able to conceptualize changes from present circumstances (i.e., look ahead), deal objectively with oneself in relation to the environment, and view the environment objectively" (Lezak, 1995, p. 653). "The planner must also be able to conceive alternatives, weigh and make choices, and entertain both sequential and hierarchical ideas necessary for the development of a conceptual framework or structure that will give direction to the carrying out of the plan" (Lezak, 1995, p. 653). In terms of purposive action, Lezak stated, "the translation of an intention or plan into productive, self-serving activity requires the actor to initiate, maintain, switch, and stop sequences of complex behavior in an orderly and integrated manner" (1995, p. 658). According to Lezak, "a performance is as effective as the performer's ability to monitor, self-correct, and regulate the intensity, tempo, and other qualitative aspects of delivery" (1995, p. 674).

Stuss and Benson formulated a comprehensive behavioral/anatomical model of frontal lobe functioning whereby the prefrontal cortex is the biological base for executive functions. They conceptualized frontal lobe functioning as hierarchical and increasingly more abstract in nature. In the words of Stuss and Benson, "the executive functions remain among the most significant of human frontal lobe accomplishments" (1986, p. 205). Executive functions are interrelated with other brain functions and appear to play a superordinate role in relation to the posterior functional systems.

Stuss and Benson (1986) proposed that the brain is an integrated unit composed of separate, organized, yet interrelated functional systems that include, among others, memory, language, sensory-motor functions, attention, emotion, and cognitive abilities. These functional systems are posterior to the prefrontal cortex with reciprocal connections to the frontal lobes. The prefrontal cortex assumes a supervisory, executive role over these posterior systems (Stuss & Benson, 1986).

Parallel and superordinate to these posterior systems are two anterior systems that regulate behavioral control functions (Stuss & Benson, 1986). These anterior systems involve: (a) sequencing, set development, and information integration, and (b) drive, motivation, and will (Stuss & Benson, 1986). Higher mental activities depend on the ability to maintain and organize units of information in sequence, to identify relevant information and form new sets of sequences, and to integrate data from sets of information to form new knowledge (Stuss & Benson, 1986). The processing and integration of sequential information require intact lateral frontal structures (Stuss & Benson, 1986). Drive, motivation, and will comprise the other group of behavior control functions linked to prefrontal regions (Stuss & Benson, 1986). These are systems related to medial frontal structures. Drive is seen as an energizing force. Motivation and will are associated with drive, but reflect a higher degree of mental control over basic instincts.

Within the hierarchy, muscle control represents the lowest level, progressing to superordinate levels of frontal lobe functioning, represented as the "executive controller" (Stuss & Benson, 1986). The executive controller acts as the "internal programmer" or "decision-maker" for the establishment and attainment of internally motivated goals (Stuss & Benson, 1986). According to Stuss and Benson (1986), executive functions include anticipation, goal-selection, planning, monitoring, and use of feedback. These levels of control are conceptually viewed as independent, yet interactive and increasingly more abstract (Stuss & Benson, 1986). They become activated during novel nonroutine activities where situations require new solutions or when initial learning is taking place (Stuss & Benson, 1986). Frontal control exerts influence on systems of language, memory, and cognition during higher mental activities that require novel responses (Stuss & Benson, 1986). Once activities become routine or overlearned, other brain regions replace frontal involvement (Stuss & Benson, 1986).

Barkley (2001) defines executive functions in terms of self-regulation and inhibition, with self-control as their main purpose. Self-control requires one to act in opposition to his or her immediate impulses and self-interest in order to achieve a future goal. The executive functions oversee self-directed and intentional behavior used in self-regulation. When an intention of a future goal is effectively regulated by executive function use, a temporal delay occurs during which the consequences of alternative responses are weighed in terms of risk/benefit ratios over time. Barkley links behavioral inhibition to four executive functions: (a) nonverbal working memory, (b) verbal working memory, (c) self-regulation of affect/motivation/arousal, and (d) reconstitution. These components represent covert forms of behavior relative to the self that allows one to mentally test possible consequences before engaging in a response, thereby facilitating adaptive functioning.

Nonverbal working memory consists of visual imagery and covert audition (covert seeing and hearing represented to the self), providing mental representations of possible future events. Verbal working memory is the covert self-directed speech that forms the basis of such activity as reflection, self-instruction, self-questioning, and problem solving. Self-regulation of affect/motivation/arousal comprises the associated affective and motivational properties resulting from the first two executive functions. This is the source of one's intrinsic motivation to achieve a future goal. Reconstitution provides analysis and synthesis of behavioral units. Familiar behavioral patterns are divided into smaller sequences (analysis) and new behavioral patterns are created by recombining units (synthesis) in novel ways. Generating new solutions when confronted with obstacles in goal attainment facilitates successful outcomes. Reconstitution is also known as fluency, flexibility and generativity in the neuropsychological literature.

McCloskey and colleagues present a holarchical model of executive functions (McCloskey, Van Divner, & Perkins, 2008). According to this model, executive functions comprise many different capacities that operate on numerous levels across independent developmental lines. These levels are: (a) self-activation, (b) self-regulation, (c) self-realization and self-determination, (d) self-generation, and (e) trans-self-integration. At the lowest level, self-activation relates to basic executive functions that initiates the "awakening of the mind." At the next level, self-regulation refers to a set of processes that cue the use of other mental capacities to direct and control perceptions, thoughts, actions, and emotions. There are a total of 23 self-regulation executive functions that include perceive, sustain, organize, manipulate, retrieve, monitor, as well as others. These 23 self-regulation capacities serve to mobilize and direct other mental processes to act flexibly and successfully toward the accomplishment of a task when responding to new demands or situations. At the next level, self-realization and self-determination represent increasingly more abstract conceptualization of executive functions. Self-realization refers to self-awareness and self-analysis. Self-determination executive functions cue the use of other cognitive processes to visualize the future and to formulate plans for goal-directed behavior. At the next higher level, self-generation executive functions provide the cues to direct the generation of a philosophy of life that serves as guidance in the realization of intentional behavior. At the highest level, trans-self-integration executive functions assume a spiritual quality.

McCloskey postulated that progression through these levels can occur without attaining mastery of lower levels and that there is variability in performance due to the dissociable nature of executive control. Adequate executive control in the cognitive domain does not translate to adequate executive control in the domains of perception, emotion, or action. Variability also exists across four separate arenas of involvement: intrapersonal, interpersonal, environment, and symbol system.

The term metacognition has been used by educational and cognitive psychologists to describe aspects of cognitive processing that reflect the use of executive functions. Schraw (1998) proposed that metacognition is a multidimensional phenomenon that consists of two domains, knowledge of cognition and regulation of cognition. Knowledge of cognition encompasses the knowledge one possesses regarding cognition (Schraw, 1998). It includes declarative, procedural, and conditional knowledge (Schraw, 1998). Declarative knowledge refers to the individual's understanding of their learning style and cognitive capabilities; procedural knowledge relates to the knowledge of procedures and strategies to accomplish tasks; and conditional knowledge refers to one's awareness that a strategy is needed based on circumstances and draws on both declarative and procedural knowledge to meet the challenges of the situational demands of the activity when those demands exceed automatic and routinized learning processes (Schraw, 1998).

The second component of metacognition, regulation of cognition, relates to the control individuals have over their learning experiences and includes planning, monitoring, and evaluation (Schraw, 1998). Planning refers to the selecting and directing of resources to affect positive performance; monitoring relates to on-line self-awareness of one's performance while engaged in the learning activity; and evaluation refers to self-assessment of personal accomplishments (Schraw, 1998). These aspects of metacognition are interrelated; that is, the more one knows about things, the better one can plan and select strategies for effective learning (Schraw, 1998). Also, the greater the knowledge of different aspects of cognition, the greater the flexibility in controlling cognition (Schraw, 1998).

Metacognition plays an important role in academic achievement (Gourgey, 1998; Maqsud, 1997; Mayer, 2004; Schraw, 1998). It is critical for learning because it facilitates self-regulation through reflection and resulting regulatory decisions that promote strategic use of strategies and allocation of resources to achieve successful learning. Schraw (1998) makes a distinction between cognition and metacognition in that cognitive skills are content or discrete skills pertaining to a particular subject area, whereas metacognition is domain-general and relates across multiple domains. He further postulated that metacognition does not relate significantly to intelligence. Rather, high-level metacognition can compensate for low ability. In addition, metacognition can be taught to students using instructional practices such as explicit instruction and modeling.

Metacognitive knowledge has been positively associated with learning strategies. Swanson (1990) conducted a study that analyzed children's problem-solving skills. The findings revealed that children with high metacognitive knowledge perform better on problem-solving tasks than those without it. In this study, fourth and fifth grade students were grouped according to high and low aptitude and high and low metacognitive ability. Children with high metacognitive knowledge but lower aptitude achieved in a manner that was similar to those with higher aptitude on problem-solving tasks, suggesting that metacognition can compensate for low ability.

Disorders of Executive Functions

Impairments in executive skills have been observed in a number of disorders (Clark, Prior, & Kinsell, 2000; Denckla, 1989; Denckla, 1999; Gioia, Isquith, Kenworthy & Barton, 2002; Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002; Oosterlaan, Scheres, & Sergeant, 2005; Ozonoff & Jensen, 1999; Ozonoff & Pennington, 1996; Stuss & Alexander, 2000; Temple, 1997). Some of these include autism spectrum disorder, attention deficit hyperactivity disorder, traumatic brain injury (TBI), and specific learning disabilities (Denckla, 1999; Temple, 1997). The behavioral patterns in these disorders vary in severity and specificity. Some are more pervasive than others, such as autism, in which executive dysfunction can be observed across multiple areas, whereas other conditions may involve only a few specific areas of impairment. However, even in autism, there is wide variability regarding the kinds of executive function impairments that are observed in each case.

Ozonoff and Jensen (1999) found that different neurodevelopmental disorders may share the same underlying pattern, but closer analysis reveals unique executive profiles. For example, autistic children demonstrate severe dysfunction in the areas flexibility and planning, whereas ADHD children display inhibitory dysfunction. Mangeot, Armstrong, Colvin, Yeates, and Taylor (2002) examined children with brain injuries using the Behavior Rating Inventory of Executive Function (Gioia, Isquith, Guy, & Kenworthy, (2000). The study found that children between the ages of 10 and 19, sustaining injuries 5 years earlier ranging in severity from severe to moderate, showed deficits in working memory that were consistent across groups. These findings suggest that TBI children suffer long-term deficits in executive functioning.

Development of Executive Function in Children

There appears to be an orderly development of executive function capacities over time (Denckla, 1999). Studies show that most executive functions develop in stages, beginning in infancy and continuing through adolescence and into early adulthood (Anderson, 2002; Bayliss, Gunn, Baddeley, & Leigh, 2005; Denckla, 1999; Gatherole, Pickering, Ambridge, & Wearing, 2004; Passler, Isaac, & Hynd, 1985; Welsh & Pennington, 1988). Welsh and Pennington proposed that the "rudiments of frontal functioning are present early in development and have a protracted course of development" (1988, p. 202). The reach of an 11- to 12- month-old infant to grasp an object requires a goal-directed mental set in which certain behaviors are inhibited while others are strategically planned to execute the grasping behavior (Welsh & Pennington, 1988).

A critical period of development seems to occur between the ages of 7 and 9 years for cognitive flexibility, goal setting, and increases in information processing efficiency. By age 12, most executive functions are relatively mature (Anderson, 2002). Using standardized neuropsychological tests that are sensitive to frontal lobe functioning, Levin et al. (1991) found developmental changes in performance among normal children. Around age 12, most children display significant gains in the capacity to shift set and suppress inappropriate responding. Adolescents in the 13- to 15- year-old range performed better than younger children in organization of memory and word fluency. There were no gender differences found among the subjects in this study. Welsh, Pennington, and Groisser (1991) examined the executive functions of children at different ages to determine the level at which adult-level competence is achieved. Differential developmental trajectories were found. Three stages of skill integration and maturation became evident at ages 6 and 10 and during adolescence.

Studies show a linear development of working memory, beginning in early childhood to adolescence (Gathercole, Pickering, Ambridge, & Wearing, 2004). Bayliss, Gunn, Baddeley, and Leigh (2005) found that complex working memory span performance was related to processing efficiency and storage capacity. They concluded that working memory is critical for higher- level cognition and that there are considerable age-related variations in both processing speed and storage capacity, as well as developmental increases in controlled attention capacity. Bayliss et al. concluded that "as children develop, their working memory performance, and consequently, their level of educational achievement will be constrained by the developmental stage that their speed of processing and storage-related abilities have reached" (2005, p. 595). The above studies suggest that teachers' expectations for increased self-regulation of learning and academic production at the middle school level are consistent with the general models of the progression of development of executive function capacities in the adolescent years.

Relevance of Executive Functions to Academic Achievement

Executive functions play an important role in academic achievement during the middle school years (Kurtz & Borkowski, 1987; Ley & Young, 2001; Sexton, Harris, & Graham, 1997; St. Clair-Thompson & Gathercole, 2006; Wood, Murdock, & Cronin, 2002). Self-regulation executive functions are critical for complex task production (Dembo & Eaton, 2000; McCloskey et al., 2008). McCloskey provides a list of executive function processes that include, along with others, the following:

1. Inhibiting reflexive, impulsive responding
2. Interacting with and selectively directing attentional processes while screening out interference and sustaining attention
3. Cuing and initiating of effort and judgments about the amount of effort to effectively complete a task
4. Monitoring and regulating speed of information processing
5. Monitoring task performance for accuracy and efficiency
6. Directing the efficient and fluent production of language when highly specific production demands are made.

Poor executive functions can lead to inadequate academic production in the areas of reading, mathematics, and writing (McCloskey, et al., 2008). For example, problems in sustaining attention and monitoring the inflow of information can have adverse effects on reading comprehension, performing calculations, and producing extended written text (McCloskey, et al., 2008).

Using an information-processing model, Mayer (1992) describes three main cognitive processes: selecting, organizing, and integrating. Effective learners must first select relevant information from the text. Then that information is organized into a coherent whole in a manner that makes sense to the learner. Finally, connections are formed between newly acquired information and existing knowledge in long-term memory. Effective learners possess a repertoire of strategies in long-term memory and can apply the appropriate strategy to the task. Most importantly, they are aware of the need to employ an appropriate strategy. Conversely, ineffective learners lack appropriate strategies or are unaware of the need to produce a strategy for learning (Mayer, 1992).

Borkowski and Burke (1999) describe an information processing model that consists of three main components: analysis of a task, selection of an appropriate strategy to accomplish the task, and monitoring the selection and progress of the strategy toward the desired learning outcome. As children become more adept at analyzing, selecting, and monitoring strategies to meet the demands of the task, they develop a sense of self-efficacy.

Borkowski and Muthukrishna believe that "strategy-based learning is deliberate, effortful, and usually produces a higher level of performance than nonstrategic learning" (1999, p.482). They define strategies as sets of interdependent mental processes that guide and control covert and overt operations in the learning process. Strategies are interchangeable and flexible, with revisions occurring in response to specific situations. Strategies such as repetition, organization, elaboration, paraphrasing, and summarization facilitate information processing in reading comprehension. Becoming a strategic learner is a developmental process (Borkowski & Muthukrishna, 1992). The process begins with the child gaining knowledge of one strategy. Through repetitive use of that strategy in multiple contexts, the child gains an understanding of its usefulness, as well as its limitations. Other strategies are mastered, and the child develops awareness that some strategies work better than others in particular situations. When the child encounters obstacles in achieving the desired outcome, higher-order executive processes are activated to analyze the components of the task and to select an appropriate strategy, beginning the process of self-regulation (Borkowski & Muthukrishna, 1992). The involvement of executive functions shifts from analyzing and selecting a strategy to strategy monitoring and revision based on feedback (Borkowski & Muthukrishna, 1992). As the child becomes more efficient in the use of executive functions in learning, the child learns that success is based on effort. The child attributes successful outcomes to effort and strategy use, rather than luck (Borkowski & Muthukrishna, 1992). In addition, the child learns that mental competencies can be enhanced through self-directed goal-oriented actions (Borkowski & Muthukrishna, 1992). Metacognition integrates cognitive acts (strategy use) and motivational factors (Borkowski & Muthukrishna, 1992). The feedback the child receives regarding the causes and consequences of their performance shape his or her personal-motivational states regarding self-esteem, internal locus of control, and effort-related attributional beliefs about personal successes (Borkowski and Muthukrishna, 1992).

Marlowe contends that teaching children a general model of how to learn will facilitate adaptive thinking that can be useful regardless of the learning situation.

According to Marlowe, a series of specific procedures for the use of executive thinking involves (2000, p.450):

1. Identifying the goal to be accomplished
2. Identifying potential strategies (action plans) to accomplish the goal
3. Selecting the best strategy (action plan)
4. Developing a sequential series of steps to accomplish that plan
5. Identifying and collecting the appropriate materials to complete the task
6. Beginning the task according to the plan
7. Monitoring for accuracy
8. Modifying as necessary
9. Completing the task (and rechecking for accuracy)
10. Modifying as necessary

Marlowe stresses that executive thinking is complex and learned over a long period of time with practice.

Anderman, Anderman, and Griesinger (1999) examined the relation of self-concept and achievement goals among seventh grade students. They were interested in the predictive utility of present and possible (what students would like to become) selves as determinants of achievement and motivation. Drawing from previous research (Markus & Nurius, 1986), possible selves were perceived as catalysts for future behavior. That is, individuals strive toward desired possible selves or avoid possible selves they are afraid of becoming. The results showed a positive relationship between present good-student and future good-student self-concepts and achievement goals, as measured by grade-point average, suggesting that students' perceptions of their present and future academic selves are related to achievement (Anderman, Anderman, and Griesinger, 1999).

Self-monitoring enhances learning (Malone & Mastropieri, 1992 & Wood, Murdock, & Cronin, 2002). Wood, Murdock, and Cronin (2002) found that middle school students who were taught how to self-monitor improved their academic performance, as measured by their grades and related academic behaviors. In addition, self-monitoring generalized to other settings, and benefits were maintained the following school year.

Miranda, Villaescusa, and Vidal-Abarca (1997) investigated the use of self-instructional procedures in enhancing reading comprehension among fifth and sixth grade learning disabled students. The students were taught the following reading strategies: activating previous knowledge, previewing text, self-questioning, clarifying, and mapping ideas. Explanations were given to them regarding why, when, and how to use these strategies. The students applied a general self-instructional procedure adapted from Meichenbaum and Goodman (1971) with the reading tasks. The research findings indicated that the learning disabled students scored at the same level as the normally achieving students after treatment, whereas learning disabled students in the control group did not show gains (Miranda, Villaescusa, & Vidal-Abarca, 1997). These results supported the use of self-regulation procedures in increasing reading comprehension strategies (Miranda, Villaescusa, & Vidal-Abarca, 1997).

Reid and Borkowski (1987) conducted a study of elementary students characterized as having inadequate strategic skills, immature self-control, and negative attributional beliefs. The results of the study showed that children who received a program consisting of strategy training, self-control instructions, and attributional retraining had short-term successes in strategy-based learning, improved attributional beliefs, and greater self-control (Reid & Borkowski, 1987). These treatment effects lasted for 10 months (Reid & Borkowski, 1987). Strategy generalization and persistent use of strategies up to the 10-month follow-up highlights the need to address affective, motivational beliefs underlying behavior with problem-solving strategy programs (Reid & Borkowski, 1987). Also, the results suggested that the strategy plus attribution condition resulted in increased metacognitive awareness about the importance of strategic performance (Reid & Borkowski, 1987). That is, the utilization of complex strategic behavior corresponded to beliefs about the necessity of using strategies (Reid & Borkowski, 1987). Self-realization of the importance of using effort in deploying strategies and the resulting feelings of competency function to energize further strategy use and metacognition growth (Reid & Borkowski, 1987).

Kurtz and Borkowski (1987) conducted a longitudinal study to assess the relationships among metacognition and strategic behavior in the domain of reading comprehension between impulsive and reflective children. It was postulated that many impulsive children fail to transfer newly acquired strategies and that metacognitive deficits were associated with deficient knowledge about cognitive strategies or deficient knowledge about executive processes. The researchers hypothesized that early knowledge about memory and learning strategies are causally related to the more mature and complex strategies and skills required for reading comprehension in later grades (Kurtz and Borkowski, 1987).

Fourth, fifth, and sixth grade students were randomly assigned 3 years earlier to three treatment conditions involving a reading summarization task (Kurtz and Borkowski, 1987). These were: (a) a strategy condition, in which children received instruction in summarization, (b) an executive condition, in which the children had the same summarization instruction plus metacognitive information about the importance of monitoring performance, deliberate strategy selection and revision, and pacing to control the flow of information, and (c) practice control group, in which students practiced summarizing paragraphs without receiving summarization skills instruction or metacognitive instructions (Kurtz and Borkowski, 1987). It was hypothesized that executive training would facilitate strategy acquisition and influence cognitive style, in that reflective children would be more reflective in responding to the reading task (Kurtz and Borkowski, 1987).

The pretraining test included three descriptive and two explanatory paragraphs, and the posttraining test included four descriptive and two explanatory paragraphs (Kurtz and Borkowski, 1987). Children learned how to identify the main idea and relevant parts of a paragraph and how to create topic sentences (Kurtz and Borkowski, 1987). A self-questioning procedure was used to assist them in summarizing (Kurtz and Borkowski, 1987). The students were instructed to ask themselves "What is this story about? What is the main idea in one word? What is the most important thing about the main idea?" The students learned to summarize explanatory paragraphs using a three-step strategy: identify the main idea sentence, identify the reason, and combine the main idea and reason into a summary statement (Kurtz and Borkowski, 1987).

The executive group students received lectures accompanied by active dialog about how problem-solving can be approached in various ways and that a strategy that works in one situation may not work well in another (Kurtz and Borkowski, 1987). The importance of strategy selection and revision were discussed, along with the importance of working slowly (Kurtz and Borkowski, 1987). Emphasis was placed on strategy modification and strategy monitoring to assess progress. During the summarization skills exercises, the students were reminded to work slowly, monitor their performance, and evaluate strategy efficacy (Kurtz and Borkowski, 1987).

Results of the study showed that summarization scores improved at posttest for the executive training group (Kurtz and Borkowski, 1987). Both reflective and impulsive students who received metacognitive instructions about executive skills performed better in summarization than students who received strategy training alone and the students who only practiced summarizing paragraphs (Kurtz and Borkowski, 1987). The study showed a causal link between early knowledge of learning strategies and later acquisition of skills, with both impulsive and reflective students benefiting from training in the use of summarization skills and executive processes (Kurtz and Borkowski, 1987). The researchers hypothesized that the learning of higher order executive processes depends on the development of lower-level strategies and that specific strategy knowledge, beliefs about self-efficacy, and executive processes interact in a manner that facilitate subsequent strategy acquisition (Kurtz and Borkowski, 1987).

Case, Pericola, & Karen (1992) conducted a study to examine the effectiveness of using self-regulated strategy procedures (self-assessment, self-recording, and self-instruction) to improve mathematics skills in learning disabled students. The participants were fifth and sixth grade students identified as having difficulties solving simple addition and subtraction word problems due to errors in executing the correct operations. Task analysis of errors revealed that the students were capable of correctly performing addition and subtraction, but they tended to use the wrong operation and added instead of subtracting and vice versa.

The problem-solving strategy portion of the study was: (a) read the problem out loud, (b) circle important words, (c) draw pictures to show what is happening, (d) write down the math sentence, and (e) write down the answer. Students and instructor worked collaboratively in discussing the value of each step of the process. The students also were taught metacognitive, self-regulatory strategies (self-instructions, self-assessments, and graphing procedures) for the organization, planning, and monitoring of the use of the five-step problem solving strategy. The students generated and recorded self-instructional statements they could say to themselves to help find cue words or phrases in word problems. During rehearsal of the self-instructional statements, the students practiced subvocalizing or using them mentally, rather than verbalizing aloud. The following excerpt illustrates the modeling of the strategy and self-instructions (Case, Pericola, and Karen, 1992, p. 4):

> The student laid out the chart containing the strategy steps and the chart containing the self-generated instructions; the instructor modeled the use of the strategy while "thinking aloud." While modeling the strategy, the instructor used the following types of self-instructions to guide and direct behavior: (a) problem definition (e.g., "What is it I have to do?"); (b) planning (e.g., "How can I solve this problem?...by looking for important words."); (c) strategy use (e.g., "The

five-step strategy will help me look for important words."); (d) self-evaluation (i.e., "How am I doing? Does this make sense?"); and (e) self-reinforcement (i.e., "I did a nice job; I got it right.").

The results of the study showed improved performance in executing the correct operation for addition and subtraction problems (Case, Pericola, & Karen, 1992). Their teacher reported that the students used the strategy in the classroom, and the students reported using self-instructions in other settings (Case, Pericola, & Karen, 1992).

Waber, Gerber, Turcios, Wagner, and Forbes (2006) examined the relationship between executive functions and achievement on state mandated standards-based testing among fifth grade students in low-income schools. Neuropsychological tests were conducted to assess executive functions, as well as motor speed, working memory, and processing speed. In addition, teachers completed structured questionnaires designed to evaluate their students' executive functions and behavioral problems, as manifested within the school environment. The mandated exam provided English and mathematics scores for the participants. The majority of the students received scores in the "Failing" or "Needs Improvement" range. The results of the study revealed a high correlation between executive functions and achievement test scores (Waber, Gerber, Turcios, Wagner, and Forbes, 2006). These students performed at or above normative expectations on measures of working memory, processing speed, planning, and motor coordination, and exhibited externalizing and internalizing behaviors within the normal range (Waber, Gerber, Turcios, Wagner, and Forbes, 2006). These results suggest that basic information processing and psychosocial adjustment were not contributing factors to low achievement scores (Waber, Gerber, Turcios, Wagner, and Forbes, 2006). In addition, this study suggests that children from impoverished backgrounds may have selectively diminished executive functions, which may contribute to the disparity in academic achievement between poor children and their more advantaged peers (Waber, Gerber, Turcios, Wagner, and Forbes, 2006).

Assessments of Executive Functions

Neuropsychological tests are commonly used to assess brain dysfunction and, more recently, executive function deficits (Royall, Lauterbach, Cummings, Reeve, Rummans, et al., 2002). However, there is no established framework for interpretation of the results of assessments of executive functions (Royall, Lauterbach, Cummings, Reeve, Rummans, et al., 2002). Executive functions encompass a diverse set of cognitive capacities that are associated with higher mental functions, such as abstract thinking and judgment. They have been linked to frontal lobe functioning that is involved in planning, hypothesis generation, and abstraction (Royall, Lauterbach, Cummings, Reeve, Rummans, et al., 2002). Because lesions to the frontal lobes are generally not well defined, it may be difficult to localize specific executive operations to specific prefrontal regions in specific cases of brain damage (Royall, Lauterbach, Cummings, Reeve, Rummans, et al., 2002). Also, executive control depends on the integrity of frontal lobe systems (Royall, Lauterbach, Cummings, Reeve, Rummans, et al., 2002). Executive impairments may follow disruption of frontal system information processing, regardless of the location of the lesion within the system. In some cases, remote lesions in subcortical regions can affect processing within the frontal circuits. Typical executive function tests measure multiple dimensions of executive control (Delis, Kaplan, &

Kramer, 2001). Also, performance on these tasks requires both fundamental cognitive functions, such as visual attention or verbal knowledge, as well as higher executive control functions (Delis, Kaplan, & Kramer, 2001). No single test can adequately measure all executive function capacities (Delis, Kaplan, & Kramer, 2001). Despite these limitations, neuropsychological tests offer important information regarding executive processes (Delis, Kaplan, & Kramer, 2001).

There are standardized neuropsychological tests that are particularly useful in assessing different aspects of executive functions, such as the Rey-Osterrieth Test (Meyers & Meyers, 1995), a measure of visual perception and long-term memory. One is presented a complex picture of geometric figures, then draws it from memory. This instrument taps the organizational and planning processes of executive functions.

The Delis-Kaplan Executive Function System (D-KEFS) (Delis, Kaplan, & Kramer, 2001) is a set of nationally normed standardized tests designed to measure executive functions in children and adults. It consists of nine tests that measure various types of executive functioning. The D-KEFS can be administered as a battery of tests to provide a comprehensive assessment of a diverse set of executive functions, or each subtest can be administered alone and/or in combination of other subtests, depending on the purpose of the assessment. The following is a brief description of the subtests that comprise the D-KEFS.

Trail Making Test. This is a visual-motor sequencing test. The examinee is required to connect numbers and letters in alternating sequences. This test is designed to assess cognitive shifting on a visual-motor task. Several other conditions are presented to the examinee that tap underlying component skills related to task switching. These are visual scanning, number sequencing, letter sequencing, and motor speed.

Verbal Fluency Test. This test requires the examinee to generate words that begin with a designated letter, generate words within a specific semantic category, and generate words alternating between two semantic categories. This test taps verbal fluency and cognitive flexibility.

Design Fluency Test. This test requires the examinee to draw different designs consisting of four lines inside boxes with filled and empty dots. Several conditions exist: drawing lines connecting filled dots, drawing lines connecting empty dots, and drawing lines that alternate between filled and empty dots. This test taps executive skills of initiation of problem-solving behavior, visual fluency, inhibition in drawing previous designs, monitoring performance, and cognitive shifting.

Color-Word Interference. First the examinee is required to name the color of squares presented on a stimulus card. Next, the examinee reads the color names that are printed in black ink. In the third condition, color names are printed in different color ink and the examinee is required to name the color of the ink. In the fourth condition, the examinee alternates between naming the color of the ink and reading the name of the color word. This test taps verbal inhibition and cognitive flexibility.

Sorting Test. This test comprises two testing conditions. In the first condition, the examiner places six cards that contain stimulus words and perceptual features into two groups according to a specific category or concept. Subsequent to sorting, the examinee generates a description of the categorization rule or concept. In the second condition, the examiner sorts the same cards into two groups according to specific target sorts and asks the examinee to explain the sorting rules or concepts. This test assesses initiation of problem-solving behavior, verbal and nonverbal concept formation skills, ability to describe sorting rules, and ability to inhibit previous responses in order to think and behave flexibly.

Twenty Questions Test. The examiner presents an array of 30 pictures depicting common objects to the examinee. The examiner selects one of the pictures and the examinee must determine which one it is, based on answers to yes/no questions. The purpose of the task is to identify the target picture using the lowest number of pictures. This test taps ability to benefit from feedback and flexible abstract thinking in generating yes/no questions.

Word Context Test. The examiner presents a made-up word to the examinee in a sentence. The examinee must decode the word using clues provided in the sentence. Five sentences are provided to the examinee, each containing more information about the mystery word. The examinee must provide the correct meaning of the word using the lowest number of sentences for clues. This test taps deductive reasoning and flexibility in thinking.

Tower Test. The examinee must construct a tower by placing disks of varying sizes on wooden pegs to match a designated tower in the fewest possible moves. Executive functions tapped by this test are spatial planning, rule learning, inhibition of impulsive responding, and establishing and maintaining the cognitive set of the task.

Proverb Test. Individual proverbs are presented to the examinee for interpretation. This test measures the ability to formulate meaning from a concrete phrase, tapping verbal fluency in generating abstract thinking.

Behavior rating scales are also used to assess executive functions. Gioia, Isquith, and Guy (2000) developed the Behavior Rating Inventory of Executive Function (BRIEF), a questionnaire for parents and teachers of children designed to assess executive functions behaviors. There are eight clinical scales: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. This rating scale has two forms that measure executive function behaviors manifested in the home and school settings.

Concept of Competent Learner Viewed From a Prototype Perspective

The present study attempted to examine the concept of executive function as an important attribute for achieving academic success in middle school. Drawing from psychological research, competent learners can be best understood as a group, or category, that can be distinguished by the effective use of executive functions exhibited by members of this group. For purpose of clarity, it may be useful to outline some fundamental principles of categorization that can be applied to prototype formation.

A prototype is defined as a mental representation, an "ideal" exemplar, that contains the characteristic features of a category (Hampton, 1995; Rosch, 1975; Tversky, 1977). It captures the central tendency or average of all the cases or instances of the category. It does not necessarily need to correspond to an actual case or instance. According to Rosch (1975), categories are defined as prototypes that represent the typical attributes that are common to most members and resembles least to members of other categories. Structurally, category prototypes are formed by shared attributes. The "ideal" prototypical member contains the maximum number of features shared by all members of the category. Other members of the category can be seen as more or less typical, depending on the extent to which they resemble the ideal prototype concept. According to Rosch (1975), categories function to provide information to the perceiver about the environment in the most coherent and efficient manner that corresponds to the correlational structure of the attributes in the world. Rosch proposed two general psychological principles for categorization:

> The first has to do with the function of category systems and asserts that the task of category systems is to provide maximum information with the least cognitive effort. The second principle has to do with the structure of the information so provided and asserts that the perceived world comes as structured information rather than as arbitrary or unpredictable attributes (1978, pp. 312-313).

Prototype theory emerged several decades ago as a departure from the classical view that specified that concepts are organized into categories according to strict adherence to a set of defining essential and necessary features or properties in equal degree (Rosch & Mervis, 1975). Rosch and Mervis (1975) reconceptualized the natural category by replacing defining criteria features for membership with a family resemblance view in which categories are structured by similar attributes that members of a category have in common with each other. A mental prototype or best example of the category embodies the characteristics or typical features of the category. Classifying objects by comparing instances to a prototype would increase the flexibility of categories and allow variability in membership.

Categories vary along vertical and horizontal dimensions (Rosch, 1978). The vertical dimension refers to the inclusiveness of a category, whereby categories vary within a three-level hierarchical taxonomy, consisting of superordinate level (e.g., furniture), basic level (e.g., chair), and the subordinate level (e.g., kitchen chair). Based on Rosch's (1978) research on categories of common objects, the superordinate category is too general, with few highly abstract shared attributes, and the subordinate category is too specific, with less than a significant number of shared attributes with the basic category level. Rosch asserted that categories at the basic level contain the maximum number of shared attributes and the minimal number of distinctive attributes among members. In natural categories, Malt and Smith (1984) found that properties seem to occur in predictable clusters and that the major groupings allow for divisions into distinct subtypes. These are especially noted at the basic level of categories.

The horizontal dimension relates to the notion of separateness (Rosch, 1978). Using a classical approach to achieve separateness, a set of necessary and defining features is used for category membership, resulting in sharp, distinct boundaries. Prototype theory offers a different approach to achieve separateness. Instead of using boundaries to denote separateness, categories can be defined in terms of clear cases, "defined operationally by people's judgments of goodness of membership in the category" (Rosch, 1978, p. 317). The result is an internal structure that has "fuzzy," indistinct boundaries.

Members of a category are heterogeneous. One member may be a better example of its category than others. For example, most people would likely consider an apple as a typical fruit, rather than a tomato, even though both fall within the same category (Rosch & Mervis, 1975). Categories tend to be organized around typicality. Typicality is related to property overlap between category members or their superordinate. Typical category members will have a higher family resemblance score. Malt and Smith define family resemblance score for a category member as "a weighted sum of the properties it possesses, where the weight for each property is determined by the number of category members that possess it" (1984, p. 251). For example, a robin has many properties that are shared by many other birds (has a beak, can fly, has feathers, etc.), whereas a penguin has much fewer shared properties. Therefore, a robin will have a higher family resemblance score than a penguin. Rosch and Mervis (1975) asserted that family resemblance can be considered as the structural basis for prototype formation. There are mathematical formulas that can determine a threshold criterion based on matching features, so that those above it will be included in a particular category while those below it will be excluded (Hampton, 1995). Thus, the formation of categories reflects the degree of similarity or family resemblance among common and distinctive features (Rosch, 1975; Tversky, 1977).

Sternberg and Horvath (1995) proposed the use of a prototype to examine teaching expertise. They conceptualized teaching expertise as a natural category organized around the similarities among expert teachers and represented by the typical exemplar, or the prototype of expert teacher. Their prototype of an expert teacher contained three features: knowledge, efficiency, and insight. Expert teachers possess a great fund of information, use this content knowledge in more efficient ways in designing teaching methods with less effort, and are more creative and insightful in solving problems than novice teachers. The present study attempts to extend this research by focusing on student variables for successful outcomes in academic learning in middle school.

Summary of Literature Review

Although there are various definitions of executive functions, it is commonly believed that executive function is a psychological construct that can best be described as an umbrella term comprised of a number of separate yet interrelated control processes that are activated during novel activities in which new solutions are needed or when initial learning is taking place. Included under this umbrella construct are such processes as planning, higher-order organizational strategies, initiation, inhibition and delay of responding, working memory, goal selection, self-monitoring, self-evaluation, and self-correcting. In general, executive function processes are responsible for directing and managing internally motivated, goal-oriented, and purposeful behavior. These control processes operate within the cognitive, behavioral, and emotional domains. Executive function capacities develop over a long period of time during childhood and adolescence, with most skills maturing at age 12. However, there are variations in the rate of development in the normal population.

The educational challenges of middle school require good executive function capacities to manage and produce successful academic outcomes. Students are expected to apply basic skills learned in elementary school to acquire new knowledge or expand current knowledge in content areas that become increasing more complex and abstract. There are greater demands for selective attention, extended mental effort, higher-order problem solving, increased control over information processing, and need for coordinating multiple processes simultaneously during academic tasks. Research studies have linked metacognitive and self-regulatory executive function capacities to academic achievement. The current study examined executive function capacities in middle school students using a prototype approach. Prototypical successful and unsuccessful students were created using teacher perceptions of the typical executive function attributes that members of each category had in common.

Research Question and Hypothesis

Do middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically successful differ significantly from these same middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically unsuccessful?

It is hypothesized that the unsuccessful students' prototypical profile will reflect significantly more executive function impairment than the prototypical profile of successful students.

Chapter 3

Method

Overview of Research Design

The present comparative study attempted to create a prototype of a successful student based on characteristics judged to be important by teachers for academic learning in middle school. This study also attempted to create a prototype of an unsuccessful student based on characteristics judged by teachers to be obstacles to learning in middle school. Archival data was used that consisted of questionnaires that were collected from an in-service workshop presented to teachers at four large urban middle schools. The purpose of the workshop was informational in nature and focused on expanding teachers' knowledge about students' characteristics that are necessary for academic learning in middle school.

The concept of academic competence was viewed as a category structured by the similarities of successful middle school students to one another in discrete behavioral manifestations of executive functions and organized around a prototype that represents the central tendency of all the exemplars in the category of successful student, as operationally defined by the BRIEF items. A second prototype was constructed in a similar manner for the unsuccessful student category. To examine differences between these two prototypical categories, *t* tests were conducted using T scores from the BRIEF domains. It was postulated that there would be a significant difference between the successful learner prototype and the unsuccessful learner prototype. It was expected that the successful student prototype would possess fewer executive function impairments than the unsuccessful student prototype.

Procedures

At the beginning of the workshop, the teachers were requested to complete two Behavior Rating Inventory of Executive Function (BRIEF) (Gioia, Isquith, Guy, & Kenworthy, 2000) forms. They were asked to recall, from their professional teaching experience, a student who demonstrated the characteristics that are necessary for educational success in middle school. With that student in mind, they completed the BRIEF form. After they completed the first form, the teachers were asked to recall, from their professional teaching experience, a student who had failed to demonstrate the characteristics that are necessary for educational success in middle school. With that student in mind, they completed the second BRIEF form.

The following instructions were given:

> I would like you to think about one of your successful students who had earned an A or a B in a course that you taught either in the current year or in the past. With that student in mind, I would like you to complete a questionnaire. Please complete the label that is located on the top portion of the front page, specifying the gender and age of the student, the course that was taught, and whether the student was a regular education student or a special education student. Do not write the student's name or the birth date of the student on the form. Also, do not write your name on the questionnaire form.

After completing the first questionnaire, the following instructions were given:

> I would like you to think about one of your students who had failed a course that you had taught, either in the current year or in the past. With that student in mind,

I would like you to complete a questionnaire. Please complete the label that is located on the top portion of the front page, specifying the gender and age of the student, the course that was taught, and whether the student was a regular education student or a special education student. Do not write the student's name or the birth date of the student on the form. Also, do not write your name on the questionnaire form.

Measures

The Behavior Rating Inventory of Executive Function (BRIEF) Teacher form was used to assess executive functions. The BRIEF is an 86-item standardized questionnaire that takes approximately 15 minutes to complete (Gioia, Isquith, Guy, & Kenworthy, 2000). Each item response reflects the rater's perception of everyday behavioral manifestations of executive functions in children (Gioia et al., 2000). Executive functions were measured based on teachers' 3-point ratings of the frequency of target behaviors. Items are scored as: 1 = Never, 2 = Sometimes, and 3 = Often (Gioia et al., 2000). The item scores are organized along specific executive function domains (Gioia et al., 2000). These raw scores are converted to T scores, with corresponding percentiles, as an indication of the child's level of executive functioning (Gioia et al., 2000). A T score with a mean of 50 and a standard deviation of 10 reflects an individual's score in relation to the scores of others in the standardization sample (Gioia et al., 2000). A T score of 65 is suggestive of being clinically significant (Gioia et al., 2000). The higher the score above the cutoff of 65, the greater the dysfunction in specific executive functioning (Gioia et al., 2000). BRIEF scores are standardized according to age and gender (Gioia et al., 2000). The T scores were obtained from the Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor scales.

Below is a list of each subdomain of the executive functions, along with behavioral definitions and examples of the types of dysfunction (Gioia et al., 2000):

1. Inhibit: Delay a response long enough to consider options; impulse control; end the activity at the appropriate time.

   Dysfunction: The student blurts out answers or acts silly in class. An adolescent acts impulsively when engaged in a dispute with another student and hits him without thinking of the consequences of his behavior.

2. Shift: Transitions from one situation, activity, or aspect of a task to another smoothly; problem solves flexibly.

   Dysfunction: The student uses the same approach over and over again, even though it does not solve the problem. The child continues to act in the same manner when the situation requires a change in behavior.

3. Emotional Control: Modulates one's own emotional reactions to situations in an appropriate manner.

   Dysfunction: The child shouts, screams, or hits another child in response to a minor provocation.

4. Initiate: Takes the initiative; solves problems creatively.

   Dysfunction: A student has trouble starting his homework or school project. The student requires teacher's prompts to begin a class assignment. The child has problems generating ideas for a writing assignment.

5. Working Memory: Holding information in mind while manipulating it for some purpose; keep information in memory in order to complete an activity.

   Dysfunction: The student has trouble completing multidigit calculations or forgets the first part of a three-part explanation of a concept during lecture. When writing a paragraph, the child loses one's train of thought.

6. Plan: Develop goals and establish strategic objectives to meet the goals; keep daily schedule or calendar of events; work at an appropriate pace to accomplish a task.

   Dysfunction: The student underestimates the time needed for a project and misses the deadline for completion.

7. Organize: Organize materials; work in an orderly way; use a systematic approach when problem solving.

   Dysfunction: The student arrives to class without textbooks, paper, and pencils. The student loses important notes and homework assignments. In solving a problem, the student works hastily and misses relevant details.

8. Monitor: Periodically checks one's own work; self-monitors activities to ensure goal attainment; aware of other's reaction to one's behavior; use self-questioning or self-assessment strategies to direct and guide thinking processes.

   Dysfunction: The student makes careless mistakes on a math test (i.e., neglects to read the operational sign and performs addition instead of subtraction). The student is unaware of classmates' reactions when causing a disruption in class.

The BRIEF possesses strong psychometric properties for internal consistency and test-retest reliability (Gioia et al., 2000). Factor analyses supported a two-factor model of executive function showing high correlations with other instruments that measure similar constructs and lower correlations where associations are not expected (Gioia et al., 2000). Factor 1, the metacognitive problem-solving factor, comprises the subdomains of Initiate, Working Memory, Plan-Organize, Organization of Materials, and Monitor (Gioia et al., 2000). Factor 2, a behavior regulation factor, includes the subdomains of Inhibit, Shift, and Emotional Control (Gioia et al., 2000). The BRIEF was examined in comparison to other behavior rating scales to establish convergent validity and discriminate validity (Gioia et al., 2000). In relation to the Teacher Report Form (TRF; Achenbach, 1991b) and the Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1992), strong correlations were established along the two-factor structures of the BRIEF with the metacognitive problem-solving factor correlating strongly with the Attention scale of the TRF and BASC and the behavior regulation factor with the BASC Aggression scale (Gioia et al., 2000).

Contents for the Prototypes

The formation of the prototype categories successful student and unsuccessful student was structured by discrete executive function behaviors, operationally defined as the BRIEF descriptive statements reported by the teachers. The following are samples of behavioral statements and their corresponding domains:

Domain	Behavioral Statement
Inhibit	Does not think before doing
	Is impulsive
	Gets in trouble if not supervised by an adult
Shift	Acts upset by a change in plans
	Gets stuck on one topic or activity
	Resists or has trouble accepting a different way to solve a problem with schoolwork, friends, chores, etc.
Emotional Control	Overreacts to small problems
	Mood changes frequently
	Has explosive, angry outbursts
Initiate	Is not a self-starter
	Needs to be told to begin a task even when willing
	Has trouble thinking of a different way to solve a problem when stuck
Working Memory	Has a short attention span
	Has trouble with chores or tasks that have more than one step
	Has trouble remembering things, even for a few minutes

Domain	Behavioral Statement
Plan/Organize	Has good ideas but does not get job done (lacks follow-through)
	Forgets to hand in homework, even when completed
	Underestimates time needed to finish tasks
Organization of Materials	Cannot find things in room or school desk
	Leaves a trail of belongings wherever he/she goes
	Has a messy desk
Monitor	Does not check work for mistakes
	Leaves work incomplete
	Does not notice when his/her behavior causes negative reactions

Chapter 4

Results

This chapter will present the data analyses of the teacher BRIEF ratings of prototypical successful and unsuccessful middle school students, including statistical tests of significance using *t* tests, intercorrelations for teachers' ratings, and cross-tabulations comparing prototypical teacher ratings of successful and unsuccessful students distributed by level of clinical significance of BRIEF scale T scores. Prototypical BRIEF scale executive function score profiles of successful and unsuccessful students will be constructed using the central tendency, i.e., the mean T score, of the cases in each group. The successful and unsuccessful student profiles reflect teacher perceptions of the typical executive function attributes shared by members of each group.

Demographic Data

The study was conducted using archival data consisting of BRIEF scale ratings of prototypical successful and unsuccessful students provided by middle school teachers during four workshops conducted at separate locations within a large urban school district. There were 113 teachers who attended the workshops, but 50 teachers chose not to complete the BRIEF forms. Therefore, the size of the sample was reduced to 63 teachers. Demographic information for the teachers was limited to information about subject taught in middle school and the hypothetical demographic characteristics of the prototypical students being rated by each workshop attendee who chose to participate in the prototypical BRIEF rating exercise. Each teacher completed two BRIEF forms: one based on their perceptions of the behavior of a successful student and another based on their perceptions of the behavior of an unsuccessful student. Table 1 shows the demographic characteristics provided by the teachers for their prototypical successful/unsuccessful student pairs. Table 2 shows the frequency distribution of the subjects taught by the teachers who provided the prototypical ratings. All teachers were asked to provide BRIEF ratings based on their recollection of the behavior of a successful and an unsuccessful student that they had taught recently in their subject area.

Table 1a

Frequency Table of Demographic Characteristics of Prototypical Students

	Frequency	Percent
Gender		
Female	35	55.6
Male	28	44.4
Total	63	100.0
Educational program		
Special education	9	14.3
Regular education	54	85.7
Total	63	100.0

Table 1b

Frequency Table of Demographic Characteristics of Prototypical Students (cont.)

	Frequency	Percent
Age		
10	2	3.2
11	8	12.7
12	20	31.7
13	17	27.0
14	15	23.8
15	1	1.6
Total	63	100.0
Grade		
5	6	9.5
6	12	19.0
7	15	23.8
8	30	47.6
Total	63	100.0

Table 2

Frequency Table of Subjects Taught by the Teachers Who Provided the Prototypical Ratings

Subject	Frequency	Percent
Math	20	31.7
Reading	22	34.9
Science	7	11.1
Social Studies	3	4.8
Computer Sciences	2	3.2
Music	2	3.2
Art	1	1.6
All Subjects	5	7.9
ESL	1	1.6
Total	63	100.0

Relationship Between Successful Student and Unsuccessful Student Prototypes

The differences between BRIEF scale mean T scores derived from teacher ratings of prototypical successful and unsuccessful students were tested for statistical significance using *t* tests. Table 3 summarizes the results of the tests and the Figure shows the mean score profiles of the prototypical successful and unsuccessful students. As shown in Table 3, the *t* test results for each BRIEF scale are all highly significant and all conform to what would be expected in terms of successful and unsuccessful student prototypes. The differences between middle school teachers' prototypical ratings of successful and unsuccessful students were both statistically significant and very large; scale T score differences between these two groups ranged from 2.5 to 3 standard deviations in magnitude. These results are in support of the research hypothesis. Teachers' prototypical ratings indicated that, on average, teacher perceptions of the behavior of unsuccessful students reflect statistically significant, clinically relevant executive function impairments, while teacher perceptions of the behavior of successful students reflect no specific executive function difficulties. The significant impairment of unsuccessful students was reflected in the teachers' prototypical ratings across all eight BRIEF domains: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor.

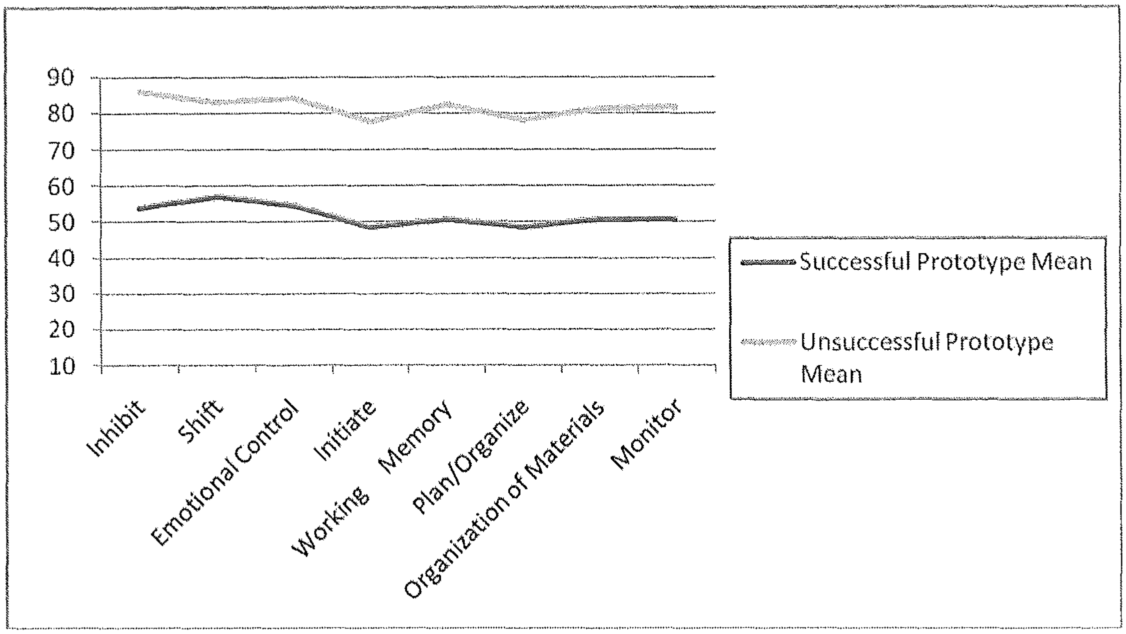
Table 3

BRIEF Scale Mean Scores, Standard Deviations, and t *Test Results for the Comparisons of Teacher Ratings of Prototypical Successful and Unsuccessful Students*

	Successful Student Prototype		Unsuccessful Student Prototype		*t* test results ($df = 63$)		
BRIEF Scale	Mean	*SD*	Mean	*SD*	*t*	Significance Level	*d*
Inhibit	53.92	14.43	85.94	16.23	-10.62	0.000	-1.34
Shift	57.03	13.07	82.94	19.67	-8.66	0.000	-1.09
Emotional Control	54.43	12.70	84.14	17.81	-11.17	0.000	-1.40
Initiate	48.43	6.69	77.60	11.15	-18.54	0.000	-2.34
Working Memory	50.49	9.40	82.10	15.48	-13.76	0.000	-1.73
Plan/Organize	48.33	6.76	78.10	12.39	-17.39	0.000	-2.19
Organization of Materials	50.60	8.87	81.29	20.84	-10.61	0.000	-1.34
Monitor	50.59	10.18	81.43	12.60	-14.31	0.000	-1.80

Figure

Profile for Successful and Unsuccessful Prototypes



Intercorrelations for Teacher Ratings of Academically Successful and Unsuccessful Students

Table 4 shows the intercorrelations for all BRIEF scale teacher ratings of academically successful students. Statistically significant, relatively strong correlations were found among all of the BRIEF scales, suggesting that the prototypically successful students are not perceived as frequently exhibiting behaviors indicative of executive function difficulties. Correlations ranged from a high of .864 to a low of .334, but the greatest majority of the correlation coefficients were in the stronger ranges, with 18 of the 28 correlations in the *r* >.60 range and 10 of those in the *r* > .70 range. The strongest correlation ($r = .864$) was found between scores on the Inhibit and Monitor scales, while the weakest relationship was found between scores on the Inhibit and Initiate scales. The Emotional Control and Working Memory scales showed the greatest number of extremely strong correlations ($r > .70$) with other scales. Scores on the Emotional Control scale showed the strongest relationship with scores from the Inhibit, Shift, Working Memory, and Monitor scales. Working Memory scale scores were most strongly associated with scores from the Shift, Emotional Control, Initiate, and Plan/Organize scales. The Organization of Materials scale demonstrated a pattern of least strong association with all seven of the other BRIEF scales, with only one correlation in the $r > .60$ range (Organization of Materials with Working Memory).

Table 4

BRIEF Scale and Index Intercorrelations for Teacher Ratings of Academically Successful Students

	Shift	Emotional Control	Initiate	Working Memory	Plan/ Organize	Organization of Materials	Monitor
	r	*r*	*r*	*r*	*r*	*r*	*r*
	p	*p*	*p*	*p*	*p*	*p*	*p*
Inhibit	0.577	0.758	0.334	0.617	0.530	0.586	0.864
	0.000	0.000	0.007	0.000	0.000	0.000	0.000
Shift		0.782	0.656	0.796	0.736	0.553	0.654
		0.000	0.000	0.000	0.000	0.000	0.000
Emotional Control			0.554	0.722	0.660	0.549	0.767
			0.000	0.000	0.000	0.000	0.000
Initiate				0.755	0.744	0.575	0.580
				0.000	0.000	0.000	0.000
Working Memory					0.752	0.653	0.687
					0.000	0.000	0.000
Plan/ Organize						0.572	0.671
						0.000	0.000
Organization of Materials							0.688
							0.000

The intercorrelations for teachers' ratings of academically unsuccessful students are shown in Table 5. Although all of the correlations in Table 5 are statistically significant, the degree of association among BRIEF scales is much more varied for teachers' perceptions of the prototypically unsuccessful student than for the prototypically successful student. Correlations ranged from a high of .841 to a low of .225. Although a similar number of correlations reached the $r > .60$ range (16 of 28) and seven of these reached the $r > .70$ range, as was the case for the successful student prototype analysis, correlations in the $r < .55$ range were more common (11 of 28) in the unsuccessful student analysis. The pattern of correlations among the BRIEF scale score of the prototypically unsuccessful students suggests that teacher's ratings of these students are not as consistent across BRIEF scales as their ratings of prototypically successful students. While teachers' perceived prototypically unsuccessful students as being prone to exhibiting behaviors indicative of executive function difficulties, the number and degree of these difficulties varied to some degree across the eight BRIEF scales.

Similar to the correlations for the successful student prototypes, unsuccessful student prototype ratings reflect the strongest correlation ($r = .841$) between scores on the Inhibit and Monitor scales. The relationships among the three Behavior Regulation scales were also very strong (Inhibit with Emotional Control $r = .775$; Shift with Emotional Control $r = .791$; Shift with Inhibit $r = .687$). As with the successful student ratings, unsuccessful student ratings produced a low correlation between the Inhibit and the Initiate scales, but this weak association was joined by an even weaker association between the Initiate and the Emotional Control scale scores.

One very notable difference between the pattern of correlations for the successful and unsuccessful student prototypes is that while correlations tended to be more varied and a greater number were pulled toward lower levels of association, three of the BRIEF scales demonstrated a pattern of strong correlation with all of the other BRIEF scales. These three scales – Shift, Working Memory, and Plan/Organize – appear to form somewhat of a baseline level around which the scores from the other subtests tend to cluster. Another notable difference in the pattern of correlations for the successful and unsuccessful student prototypes is that three of the BRIEF scales (Inhibit, Emotional Control, and Initiate) demonstrate extremely variable degrees of association with the other BRIEF scales. The correlations between the Inhibit scale and the other seven BRIEF scales ranged from a low of .328 to a high of .841; the correlations of the Emotional Control scale with the other seven BRIEF scales varied from .225 to .791; the correlations of the Initiate scale with the other seven BRIEF scales ranged from .225 to .656.

Table 5

BRIEF Scale and Index Intercorrelations for Teacher Ratings of Academically Unsuccessful Students

	Shift	Emotional Control	Initiate	Working Memory	Plan/ Organize	Organization of Materials	Monitor
	r	*r*	*r*	*r*	*r*	*r*	*r*
	p	*p*	*p*	*p*	*p*	*p*	*p*
Inhibit	0.687	0.775	0.328	0.652	0.512	0.433	0.841
	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Shift		0.791	0.470	0.653	0.704	0.663	0.631
		0.000	0.000	0.000	0.000	0.000	0.000
Emotional Control			0.225	0.460	0.445	0.454	0.632
			0.076	0.000	0.000	0.000	0.000
Initiate				0.611	0.656	0.513	0.483
				0.000	0.000	0.000	0.000
Working Memory					0.784	0.682	0.719
					0.000	0.000	0.000
Plan/ Organize						0.725	0.569
						0.000	0.000
Organization of Materials							0.506
							0.000

The intercorrelations for teachers' ratings of academically successful and academically unsuccessful prototypical students are shown in Table 6. Comparisons between the successful and unsuccessful student prototypes produced no statistically significant correlations. The results reflect zero-order correlations, i.e., they indicate that no consistent associations could be found between teachers' ratings for successful students and teachers' ratings for unsuccessful students among any of the BRIEF scales.

Table 6

BRIEF Scale and Index Intercorrelations for Teacher Ratings of Academically Successful and Unsuccessful Students

	Inhibit	Shift	Emotional Control	Initiate	Working Memory	Plan/ Organize	Organization of Materials	Monitor
	r	*r*	*r*	*r*	*r*	*r*	*r*	*r*
	p	*p*	*p*	*p*	*p*	*p*	*p*	*p*
Inhibit	-0.217	-0.072	-0.002	0.202	0.006	0.114	-0.131	-0.108
	0.088	0.575	0.989	0.113	0.965	0.374	0.305	0.400
Shift		-0.011	0.082	0.168	0.085	0.138	-0.064	-0.084
		0.930	0.524	0.189	0.509	0.280	0.619	0.513
Emotional Control			0.072	0.193	0.101	0.095	-0.006	-0.116
			0.573	0.129	0.429	0.461	0.960	0.367
Initiate				0.087	0.054	0.185	-0.013	0.051
				0.498	0.673	0.146	0.918	0.692
Working Memory					-0.016	0.029	-0.198	-0.148
					0.903	0.824	0.120	0.247
Plan/ Organize						0.088	-0.082	-0.089
						0.492	0.524	0.487
Organization of Materials							-0.036	-0.215
							0.778	0.080
Monitor								-0.118

Frequency Distribution for Successful and Unsuccessful Prototypes

In light of the pattern of zero-order correlations obtained from correlating teachers' BRIEF scale ratings of successful and unsuccessful prototypical students, additional descriptive analyses were conducted to provide a clearer picture of the relationship between teachers' BRIEF scale ratings of successful and unsuccessful prototypical students. To prepare the data for this analysis, the BRIEF scale T scores were converted into clinical level scores as follows: 0 = subclinical level T scores below the 90th percentile; 1 = clinically significant elevated T scores in the 90th to 94th percentile range; 2 = clinically significant elevated T scores in the 95th to 98th percentile range; and 3 = clinically significant elevated T score at or above the 99th percentile. These clinical levels were used to classify the BRIEF scale T scores from teachers' ratings of the successful and the unsuccessful student prototypes. Results of these analyses reflected some very consistent patterns of score relationships that deserve interpretation. Results of these analyses indicated that teacher ratings of prototypical successful students most frequently produced T scores in the clinically nonsignificant range (score level 0), while the teacher ratings of prototypical unsuccessful students most frequently produced T-scores in the clinically significant ranges (score levels 1, 2, or 3). Results are discussed for each of the eight BRIEF scales in separate subsections below.

Inhibit scale. For the Inhibit scale, the large majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Inhibit T scores below the clinically significant level in 82.5% of cases (52/63).

Unexpectedly, teachers' successful student ratings produced T scores at the clinically significant levels in the 90th to 94th percentile range for 12.7% of the cases (8/63), and 4.8% (3/63) of the successful students' cases were rated at or above the 99th percentile.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 6.3% (4/63) of the unsuccessful students' ratings produced Inhibit scale T scores below the clinically significant level. The overwhelming majority of unsuccessful student prototypical ratings produced Inhibit scale T scores within the clinically significant levels. Approximately half of the unsuccessful students' ratings produced clinically significant T scores at or above the 99th percentile (52.4%; 33/63). The remainder of the unsuccessful students' ratings produced lower-level but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Inhibit T- scores in the 90th to 94th percentile range for 9.5% of the cases (6/63) and clinically significant T scores in the 95th to the 98th percentile range for 31.7% of the cases (20/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, only one teacher's ratings of both her successful and her unsuccessful prototype students produced Inhibit scale T scores below the 90th percentile. Of the 11 teachers whose ratings of their successful prototypes produced Inhibit T scores in the clinical ranges, three of these teachers' ratings of their unsuccessful students paradoxically produced Inhibit T scores below the 90th percentile. The other eight teachers rated their unsuccessful students as having Inhibit T scores in the clinical ranges. Only one of these eight teachers' ratings produced a higher clinical level rating for their successful student (level 3) than for their unsuccessful student (level 2). For six of the eight teachers whose ratings of both their successful and unsuccessful students produced T scores in the clinically significant range, their ratings always produced a higher clinical level assignment for their unsuccessful students (two rated successful at level 1, but unsuccessful at 2; four rated successful student at 1, but unsuccessful student at 3). One teacher's ratings of both successful and unsuccessful prototypes produced an Inhibit T score at level 3 (at or above the 99th percentile).

Table 7

Comparison of BRIEF Inhibit Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	1	6	17	28
90th to 94th percentile	2	0	2	4
95th to 98th percentile	0	0	0	0
≥ 99th percentile	1	0	1	1

Shift scale. For the Shift scale, the majority of comparisons of teachers' ratings of successful and unsuccessful prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Shift T scores below the clinically significant level in 73.0% of the cases (46/63). Unexpectedly, teachers' successful student ratings produced T-scores at the clinically significant levels in the 90^{th} to 94^{th} percentile range for 7.9% of the cases (5/63), 12.7% of the successful student cases (8/63) were rated in the 95^{th} to 98^{th} percentile range, and 6.3 percent (4/63) of the successful student cases were rated at or above the 99^{th} percentile.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 12.7% (8/63) of the unsuccessful students' ratings produced Shift scale T scores below the clinically significant level. The overwhelming majority of unsuccessful student prototypical ratings produced Shift scale T scores within the clinically significant levels. Teachers' ratings of prototypical unsuccessful students produced Shift T scores at or above the 99^{th} percentile for 41.3% of the cases (26/63), 20.6% (13/63) of the unsuccessful student cases were rated in the 90^{th} to 94^{th} percentile range, and 25.4% (16/63) of the unsuccessful student cases were rated in the 95^{th} to 98^{th} percentile range.

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, seven teachers' ratings of both their successful and her unsuccessful prototype students produced Shift T scores below the 90^{th} percentile. Of the 17 teachers whose ratings of their successful prototypes produced Shift T scores in the clinical ranges, six of these teachers' ratings produced higher clinical ratings for their successful student (five rated successful at level 2, but one unsuccessful at level 0 and four unsuccessful at level 1; one rated successful at level 3, but unsuccessful at level 2) than their unsuccessful student. For the 11 remaining, one teacher's ratings of both her successful and unsuccessful prototypes produced a Shift T score at level 1, two teachers' ratings of both their successful and unsuccessful prototypes produced a Shift T score at level 2, and three teachers' ratings of both her successful and unsuccessful prototypes produced a Shift T score at level 3 (at or above the 99th percentile). The other five teachers' ratings produced Shift T scores at a higher clinical level for their unsuccessful students than for their successful students (two rated successful at level 1, but unsuccessful at level 2; two rated successful at level 1, but unsuccessful at level 3; and one rated successful at level 2, but unsuccessful at level 3).

Table 8

Comparison of BRIEF Shift Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	7	8	11	20
90th to 94th percentile	0	1	2	2
95th to 98th percentile	1	4	2	1
≥ 99th percentile	0	0	1	3

Emotional Control scale. For the Emotional Control scores, the large majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Emotional Control T scores below the clinically significant level in 84.1% (53/63) of the cases. Unexpectedly, teacher's successful ratings produced T scores at the clinically significant levels in the 90th to 94th percentile range for 6.3% (4/63) of the cases; 3.2% (2/63) of the successful students cases were rated in the 95th to 98th percentile range; and 6.3% (4/63) of the successful student cases were rated at or above the 99th percentile.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 15.9% (10/63) of the unsuccessful students' ratings produced Emotional Control T scores below the clinically significant range. The majority of unsuccessful student prototypical ratings produced Emotional Control T scores within the clinically significant levels. Approximately half of the unsuccessful students' ratings produced clinically significant Emotional Control T scores at or above the 99th percentile (50.8%; 32/63). The remainder of the unsuccessful students ratings produced lower-level but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Emotional Control T scores in the 90th to 94th percentile range for 15.9% of the cases (10/63) and clinically significant T scores in the 95th to the 98th percentile range for 17.5% of the cases (11/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, nine teachers' ratings of both their successful and their unsuccessful prototype students produced Emotional Control T scores below the 90th percentile. Of the 10 teachers whose ratings of their successful student prototypes produced T scores in the clinical ranges, one teacher's rating of her unsuccessful student paradoxically produced an Emotional Control T score below the 90th percentile and her rating of her successful student produced a T score at or above the 99th percentile. The other nine teachers rated their unsuccessful students as having Emotional Control T scores in the clinical ranges. One teacher's ratings produced a higher clinical level rating for her successful student (level 2) than for her unsuccessful student (level 1). One teacher's ratings of both successful and unsuccessful prototypes produced an Emotional Control T score at level 2 and three teachers' ratings of both successful and unsuccessful prototypes produced T scores at level 3 (at or above the 99th percentile). Four teachers' ratings produced higher clinical level ratings for their unsuccessful students (level 3) than for their successful students (level 1).

Table 9

Comparison of BRIEF Emotional Control Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	9	9	10	25
90th to 94th percentile	0	0	0	4
95th to 98th percentile	0	1	1	0
≥ 99th percentile	1	0	0	3

Initiate scale. For the Initiate scale, the overwhelming majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teachers' ratings of prototypical successful students produced Initiate T scores below the clinically significant level in 98.4% of the cases (62/63). Only one teacher's successful student rating (1.6%; 1/63) produced an Initiate T score at the clinical significant level in the 90^{th} to 94^{th} percentile range.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 7.9% (5/63) of the unsuccessful student ratings produced an Initiate T score below the clinically significant level. The majority of unsuccessful student prototypical ratings produced Initiate T scores within the clinically significant levels. Approximately one third of the unsuccessful students' ratings produced clinically significant T scores at or above the 99^{th} percentile (34.9%; 22/63). The remainder of the unsuccessful students' ratings produced lower, but clinically significant T scores. Unsuccessful students' prototypical ratings produced clinically significant Initiate T scores in the 90^{th} to 94^{th} percentile range for 22.2% of the cases (14/63) and clinically significant T scores in the 95^{th} to 98^{th} percentile range for 34.9% of the cases (22/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, five teachers' ratings of both their successful and their unsuccessful prototype students produced Initiate T scores below the 90^{th} percentile. One teacher whose rating of her successful student produced a T score at the clinically significant level (level 1) produced a higher clinical assignment for her unsuccessful student (level 3).

Table 10

Comparison of BRIEF Initiate Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	5	14	22	21
90th to 94th percentile	0	0	0	1
95th to 98th percentile	0	0	0	0
≥ 99th percentile	0	0	0	0

Working Memory scale. For the Working Memory scale, the majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conform to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Working Memory T scores below the clinically significant level in 90.5% of the cases (57/63). Unexpectedly, teacher's successful student ratings produced T scores at clinically significant levels in the 90th to 94th percentile range for 6.3% of the cases (4/63); 1.6% (1/63) of the successful student cases were rated at the 95th to 98th percentile range; and 1.6% (1/63) of the successful student cases were rated at or above the 99th percentile.

Teacher ratings of the unsuccessful student prototype generally showed predictable results. Only 9.5% (6/63) of the unsuccessful student ratings produced Working Memory T scores below the clinically significant level. The majority of unsuccessful student prototypical ratings produced Working Memory T scores within the clinically significant levels. Approximately half of the unsuccessful student ratings produced clinically significant T scores at or above the 99^{th} percentile (50.8%; 32/63). The remainder of the unsuccessful students' ratings produced lower but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Working Memory T scores in the 90^{th} to 94^{th} percentile range for 22.2% of the cases (14/63) and clinically significant T scores in the 95^{th} to 98^{th} percentile range for 17.5% of the cases (11/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, six teachers' ratings of both their successful and their unsuccessful prototype students produced a Working Memory scale T score below the 90^{th} percentile. Of the six other teachers whose ratings of their successful prototypes produced Working Memory T-scores in the clinical ranges, one of these teachers' ratings produced a higher clinical level rating for her successful student (level 2) than for her unsuccessful student (level 1). One teacher's ratings of both successful and unsuccessful prototypes produced a Working Memory T score at level 3 (at or above the 99^{th} percentile). Another teacher's rating of both successful and unsuccessful prototypes produced a Working Memory T score at level 1. For the other teachers whose ratings of both their successful and unsuccessful students produced T scores in the clinically significant range, their ratings always produced a higher clinical level assignment for their unsuccessful students (one rated successful at level 1, but unsuccessful at level 2; two rated successful at level 1, but unsuccessful at level 3).

Table 11

Comparison of BRIEF Working Memory Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	6	12	10	29
90th to 94th percentile	0	1	1	2
95th to 98th percentile	0	1	0	0
≥ 99th percentile	0	0	0	1

Plan/Organize scale. For the Plan/Organize scale, the large majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Plan/Organize T scores below the clinically significant level in 95.2% of the cases (60/63). Unexpectedly, teachers successful student ratings produced T scores at the clinically significant levels in the 90th to 94th percentile range for 4.8% of the cases (3/63).

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 6.3% (4/63) of the unsuccessful student ratings produced Plan/Organize T scores below the clinically significant level. The overwhelming majority of unsuccessful student prototypical ratings produced Plan/Organize T scores within the clinically significant ranges. Approximately one third of the unsuccessful students' ratings produced clinically significant T scores at or above the 99^{th} percentile (31.7%; 20/63). The remainder of the unsuccessful students' ratings produced lower-level but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Plan/Organize T scores in the 90^{th} to 94^{th} percentile range for 20.6% of the cases (13/63) and clinically significant T scores in the 95^{th} to 98^{th} percentile range for 41.3% of the cases (26/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, four teachers' ratings of both their successful and their unsuccessful prototype students produced Plan/Organize T score below the 90^{th} percentile. Of the three teachers whose ratings of their successful prototypes produced Plan/Organize T scores in the clinical ranges, their ratings always produced a higher clinical level assignment for their unsuccessful students (two rated successful at level 1, but unsuccessful at level 2; one rated successful at level 1, but unsuccessful at level 3).

Table 12

Comparison of BRIEF Plan/Organize Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	4	13	24	19
90th to 94th percentile	0	0	2	1
95th to 98th percentile	0	0	0	0
≥ 99th percentile	0	0	0	0

Organization of Materials scale. For the Organization of Materials scale, the large majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Organization of Materials T scores below the clinically significant level in 92.1% of the cases (58/63). Unexpectedly, teacher's successful student ratings produced T scores at the clinically significant levels in the 90th to 94th percentile range for 1.6% of the cases (1/63), and 6.3% of the successful student cases (4/63) were rated at the 95th to 98th percentile range.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Analysis showed that 23.8% (15/63) of the unsuccessful student ratings produced Organization of Materials T scores below the clinically significant level. The majority of unsuccessful student prototypical ratings produced Organization of Materials T scores within the clinically significant range. Approximately 40% of the unsuccessful students' ratings produced clinically significant T scores at or above the 99^{th} percentile (42.9%; 27/63). The remainder of the unsuccessful students' ratings produced lower-level but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Organization of Materials T scores in the 90^{th} to 94^{th} percentile range for 7.9% of the cases (5/63) and clinically significant T scores in the 95^{th} to 98^{th} percentile range for 25.4% of the cases (16/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, 14 teachers' ratings of both their successful and their unsuccessful prototype students produced Organization of Materials T scores below the 90^{th} percentile. Of the five teachers whose ratings of their successful prototype produced Organization of Materials T scores in the clinical ranges, one of these teachers' ratings of her unsuccessful students paradoxically produced Organization of Materials T score below the 90^{th} percentile. Two teachers' ratings of both successful and unsuccessful prototypes produced Organization of Materials T scores at level 2. For the other two teachers whose ratings of both their successful and unsuccessful students produced T scores in the clinically significant range, their ratings produced a higher clinical level assignment for their unsuccessful students (two rated successful at level 2, but unsuccessful at level 3).

Table 13

Comparison of BRIEF Organization of Materials Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	14	5	14	25
90th to 94th percentile	1	0	0	0
95th to 98th percentile	0	0	2	2
≥ 99th percentile	0	0	0	0

Monitor scale. For the Monitor scale, the large majority of comparisons of teachers' ratings of successful and unsuccessful student prototypes conformed to the expected nonclinical versus clinical pattern. Teacher ratings of prototypical successful students produced Monitor T scores below the clinically significant level in 92.1% of the cases (58/63). Unexpectedly, teacher's successful student ratings produced T scores at the clinically significant levels in the 90th to 94th percentile range for 1.6% of the cases (1/63), and 6.3% (4/63) of the successful students were rated at the 95th to 98th percentile range.

Teacher ratings of the unsuccessful student prototype also generally showed predictable results. Only 4.8% (3/63) of the unsuccessful student ratings produced

Monitor Scale T scores below the clinically significant level. The overwhelming majority of unsuccessful student prototypical ratings produced Monitor T scores within the clinically significant range. Approximately one third of the unsuccessful students' ratings produced clinically significant T scores at or above the 99th percentile (31.7%; 20/63). The remainder of the unsuccessful students' ratings produced lower-level but clinically significant T scores. Unsuccessful students' prototype ratings produced clinically significant Monitor T scores in the 90th to 94th percentile range for 22.2% of the cases (14/63) and clinically significant t scores in the 95th to 98th percentile range for 41.3% of the cases (26/63).

Comparing the teachers' successful prototype ratings with their unsuccessful prototype ratings, only two teachers' ratings of both their successful and their unsuccessful prototype students produced Monitor T scores below the 90th percentile. Of the five teachers whose ratings of their successful prototype produced Monitor T scores in the clinical ranges, one of these teachers' ratings of her unsuccessful student unexpectedly produced Monitor T score below the 90th percentile. The other four teachers rated their unsuccessful students as having Monitor T scores in the clinical ranges. For three of the five teachers whose ratings of both their successful and unsuccessful students produced T scores in the clinically significant range, their ratings produced a higher clinical assignment for their unsuccessful students (one rated successful at level 1, but unsuccessful at level 2; two rated successful at level 2, but unsuccessful at level 3). One teacher's ratings of both successful and unsuccessful prototypes produced a Monitor T score at level 2.

Table 14

Comparison of BRIEF Monitor Scale Scores at Clinically Significant Levels for Teacher Ratings of Successful and Unsuccessful Prototypical Students

	Unsuccessful Prototype			
Successful Prototype	< 90th Percentile	90th to 94th Percentile	95th to 98th Percentile	≥ 99th Percentile
< 90th percentile	2	14	24	18
90th to 94th percentile	0	0	1	0
95th to 98th percentile	1	0	1	2
≥ 99th percentile	0	0	0	0

Summary of Clinical Level Analyses

Table 15 provides a summary of the results of the clinical level analyses completed for each BRIEF scale. Teachers' ratings of prototypical students produced T scores that were highly consistent with the expected pattern of results. For the Inhibit, Initiate, Plan/Organize, and Monitor scales, teachers' ratings of their unsuccessful prototypical student produced T scores of greater clinical significance than their ratings of the successful prototype students more than 90% of the time. Teacher ratings for the Working Memory scale produced this same pattern of expected results 86% of the time. The Shift, Emotional Control, and Organization of Materials scales produced the expected pattern more than 70% of the time. Most of these consistent ratings conformed to the standard expected pattern, wherein successful prototype ratings produced T scores in the nonclinical range and unsuccessful student prototype ratings produced T scores in the clinical range. For each scale, a small portion of the sample produced an elevated expected score pattern where both successful and unsuccessful teacher ratings produced clinically significant T scores, but the unsuccessful student prototype was always rated as more clinically significant than the successful student prototype. Elevated rating percentages ranged from 2% for the Initiate scale to 9% for the Inhibit scale.

Table 15a

Summary of Clinical Level Analyses

	Inhibit		Shift		Emotional Control		Initiate		Working Memory		Plan/ Organize		Organization of Material		Monitor	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Expected score patterns																
Standard	51	81	39	62	44	70	57	91	51	81	56	89	44	70	56	89
S = 0, U = 1,2 or 3																
Elevated	6	9	5	8	4	6	1	2	3	5	3	5	2	3	3	5
S and U = 1, 2, or 3 with S < U																
Total Expected	57	90	44	70	53	76	58	93	5	86	59	94	46	73	59	94
Nondiscerning patterns																
Positive bias	1	2	7	12	9	15	5	7	6	9	4	6	14	22	2	3
S and U = 0																
Negative bias	1	2	6	9	4	6	0	0	2	3	0	0	2	3	1	2
S and U = 1, 2, or 3																
Total nondiscerning	2	4	13	21	13	21	5	7	8	12	4	6	16	25	3	5

Table 15b

Summary of Clinical Level Analyses (cont.)

	Inhibit		Shift		Emotional Control		Initiate		Working Memory		Plan/ Organize		Organization of Material		Monitor	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Unexpected pattern																
Reverse discerning S > U	4	6	6	9	2	3	0	0	1	2	0	0	1	2	1	2

Very few of the teacher ratings produced the unexpected pattern of reverse discerning scores, i.e., ratings where the successful student prototype ratings produced a T score in the clinically significant range, while the unsuccessful student prototype ratings produced a T score that was less clinically significant or in the clinically nonsignificant range. No teacher provided ratings that were in total contradiction of the expected results for the Initiate and Plan/Organize scales. Teacher ratings producing a successful prototype T score in the clinical range while their unsuccessful prototype ratings produced a T score in the nonclinical range or less significant clinical range occurred only once (2%) for the Working Memory, Organization of Materials, and Monitor scales and only twice (3%) for the Emotional Control scale. Contradictory results occurred only slightly more often for the Inhibit scale (four teacher ratings, 6%) and the Shift scale (six teacher ratings, 9%).

A small number of teacher ratings produced nondiscerning score patterns. Some teachers' ratings produced a positive bias pattern in which both the successful and the unsuccessful student prototypes ratings produced T scores in the clinically nonsignificant range. Occurrence of the positive bias score pattern ranged from 2% for the Inhibit scale to 22% for the Organization of Materials scale. A few teachers' ratings produced a negative bias pattern in which both the successful and the unsuccessful student prototypes ratings produced T scores in the same clinically significant range. Occurrence of the negative bias score pattern ranged from 0% for the Initiate scale to 9% for the Shift scale.

Summary of Results

Overall, results of the analyses indicate that teachers' ratings of the executive function capacities of prototypical successful and unsuccessful students produced BRIEF Scale T score patterns consistent with the hypothesis that successful students exhibit very few executive function difficulties, while unsuccessful students exhibit executive function difficulties in the clinically significant range. Teacher ratings most consistently produced the expected pattern of T score results for the Inhibit, Initiate, Plan/Organize, Monitor, and Working Memory scales. Teachers were least likely to see large differences in successful and unsuccessful students in behaviors that reflected the executive function capacities of Shift, Emotional Control, and Organization of Materials.

Chapter 5

Discussion

The purpose of the research study was to address the relationship between underachievement and executive functions at the middle school level by comparing successful students with unsuccessful students using a prototype rating methodology. The prototypes were created using teachers' ratings on a behavior rating scale (Behavior Rating Inventory of Executive Function; Gioia et al., 2000) that measures behavioral manifestation of executive function difficulties in children and adolescents. Two prototypes were formed, the successful student and the unsuccessful student, using the T score means of the eight scales that make up the rating form.

Research Question

The research question addressed whether middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically successful differ significantly from these same middle school teachers' prototypical ratings of the executive function capacities of middle school students who are academically unsuccessful. Statistically significant findings were obtained, suggesting that teachers' perceptions of prototypical successful students differed from these same teachers' perceptions of prototypical unsuccessful students in their behavioral manifestation of executive function capacities in all eight domains assessed by the BRIEF.

Discussion of Findings

The results of this study are consistent with prior research that links executive function with achievement. Defining executive function varies depending on the theoretical model or discipline. However, researchers commonly agree that executive function is an overarching term for a broad collection of directive cognitive processes that are responsible for intentional, goal-oriented, self-directed, and purposeful behavior. These processes cue and direct self-regulation capacities including, but not limited to: working memory, inhibition and delay of responding, planning, organization, anticipatory/preparedness to act, goal selecting, monitoring, and use of feedback. Although executive function capacities have distinct roles, they form an interrelated network of directive processes that control and regulate cognition, emotion, and behavior. Executive functions become activated when situations place demands on individuals that exceed automatic or well-established routines, when specific demands for action or production are made, and when new solutions to problems are required. The demands of middle school require well-developed executive function capacities in order to deal with increasingly complex academic tasks and teachers' expectations for increased student autonomy and self-sufficiency (Borkowski & Burke, 1999).

The current study examined teachers' perceptions about executive function as an important attribute for success in middle school course work using a prototype rating methodology. The concepts of the successful student and the unsuccessful student were defined as categories created by teachers' judgments of important characteristics that impact achievement in middle school. Drawing from research, these categories capture the central tendency or average of all cases and are defined in terms of the most representative or "ideal" exemplar that contains the characteristic shared features that members of respective categories have in common (Rosch, 1975). The results of the present study revealed that teachers' perceptions of prototypical successful and unsuccessful students differed significantly in their behavioral manifestations of executive function in all domains: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The prototype of the unsuccessful student revealed significant impairment both in areas of metacognition and behavioral regulation, whereas the successful student prototype did not show significant executive function deficits in any area.

Initiate. Based on teachers' ratings, the prototypical unsuccessful student exhibits problems with initiation. Initiation problems can manifest as difficulty beginning an assignment or requiring multiple prompts to get homework started. In addition, students with initiation problems may have difficulty generating ideas or problem solving in unique or unconventional ways to overcome roadblocks in pursuit of a goal. These difficulties occur despite having motivation to succeed. In contrast, the prototypical successful student was perceived as a self-starter who displays initiative and creative problem-solving skills to achieve success.

Working Memory. The items of the Working Memory scale involve ratings of attention span, distractibility, lack of persistence in task effort, the need for prompting to stay on task, and forgetting what was to be done as time goes by. It should be noted that the types of behaviors identified as working memory on this scale relate more to persistence of effort over time, rather than the use of mental resources to hold information and solve problems. In the current study, working memory as defined by the

BRIEF Working Memory scale items was highly associated with academic achievement. The unsuccessful student prototype ratings endorsed behaviors that reflect poor working memory, whereas these difficulties were judged to be minimal in the successful student prototype. Working memory is a limited capacity system that functions to simultaneously store and manipulate information in the service of performing a task. Working memory coordinates multiple units of information and selectively attends to relevant details while inhibiting irrelevant information (Baddeley, 2000; Baddeley, 1996; Baddeley, 1986). The results of this study are consistent with other research that links working memory to reading (Daneman & Carpenter, 1983), mathematics (Bull & Scerif, 2001), and writing (Kellogg, 1996; Passerault & Dinet, 2000) skills.

Working memory is essential for complex academic tasks that children encounter in middle school. In the classroom, students must remember multistep directions while carrying them out. During a lecture, they must remember the topic under discussion while connecting it with facts already learned and stored in long-term memory. In mathematics, students must retain the components of a mathematical operation while solving the problem. To comprehend text, students must decode individual words, understand syntax, have knowledge of vocabulary, retain the sequence of words in the sentences, and use contextual cues simultaneously. During the writing process, students must attend to correct punctuation, capitalization, vocabulary, and grammar, while developing ideas and organizing written text for a variety of purposes. Working memory enables one to hold small amounts of information in mind while simultaneously thinking about it, extending it, and modifying or relating it to already learned information. The storage and process of information compete for the limited working memory capacity. Students with good working memory perform better on academic tasks that involve complex mental processes. In contrast, students with weak working memory have more difficulty following multistep directions and listening to lectures while taking notes or making outlines, make frequent errors in calculations, and have difficulty composing coherent and extensive written text.

Plan/Organize, Organization of Materials, and Monitor. Teachers' perceptions of competence, as revealed in the successful student and unsuccessful student prototypes, are consistent with aspects of metacognitive and self-regulation theory. Metacognitive strategies involve planning, monitoring, and evaluation. Planning entails formulating a goal and devising methods to achieve successful outcome. Effective self-management of materials and time-management skills are incorporated within the planning process. Monitoring involves awareness of one's activities toward attaining the goal. It involves focused attention on performance and self-checking for accuracy, as well as evaluation of the effectiveness of cognitive strategies used to produce the intended outcomes and the need for revision.

In the current study, significant differences were revealed between the successful student prototype and the unsuccessful student prototype on ratings for the BRIEF Plan/Organize, Organization of Materials, and Monitor scales. Based on teachers' ratings, unsuccessful students demonstrate difficulties in planning ahead for school assignments, organizing their thoughts and ideas on paper, developing methods for completion of work, keeping track of materials, and monitoring their performance to check for errors and appropriate use of strategies. In contrast, successful students were perceived as being aware of task demands and capable of setting goals and making strategic plans to accomplish the intended outcome through self-management of resources, monitoring and self-evaluation of their performance, and revision of strategies if needed to achieve success.

Inhibit and Emotional Control. Unsuccessful students were found to exhibit significantly more difficulties in executive behavioral regulation than successful students, based on teachers' reports. Students who exhibit poor behavioral regulation tend to be impulsive, act without thinking, have difficulty remaining seated in the classroom, blurt out comments, act out of control, and frequently violate school rules when unsupervised by an adult. In the emotional control domain, unsuccessful students were perceived as having significantly more difficulty in modulating their mood and emotions. They tend to become easily upset, react intensely to minor problems, and are quick to display angry outbursts with little provocation. In contrast, successful students were perceived as significantly better able to control and regulate their emotional responses. In addition, teachers perceived successful students as having significantly better ability than unsuccessful students to delay or inhibit a response in order to review options for thoughtful planning and to avoid or stop inappropriate behaviors that might have adverse consequences.

These results are consistent with previous studies that associate emotional and behavioral control to academic and social competence. Howse, Lange, Farran, and Boyles (2003) found that attentional regulation skills and classroom motivational behaviors contribute to reading achievement in early elementary children. Silvia, Visu-Petra, and Settanni (2007) found a close association between inhibitory control and noncooperative behavior among children. In van der Schoot, Licht, Horsley, and

Sergeant's (2000) study, children with dyslexia exhibited poor ability to inhibit inappropriate responding on executive tasks that tap capacities related to response inhibition, susceptibility to interference from irrelevant information, and planning.

Shift. Teachers perceived unsuccessful students as having significantly more problems than successful students in shifting smoothly from one activity to another or from one response set to another. These ratings are consistent with previous research that link shifting ability to attainments in academic skills in the areas of writing (Hooper, Swartz, Wakely, de Kriuf, & Montgomery, 2002) and mathematics (Bull & Scerif, 2001). It is thought that writing fluency requires flexible shifting between lower-level skills needed in sentence construction and grammar to higher-level skills needed for planning, organizing, and development of ideas. Math fluency requires shifting from automatized arithmetic skills to processing highly abstract numerical concepts that can be applied to various contexts. Shifting ability is an important component for problem solving. Good problem solving requires consideration of alternative strategies and selection of the best strategy with subsequent monitoring and revision based on internal feedback (Levine, 1999). Students who have weak shifting ability tend to become overwhelmed and easily upset when confronted with changes or they may perseverate and persist on using the same strategy over and over again to solve a problem, despite lack of effectiveness.

Self-regulation summary. The attributes judged by teachers in this study that are important to achievement are consistent with Zimmerman's model of self-regulated learning (Zimmerman, 1989; Zimmerman, 1990; Zimmerman & Martinez-Pons, 1990). According to Zimmerman (1989), self-regulated students select strategies that aim to control personal processes, behavior, and learning environments to facilitate academic achievement. Students who set goals and develop strategies to achieve tasks (personal influences) monitor their performance and make adjustments to ensure completion of tasks (behavioral influences) and organize their materials and seek advice from teachers or other adults when encountering obstacles (environmental influences) are more likely to achieve academic success than those students who are more passive in their educational pursuits (Zimmerman, 1989; Zimmerman, 1990).

Executive function capacity interrelationships. The prototype view of competence highlights the interrelationships of the self-regulation executive function capacities for both the successful student and unsuccessful student types. Generally, moderate to moderately strong intercorrelations were reflected in teachers' ratings with the BRIEF scales. It is logical to expect that successful students would have the capacity to regulate their emotions and behaviors so that they can approach tasks in a thoughtful and deliberate manner, use time wisely to organize their materials, maintain concentration while resisting distraction, problem-solve flexibly, and self-monitor their performance to ensure success. Conversely, it would be expected that students with weak executive function capacity would have problems initiating tasks, maintaining effortful control, and mobilizing their resources strategically to achieve positive outcomes.

Not all of the BRIEF scale intercorrelations within each prototype reflected a high degree of consistency in teachers' ratings. For example, a low correlation was found between scores on the Inhibit and Initiate scales for both successful and unsuccessful prototypes. Also, a low correlation was found between Emotional Control and Initiate for the unsuccessful prototype. To some degree, these lower correlations reflect the dissociable nature of executive function, that is, although executive function capacities are interrelated, they remain distinct capacities that can be more or less developed within a single individual.

The results of the correlational analysis comparing the successful and unsuccessful prototype BRIEF scale T scores were somewhat unexpected. It was anticipated that the scores from the two prototypes would be strongly intercorrelated, but in a negative direction, i.e., low scores for the successful student prototypes would coincide with high scores for the unsuccessful prototypes. The actual results produced a pattern of zero-order correlations, suggesting a lack of consistent relationship between the BRIEF scores of the successful and unsuccessful student prototypes. To better understand these results, clinical level analyses were conducted.

Clinical level analyses. The clinical level analyses were extremely helpful in providing a clearer picture of how teachers assigned ratings to prototypical students from the perspective of clinical significance. A large majority of teacher's ratings consistently produced T scores in the nonclinical range for their successful student prototypes while assigning ratings to their unsuccessful student prototypes that produced T scores in the clinically significant range for all eight of the BRIEF scales. A small proportion of teachers provided ratings on some BRIEF scales that resulted in an elevated pattern of T scores, where both successful and unsuccessful prototypical student ratings were in the clinically significant range, but unsuccessful student scores were always more clinically significant than successful student scores. On scales where this pattern occurred, teachers' ratings reflected a perspective in which both successful and unsuccessful students exhibited some executive function difficulties, but the difficulties of the unsuccessful student prototypes were always greater than those thought to be exhibited by the successful student prototype.

Very few teachers provided ratings that produced what is referred to here as a reverse discerning pattern, in which successful prototype students were rated lower than in executive function capacities than unsuccessful prototypes. Although extremely uncommon, such rating patterns occurred most often for ratings on the Inhibit scale (four teachers, 6% of the sample) and Shift scale (six teachers, 9% of the sample). From the perspective of a few teachers, these executive function capacities were less important to academic success than the other executive functions reflected in the other BRIEF scales.

Some of the teachers' ratings produced what are referred to here as nondiscerning patterns, wherein teachers rated both successful and unsuccessful prototype students in the clinically nonsignificant range (a nondiscerning positive bias) or rated both successful and unsuccessful prototype students in the clinically significant range (nondiscerning negative bias). These teachers' perceptions of student behaviors related to executive functions reflected no significant difference between successful and unsuccessful student prototypes. The negative bias pattern represents what could be considered subtle philosophical bias related to executive function capacities represented on these scales. These teachers' ratings suggest that they believe that these behaviors have no significant impact on academic success in their classrooms and that most students, even good ones, are not very effective with the executive function capacities that the lack of these behaviors suggests exist. The positive bias pattern represents a more benign philosophical bias related to executive function capacities. These teachers' ratings suggest that they believe that both successful and unsuccessful students are relatively effective in the use of these executive function capacities. As a result, these capacities cannot be critical to student failure or success, since both failing and succeeding students effectively demonstrate them to the same degree.

The clinical level analyses showed that while teachers' ratings on the Inhibit and Initiate scales produced similar results in terms of the proportion of teacher ratings producing the expected pattern of T scores, teachers tended to view the Initiate scale behaviors in a more consistent manner relative to successful and unsuccessful students overall. For the Initiate scale, only one teacher's (2%) ratings produced an elevated pattern and no teachers' rating produced a negative bias or a reverse discerning pattern. In contrast, for the Inhibit scale, six (9%) teachers' ratings produced an elevated score pattern, one (2%) teacher's ratings produced a negative bias pattern, and four (6%) teachers' ratings produced a reverse discerning pattern. These variations likely are responsible for the much lower correlations between the Inhibit and Initiate scales mentioned earlier.

It is extremely important to note that the T score patterns reflected in the clinical level analyses reflected individual scale variations in teachers' ratings, i.e., no single teacher displayed a pattern other than the standard expected pattern in the responses to all eight BRIEF scales. Rather, it was much more typical that one teacher's ratings would deviate from the expected standard pattern for only one BRIEF scale; a few teachers exhibited variations for two or three scales. The occasional individual teacher rating variations from the standard expected T score pattern for each BRIEF scale formed the basis for the nonsignificant, zero-order coefficients obtained when the same teacher's successful and unsuccessful prototype T scores were correlated.

Implications of the Findings

Traditionally, an IQ score on a psychometric test has been the means by which school psychologists usually define the potential for competence in academic learning. Those students who have IQ scores above a certain percentile are thought to be capable of being successful in school-related tasks, and those students whose IQ scores fall below that percentile are perceived as less capable and at risk for school failure. Rather than using an IQ score as the necessary criterion to define academic competence, the prototype perspective attempts to define competence as a category that embodies the typical features possessed by successful students. Conversely, unsuccessful students are those who have significantly fewer numbers of those attributes that are shared by successful learners. In this study, the features consist of executive function skills that are believed to play an important role in academic learning.

The prototype perspective engenders hope and optimism for future educational endeavors that aim at helping underachievers succeed in school because competence is not viewed as a fixed trait, but as a set of skills that can be remediated if deficient. Educators can design interventions that incorporate training in executive function skills into the curriculum that is sensitive to developmental trends. Students require direct instruction and extensive practice in metacognitive and self-regulation strategies to facilitate achievement. The findings of this study attempt to extend current research in executive function and to increase teachers' awareness of the importance executive function has in academic learning. Due to the demands of middle school that require self-directed and goal-oriented behavior, executive function skills are fundamental in acquiring academic competence.

The association between learning and executive function is becoming increasingly more evident, based on a growing body of research. Yet traditional intelligence tests lack the sensitivity to detect executive function impairments in children. Therefore, school psychologists can include developmentally appropriate executive function measures in their assessments of students to determine areas of need.

Limitations of Study

There are limitations in the current study. The teachers who participated in the workshops were from a large urban school district with a large minority population. Therefore, the prototype view of a successful learner in middle school may not generalize to suburban or rural school districts that may vary in racial, ethnic, and socioeconomic status. In addition, the teachers in the study provided a sample of convenience that further restricts the generalizability of the findings of the study. The use of archival data did not allow for random selection of teachers, thereby diminishing the opportunity to obtain a representative sample. In addition, the small sample size limits the generalizability of the findings.

There are also threats to internal validity that prevent establishing a causal relationship between executive function and academic learning. Some of the teachers' ratings were contrary to expectancy. That is, some students received ratings that were suggestive of the presence of executive function impairment. Although such cases may represent true findings, it may reflect a different reference group from which teachers based their judgments. For example, successful students may have executive function impairments, but be perceived by teachers as being more capable in comparison to other students who have more severe executive function deficits. Demographic information for the teachers was not available for the study. Variables such as age, teaching experience, and years of training may influence teachers' judgments regarding the factors deemed important for academic learning in middle school. Also, the halo effect and personal biases are typical threats to validity when rating scales are used to obtain results.

Future Directions

The prototype perspective provided a rudimentary framework from which to investigate the similarities among learners so that critical features in their executive function capacities essential for successful achievement can be identified. This framework provides a standard for differentiating successful learners from unsuccessful learners in middle school. Future research can extend the prototype model to specific content areas such as reading, mathematics, or science to determine whether unique patterns of executive function emerge as significant for successful learning in these areas. In addition, specific items on the BRIEF can be examined, rather than executive function domains. The prototype model can also include motivational factors that affect achievement, such as self-efficacy. In addition, there is a need for future research to examine gender and racial/ethnic factors in relation to executive function capacities, more specifically, differences in the use of self-regulation strategies for academic learning. Finally, a rating scale was utilized in this study to construct prototypes of successful and unsuccessful learners. It would be beneficial to supplement findings with data from classroom observations and structured interviews with teachers.

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