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Inhibitory control and classroom behavior in kindergarten children

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ABSTRACT

This study examined the association between direct measures of behavioral inhibition (inhibition of prepotent response, motor inhibition, and delayed gratification) and the classroom behavior of kindergarten children. Participants included 5-6 years old kindergarten students (*N*=64), 35 boys and 29 girls, at two public elementary schools. Behavioral inhibition was assessed with the Night and Day test, Yes or No test, Draw-A-Line-Slowly task and a measure of Delayed Gratification. Classroom behavior was measured using the Teacher-Child Rating Scale 2.1 (T-CRS 2.1). The results showed no significant gender differences in performance on behavioral inhibition tasks or teacher ratings of classroom behavior. Positive correlations were found between children's performance on the measure of motor inhibition and teacher's ratings on the social skills and tasks orientation. Positive correlations were also found between inhibition of prepotent response and teacher ratings on behavioral control and task orientation. This study did not find any significant correlations among the direct measures of behavioral inhibition. Out of the four behavioral inhibition tasks, motor inhibition was the only significant predictor of teacher ratings on task orientation and performance on one inhibition of prepotent response (Night and Day) was the only significant predictor of behavioral control in the classroom.

Chapter I

INTRODUCTION

Self-regulation skills underlie many of the behaviors and attributes associated with academic success and school adjustment. A survey conducted by the National Center for Early Child Development and Learning indicated that 46% of kindergarten teachers reported that more than half of their students lacked the self-regulatory skills and social/emotional competence to function productively and learn in kindergarten (West, Denton & Reaney, 2001). In a statewide study of preschool and childcare expulsions and suspensions, over 39% of Massachusetts preschool teachers reported expelling and 15 % reported suspending at least one child during a 12-month period (Gilliam & Shahar, 2006). Furthermore, in 2014, the Centers for Disease Control and Prevention indicated that more than 10,000 American toddlers (age 2-3 years-old) are being medicated for ADHD outside of the established pediatric guidelines. Reports of the marked rise in the diagnosis and treatment of attention deficit hyperactivity disorder (ADHD) over the last decade raise concern that these diagnoses may not be medically justified. Some medical professionals suggest that children are prescribed medication merely to make their behavior more manageable and to do better in school (Schwarz, 2014). These results suggest that many children are unprepared to meet the behavioral expectations of school due to a lack of self-regulation skills.

Self-regulation broadly refers to the ability to adapt behavior as necessary to meet demands of the environment (Baumeister & Vohs, 2004). Within the neuropsychological framework, self-regulation is studied through the construct of executive functions, which

include cognitive shifting, inhibition and working memory (Miyake et al., 2000). Research in personality and temperament conceptualizes self-regulation as effortful control, which is defined as the modulation of reactivity (i.e. emotion) and behavior through attention shifting, activation control, effortful attention and/or inhibitory control (Rothbart, 1989). Despite their different theoretical frameworks, executive functions and effortful control constructs have considerable similarities in definition, core components and measurement (Zhou, Main & Wang, 2010).

Inhibition is considered a core self-regulation process (Barkley, 1998; Carlson & Moses, 2001; Hoffman, Schmeichel & Baddeley, 2012; Nigg, 2000; Rothbart & Ahadi, 1994) and is defined as the ability to plan and suppress inappropriate responses while pursuing a cognitively represented goal (Carlson & Moses, 2001). Research has identified several types of inhibition including inhibition (stopping or slowing) of motor response (Barkley, 1997; Maccoby, Dowley, Hagen & Degerman, 1965; Rimm-Kaufman, Nathanson, Brock, Curby & Grimm, 2009), delayed gratification (Kochanska et al., 1996; Mischel et al., 1989), and inhibition of prepotent response and performing a subdominant response (Gerstadt, Hong & Diamond, 1994; Stroop, 1935). The last type of inhibition also involves interference control as one should inhibit competing stimuli. Important developments in inhibition take place during the first 6 years of life with marked improvement between the ages of 3 and 6 that coincide (Carlson & Moses, 2001). This final surge in the development of inhibition coincides with the rapid growth of the prefrontal cortex around the age of school entry (Blair, 2002). This means that kindergarten is a critical time in which the development of inhibition may be helped or

hindered. Interestingly, several studies have indicated that girls have better self-regulation skills than boys (Matthews, Ponitz & Morrison, 2009).

Effective inhibitory control plays a key role in children's successful transition to school, allowing them to adopt effective classroom learning behaviors. For example, one must learn to inhibit the prepotent urge shout out an answer or take a desired object from an unsuspecting peer, in order to enact the learned response of raising one's hand and waiting one's turn. A large body of research has linked self-regulation to school readiness and academic achievement. For example, multiple studies have shown that children with strong self-regulation are more likely to form good relationships with teacher and peers and more likely to be engaged at school (Liew, 2012). Adaptive classroom behaviors in kindergarten year have been associated with gains in achievement through the sixth grade (Bronson, 2000). For example, McClelland, Acock & Morrison (2006) found that strong self-regulation skills in kindergarten significantly predicted higher reading and mathematics achievement between kindergarten and sixth grade, and growth is literacy and mathematics from kindergarten to second grade after controlling for achievement levels.

Self-regulation in preschool and kindergarten are crucial in order for a child to benefit from the learning environment. While several studies linked self-regulation and academic skills, there have been relatively few studies on self-regulation and classroom behavior. For example, Rimm-Kauffman and colleagues (2009) studied the extent to which children's self-regulation upon kindergarten entrance and classroom quality contributed to children's adaptive classroom behavior. In this study, children's self-regulation was assessed using direct measures of behavioral self-regulation including

inhibition of prepotent response, motor inhibition and delayed gratification. Adaptive classroom behavior was assessed through teacher report and observation-based measures that looked at engagement, off-task behavior, compliance, attention and disruptive behavior. Interestingly, the authors found a link between children's adaptive classroom behaviors and self-regulation measured by teacher-report but not by direct measures. In another study, Blair (2003) found that teacher ratings of preschoolers' on task behavior were not significantly correlated with performance on tasks of inhibitory control. One possible explanation for these findings is that the direct measures do not place precisely the same demands on children as the classroom environment.

Therefore, more studies are needed to explore how children's self-regulation skills associated with classroom behavior. More specifically, it is important to know which dimensions of inhibition (motor, delayed gratification, inhibition of prepotent response) contribute most to classroom behavior. This information is important for the development of targeted interventions to address inhibition deficits.

In addition, there is a need for better understanding of relationships between different types of inhibition. Because inhibition is multidimensional, research studies often use a battery of behavioral measures and aggregate scores to reflect the single construct (Kochanska, Murray, & Coy, 1997). It is assumed that the measured abilities (e.g. delay, execution of motor control, suppressing/initiating activity to signal, etc.) load together onto an overarching construct because performances on different measures tend to relate to one another (Sulik et al., 2010). The intercorrelation among tasks typically used to assess inhibition offers little in the way of understanding the relationship between the measures, if they are largely independent or if they group into meaningful

dimensions. For example, Murray & Kochanska (2002) found multiple groupings among the collection of various behavioral measures of effortful control. Factor analysis of 13 tasks used with a sample of preschoolers yielded four components (delay, gross motor control, fine motor control, and suppress/initiate behavior). However, similar analysis of 7 tasks used with early school-aged children yielded two components (motor control and suppress/initiate behavior). Similarly, Kindlon, Mezzacappa, & Earls (1995) assessed several behavioral measures of impulsivity and found two clusters: inhibitory control and insensitivity to punishment or non-reward. Reaching a better understanding of the relationship between self-regulation skills and kindergarten classroom behavior is critical because children's self-control, work habits and engagement even early on in schooling are believed to set the stage for later growth and development (Bronson, 2000).

GOAL OF THE PRESENT RESEARCH

The goal of the present research is to study the association between direct measures of behavioral inhibition (inhibition of prepotent response, motor inhibition, and delayed gratification) and the classroom behavior (rated by teachers) of kindergarten children.

Research Question 1. Does gender effect performance on behavioral inhibition tasks and teacher ratings of classroom behavior?

It is expected that girls will outperform boys on the measures of behavioral inhibition and teacher ratings of classroom behavior.

Research Question 2. Are there associations between direct measures of inhibition?

It is hypothesized that there are significant associations between all direct measures of inhibition.

Research Question 3. Which behavioral inhibition variables are most influential in predicting task orientation and behavioral control in the classroom?

This research question was explorative in nature; therefore, no specific predictions were made.

Chapter II

LITERATURE REVIEW

Inhibitory Control and Classroom Behavior in Kindergarten Children

Regulation is necessary for the survival of all living organisms. It includes basic regulatory processes that sustain life (e.g. maintenance of body temperature and eating) as well those that contribute to complex behaviors (eg. capacity to control impulses and pay attention). As Shonkoff and Phillips (2000, p. 26) note, the "operation of these multiple systems at different levels of organization is an essential feature of human development" because such processes modulate multiple physiological and behavioral systems so they remain within adaptive ranges.

Self-regulation is recognized as a critical aspect of functioning in multiple domains across the lifespan. Self-regulatory abilities and limitations have been linked to a variety of positive and negative outcomes, including academic success, coping ability, psychopathology, sexual risk-taking behavior and addiction (Raffaelli et al., 2005). Self-regulation is an important determinant of children's adjustment. For example, dimensions such as ego control, ego resilience, attentional control and undercontrol have shown to predict children's social adaptations and problem behaviors (Block & Block, 1980). Certain dimensions of self-regulation, such as impulsivity are believed to be risk factors for the development of externalizing problems; whereas others, such as attentional control are thought to be important in regulating internal emotional states and therefore relevant in the prediction of internalizing problems (Lengua, 2003).

There are many different conceptual models for self-regulation, each with its own terminology, context and scope. Self-regulation has been broadly defined as "any efforts

by the human self to alter any of its own inner states or responses" (Baumeister & Vohs, 2004, p. 2) or "the use of rules, strategies and plans to guide behavior (Bronson, 2000, p. 71). Some definitions focus on self-regulation in the process of goal attainment. Self-regulation was defined by Carver (2004, p. 13) as "a continual process of moving toward (and sometimes away from) goal representations…self-corrective adjustments are taking place as needed to stay on track for whatever purpose is being served." Demetriou (2000, p. 209) defined it as "actions directed at modifying a system's present state or activity which is necessary either because that state (or activity) is diverting from a previously set goal or because the goal itself needs to be changed." Other definitions emphasize the role of executive functions in self-regulation: it is "a host of executive and agentic functions (e.g. planning, future orientation, goal-directed behavior, effortful control, proactive behavior)" (Mischel & Ayduk, 2004, p. 99).

Self-regulation is also conceptualized in regard to emotion regulation. It is defined as "processes that serve to modulate (increase or decrease) reactivity" (Rothbart, Ahadi, Hershey & Fisher, 2001, pg. 1395) and "by which an individual initiates, modulates, maintains and coordinates internal emotional states and behavioral expression of these states of emotional arousal" (Lengua, 2003, p. 597). Some developmental literature broadly defines self-regulation as "children's ability to manage their emotions, focus their attention and inhibit some behaviors while activating others" (Rimm-Kaufman et. al, 2009). Many descriptions emphasize the stabilizing function and characterize self-regulation as the cognitive and behavioral processes that allow an individual to maintain optimal levels of emotional-motivational arousal and cognitive control (Blair & Diamond, 2008). Finally, some scholars attempt to bring all aspects of self-regulation

together. For example, it has been defined as "the ability to comply with request, to initiate and cease activities according to situational demands, to modulate intensity, frequency and duration of verbal and motor acts in social and educational settings and to postpone acting upon a desired object or goal, and to generate socially approved behavior in the absence of external monitors" (Kopp, 1982, p. 199).

Although self-regulation has become a mainstream concept in recent years, its underlying idea of adapting for the purpose of a long-term goal was introduced long-before the term "self-regulation" was coined. In the early part of the 20th century, Freud argued that the ego regulates instinctual impulses for the purpose of yielding the most gain in the long-term. In Freud's theory, self-preservation depends upon our ability to inhibit impulses that conflict with the demands of the environment (Freud, 1920).

Later, J.H. Block and Block (1980) connected the ego to the self-regulatory systems necessary for human adaptation. They proposed that ego-functions comprise a "boundary system" mediating the relationships between impulse and behavioral response (Block & Block, 1980). Their model is characterized by the core constructs of ego-control and ego-resilience. Block and Block theorized that ego-control is the expression *or* containment of impulses, feelings and desires. On one extreme of the continuum of boundary permeability, "overcontrol" is characterized by impenetrable boundaries that contain impulses, delay gratification, inhibit direct motivation and affect, and protect from environmental distracters. At the other extreme of the continuum, "undercontrol" implies the penetrable boundaries and the reverse consequences of poor impulse modulation, inability to delay gratification, expression of direct motivation and affect and vulnerability to environmental distracters (Block & Block, 1980). Ego-resilience then

refers to an individual's ability to modify his or her modal level of ego-control, in either direction, as a function of the demand characteristics of the environmental context. Thus, high ego resilience is associated with better adaptation, while low ego resilience is associated with an inability to respond to changing demands and poor adaptation (Block & Block, 1980).

Effortful Control

Effortful control, another construct related to self-regulation, has been a prominent subject of personality and temperament research. A developmental view of personality examines individual variability primarily through temperamental characteristics (Derryberry & Rothbart, 1997). Temperament refers to biologically-based, individual differences in reactivity and self-regulation (Rothbart & Bates, 1998). As a child develops, reactive forms of regulation are gradually supplemented by an increasing capacity for voluntary or effortful control (Derryberry & Rothbart, 1997). Effortful control refers to the control an individual has over impulses and emotions. It is the conscious regulation of conduct, particularly "with behavior that requires an active suppression of approach even at the cost of potentially pleasurable outcomes, or an initiation or maintenance of acts that are unpleasant" (Kochanska, Murray & Coy, 1997, p. 263). More specifically, Rothbart and Bates (1998) define effortful control "as the ability to inhibit a dominant response to perform a subdominant response" (p. 137). Effortful control encompasses the abilities to voluntarily control attention and activate or inhibit behavior (inhibitory control) as needed to adapt (Eisenberg, Champion & Ma, 2004). Studies examining the precise composition of effortful control have largely found

that attention shifting, activation control, effortful attention and/or inhibitory control underlie the higher-order construct (Zhou, Chen & Main, 2012).

Executive Functions

Within the fields of cognitive neuroscience and clinical psychology, the structures thought to be involved in self-regulation are collectively called executive functions. Executive functions refer to a cognitive "construct that unites working memory, attention, and inhibitory control for the purpose of planning and executing goal-directed activity" (Blair, 2002, p. 113). Executive functions are a set of higher-order cognitive processes that "aid in the monitoring and control of thought and action" (Carlson, Breton & Moses, 2002, p. 74) and enable us to connect past experience with present action (Barkley, 1997a).

The theoretical basis for executive functions can be traced back to the work of British psychologist, Donald Brodbent in the field of attention (Posner & Rothbart, 2000). In the 1950's, Broadbent drew a distinction between "automatic" and "controlled" processes and introduced the notion of selective attention, to which executive functions are closely related. Selective attention explains how one can make a selection of relevant information from the masses of potential input. Broadbent's work inspired a number of researchers including American psychologist Michael Posner who used the term "cognitive control" in his 1975 book, *Attention and Cognitive Control*. Posner proposed that there is a separate "executive" branch of the attentional system that is responsible for focusing attention on selected aspects of the environment. In a related line of work, British neuropsychologist Tim Shallice suggested that attention is regulated by a "supervisory system," which can override automatic responses in favor of selecting

behavior on the basis of plans or intentions (Norman & Shallice, 1986). These supervisory skills are highly interrelated and work together as managerial or "executive" cognitive skills that drive behavior. Executive functions include cognitive capacities such as planning, working memory, attention, problem solving, verbal reasoning, inhibition, mental flexibility, multi-tasking, initiation and monitoring of actions. Research on executive functions defines and measures individual skills independently from one another to the extent this is possible, since we use multiple skills in any executive function task (Miyake et al., 2000). Whereas self-regulation encapsulates the management of cognition, emotion or behavior, executive functions most often refers exclusively to the regulation of cognitive processes.

Inhibition as the Core Self-Regulation Function

Sub-disciplines within psychology examine self-regulation from different frameworks but share similar conceptual definitions of constructs, to the extent that the terms executive functioning, effortful control, and self-regulation are often used interchangeably (Bridgett, Oddi, Laake, Murdock, & Bachmann, 2013). The cognitive, affective and behavioral dimensions of self-regulation are interrelated in complex ways and are not readily distinguishable in daily experience. Furthermore, analysis of research reveals similarities in the neurobiological substrates, developmental course and measurement of effortful control and executive functioning; therefore, this substantial overlap calls for an integrated approach to the study of self-regulation (Zhou, Chen, & Main, 2012). Regardless of the research tradition, the "hallmark of successful self-regulation is the ability to actively inhibit or override behavioral responses such as (bad)

habits and impulses that are incompatible with one's goals" (Hoffman et al., 2012, pg. 176).

In Barkley's model of self-regulation, behavioral inhibition represents the foundational element that is "essential to the effective execution of executive functions (actions of self-regulation) that control the motor system in the initiation and performance of goal-directed, future oriented behavior" (Barkley, 1998, p. 226). Specifically, the inhibition of a dominant response or an ineffective ongoing response pattern generates a delay during which the other executive functions can occur. Behavioral inhibition does not directly cause executive functions to occur, but it sets the stage for their performance and shields the performance from interference. According to Barkley (1998), behavioral inhibition refers to three inter-related processes. The first process is to inhibit the initial prepotent (dominant) response to an event. When an individual is able to inhibit an initial prepotent response, he or she has the opportunity to maximize a later outcome that may lead to a greater reward. The second process of behavioral inhibition is to stop an ongoing response or response pattern. The ability to interrupt an ongoing sequence of behavior allows the individual to detect errors that signal the need to shift, interrupt and begin new and ideally more effective patterns of responding in a given context. Interference control, the third process of behavioral inhibition, protects the period of delay and the responses that occur within it from disruption by internal or external sources of interference (Barkley, 1998). Barkley (1997b) linked inhibition to four executive neuropsychological functions that appear to depend on it for their effective execution: a) working memory, b) self-regulation of affect-motivation-arousal, c) internalization of speech and d) reconstitution (behavioral analysis and synthesis).

Another construct closely related to inhibition is impulsivity. Although inhibition and impulsivity are most likely related to the same neurocognitive mechanism, the relationship between inhibitory control and impulsivity is more complex than the latter simply being the reversed former. Inhibitory control is defined as the capacity to plan and to suppress inappropriate approach responses under instruction, and impulsivity as the speed of response initiation (Rothbart, Derryberry & Posner, 1994). There is significant overlap between the two qualities and some measures appear to assess both (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). An extensive body of research has linked dominant reward seeking or impulsive behavior to childhood disorders such as Conduct Disorder and Attention Deficit and Hyperactivity Disorder (Quay, 1988).

An ability to inhibit an immediate response is also associated with delayed gratification. Delayed gratification refers to the ability to resist the temptation of immediate reward and persist in goal-directed behavior for the sake of future consequences (Mischel, Shoda & Rodriquez, 1989). An individual's ability to delay gratification relates to similar skills including willpower, patience, impulse control, and self-control. Individual differences in self-delayed gratification have been linked to a host of positive developmental outcomes including academic success, psychological health and social competence (Shoda, Mischel & Peake, 1990). In a follow-up study of adolescents who participated in delay of gratification experiments as preschoolers, Shoda, Mischel & Peake (1990), showed that early delay gratification abilities were associated with particular personality and achievement patterns later in life. Specifically, the children who were able to self-impose delay of gratification (using attentional strategies)

when rewards were exposed during the waiting period were rated by their parents 10 years later as characteristically more persistent, planful, attentive, and able to concentrate and as using and responding to reason. Delay times in this condition were also related with the participants' later SAT performance (Shoda, Mischel & Peake, 1990).

Inhibition/disinhibition is a common focus in psychopathology research yet there is no shared classification of various inhibitory processes. Researchers may adopt cognitive, personality or temperament models or a combination of these to study inhibition constructs. The difficulty in this is that the "relations among the various author's different meanings of inhibition are not clearly articulated in the literature" (Nigg, 2000, p. 220). Specifically, the extent to which "various measurement paradigms tap either the same process in different contexts or different processes" is unknown (Nigg, 2000, p. 222). Nigg addressed this very problem by developing a framework that would support the systematic mapping of inhibitory deficits in connection to specific psychopathology.

Nigg's (2000) taxonomy posits eight inhibition processes that form three fundamental classes of motivational inhibition, executive inhibition, and automatic inhibition of attention (Nigg, 2000). Nigg identified motivational and executive inhibition as the two, higher-order systems of behavioral inhibition that have emerged from laboratory data. He makes a conceptual distinction between motivational (i.e. reactive) and executive suppression (i.e. interruption of prepotent response) and argues that behavioral inhibition is best understood through a dual process model of regulatory control. Motivational and executive inhibition processes are closely connected in the

continuous regulation of actual behavior but differ in the immediacy of incentive and the degree of anxiety involved.

Motivational inhibition refers to the reflexive orienting of attention or suppression of behavior in response to emotionally salient stimuli and immediate incentive. This class of inhibition refers specifically to the interruption of ongoing behavior or suppression of behavioral response due to fear or anxiety in the presence of immediate novel social situations or cues for punishment. Motivational inhibition corresponds to reactivity in temperament theory and invokes limbic activation (Nigg, 2003). Reactivity refers to "responsiveness of emotional, activation and arousal systems" (Rothbart & Ahadi, 1994, pg. 56). The development of motivational inhibitory control is followed by executive inhibitory control, which allows for further adjustment to behavioral response based on contextual demands.

In Nigg's conceptualization, *executive inhibition* refers to the intentional control of thoughts and behaviors in the service of a distal goal (Nigg, 2003). The development of executive inhibition follows that of motivational inhibitory control. In contrast to the processes used to manage behavior in the presence of immediate stimulus incentives, executive inhibition is applied towards an internally represented long-term goal. For example, as an individual receives new information, his/her prepared motor response may be suppressed, cancelled or inhibited in order to achieve a goal held in working memory. Executive inhibition processes are not active at all times; rather, they are deliberate and activated according to situational demands. These processes require cognitive resources and can occur without significant fear or anxiety. Executive inhibition is related to personality dimensions of Constraint/Contentiousness and the construct of effortful

control (Nigg, 2000). Although effortful control is usually associated with attentional control, Nigg also relates it to executive motor control. Like executive inhibition, effortful control is considered to be the "voluntary, active, vigilant control of behavioral impulses" (Kochanska & Askan, 2006, p. 1594). Current research recognizes that both automatic or unconscious impulses and conscious strategies work to control behavior (Posner & Rothbart, 2000).

Biological Foundations of Inhibition

Russian physiologist Ivan Pavlov was one of the first theorists to explore biological underpinnings of personality or temperament. He described "excitatory and inhibitory processes" within the central nervous system that allow an animal to return to a state of stability and maintain equilibrium (Reed, Pien & Rothbart, 1984). H. Eysenck, who was heavily influenced by Pavlov's work, proposed that individual differences in personality are the result of variability in cortical arousal. He aligned differences in cortical arousal to his concept of introversion-extroversion personality dimension (Corr & Perkins, 2006). His arousal theory postulated that introverts are characterized by higher levels of cortical activity such that they reach and then exceed an optimal level of stimulation at lower levels than extroverts and may experience distress to overstimulation. Due this difference in baseline of cortical arousal, introverts seek lower levels of stimulation than extroverts to maintain a comfortable level of arousal (Rothbart, Ellis & Posner, 2004).

Jeffery Gray further built upon Pavlov and Eysenk's work and developed a psychobiological model of personality based on sensitivities to rewarding and punishing stimuli. Originally, Gray described two competitive systems: the behavioral activation

system and behavioral inhibition system. The behavioral activation or approach system (BAS) activates motor response to signals for reward and active avoidance behavior in response to non-reward or punishment. Reinforcement sensitivity theory (RST) states that individuals with a stronger behavioral activation system are high in reward responsiveness and are predisposed to the personality trait of extraversion, while people with a stronger behavioral inhibition system (BIS) are lower in reward responsiveness and are more predisposed to the personality traits of introversion and neuroticism (Gray, 1987). A revision of the RST describes three systems including the fight–flight–freeze system (FFFS) which mediates reactions towards aversive stimuli and is associated with avoidant behavior and fear; the BAS which mediates reactions to appetitive stimuli and is associated with impulsiveness and reward-seeking behavior; and the BIS which operates to resolve goal conflict (e.g., between approach and avoidance) and is associated with anxiety and inhibition of potentially conflicting behaviors (Gray & McNaughton, 2000)

Developmental Trajectory of Self-regulation in Childhood

One of the most important influences in early childhood is neurological maturation in the parts of the brain that help the children control, direct and plan their actions (Shonkoff & Phillips, 2000). Evidence from brain research shows self-regulation skills are associated with particular patterns of frontal lobe activity, specifically located in the prefrontal cortex (Blair, 2002). The development of inhibitory control begins with reciprocal communication and interaction between infant and caregiver and a child's awareness of appropriate or prohibited behaviors as defined by caregivers (Kopp, 1982). At 12 to 18 months of age, children have the ability to delay on request and are able to initiate, maintain and cease behavior, comply with caregivers' requests and develop an

awareness of social demands. By 24 months, children develop the ability to delay on request (Kopp, 1982). During the second year of life, as the capacity for representational thinking and evocative memory emerges, behavior is influenced by remembered information and children begin to behave according to expectations absent of external monitors (Kochanska et al., 1997).

The development in the prefrontal cortex in the years from 3 to 6 means the preschool period is a crucial time for acquiring self-regulation skills that are important for successful functioning in school settings (Blair, 2002; Shonkoff, & Phillips, 2000). The developmental period from infancy to preschool age is a time of major changes in regulative aspects of temperament, including a shift from an orienting-based regulatory system to systems of effortful control (Kochanska, Murray & Harlan, 2001). The capacity for individual children to function successfully in early childhood environments varies widely, in part because of differences in prefrontal cortex development, which helps explain why not all children enter kindergarten with the same level of skills (Calkins, Howse, & Philippot, 2004).

The growth of self-regulation is a cornerstone of early childhood development that cuts across all domains of behavior. Developmental research investigates how young children, who at first are almost totally dependent on external regulation, gradually become increasingly guided by inner mechanisms and thus, self-regulate. Empirical findings indicate that self-regulatory capacities emerge in early childhood and stabilize in adolescence (Raffaelli et al., 2005). Distinct self-regulatory tasks are confronted at different ages. For example, “infants initially face challenges associated with physiological self-regulation (e.g. coordinating sleep and wake cycles) and early

modulation of emotions (e.g. self-soothing); toddlers' issues of compliance and behavioral self-control; and preschool-aged children begin to delay gratification" (Raffaelli et al., 2005; pg. 55). Studies on early self-regulatory processes indicate that by age 5 to 6, children are increasingly capable of true internal self-regulation (Raffaelli et al., 2005).

Mischel and colleagues (1999) explain a child's increasing ability to forgo immediate satisfaction in the pursuit of a long-term goal through the interaction of two subsystems of personality; a cognitive cool system and an emotional, hot system. The emotional, hot "go" system is fast, impulsive and reflective. This system enables quick emotional processing that is useful for survival by "allowing rapid fight or flight responses, as well as necessary appetitive approach responses" (Mischel and Ayuduk, 2004, p.85). When activated by a trigger stimulus (e.g. a desired or feared object), the hot system elicits virtually reflective approach or avoidance reactions, which unless interrupted, preclude self-control. The hot system is well developed at birth and is most dominant in youth. In contrast, the cool system develops with age and maturity and it is the basis for self-regulation. The cool, cognitive "know" system is slow, contemplative and emotionally neutral. This system is attuned to the informational, cognitive and spatial aspects of stimuli and it generates rational, reflective and strategic behavior. Mischel explains that effortful control becomes possible to the extent that cooling strategies generated by the cool system can circumvent hot system activation. As the cool system develops, it becomes increasingly possible for the child to generate diverse cognitive cooling strategies and to be less controlled by whatever is salient in the immediate field of attention. Cooling strategies can include distraction techniques (e.g.

removing the reward from view; inventing mental games, singing songs, thinking of something else) or changing the way of thinking about the reward (e.g. imagining that the reward is less attractive, thinking about how a marshmallow looks like a cotton ball) to make the wait less aversive (Mischel & Metcalf, 1999).

Delayed gratification tasks are one well-established way of examining how hot and cool strategies interact. These tasks require children choose between an immediate reward of lower value and a delayed reward of higher value. Research on delayed gratification has identified the cognitive-attention control strategies that help children to resist temptation and persist for the delayed reward (Mischel & Ayduck, 2004). By implementing cooling strategies children are able to overcome the power of stimulus control so that behavior is no longer a reflexive response (Metcalf & Mischel, 1999).

In their research on affective decision-making, Prencipe and Zelazo (2005) suggest the delay of gratification not only indicates cognitive control but a child's ability to understand that others can have a perspective that is different from their own. They propose that in order to exercise cognitive control, children may need to disengage from their subjective desire for immediate gratification and consider the fact that, from a more objective perspective, the delayed reward is the better option. Research procedures for the delayed gratification paradigm are quite simple. For example, Mischel and colleagues have presented children with a small food treat (i.e. marshmallow, cookie, candy) and then the option to: A.) Ring a bell at any point to summon the experimenter and eat small treat or to B.) Wait until the experimenter returns (about 20 minutes later) and earn a larger treat (Mischel & Ayduk, 2004). The situation creates a conflict between

the temptation to stop the delay and take the small, immediate available reward or wait (without knowing how long the wait will be) for the larger, more preferred reward.

Children's capacity for making future-oriented decisions has been studied extensively through delayed gratification research that places children in a situation where he or she must choose between receiving a less desirable reward now or a more desirable reward at a later time. While the classic delayed gratification paradigm studies a child's behavior aimed at benefits for the self (prudence), Thompson, Barresi and Moore (1997) modified classic research methods to include examination of a child's behavior aimed for the benefit of others (altruism). Using a delay of gratification paradigm, 3- to 5-year-olds were tested on their ability to decline a current opportunity to obtain some stickers in order to gratify their own future desires- or the current or future desires of a research assistant. Results showed that 3-year-old children consistently chose the immediate alternative in preference to the delayed alternative on both the future altruism and future prudence choices. Similar developmental patterns were observed in participant performance on the two delay trial types and the correlation between them suggests an age-related change in the capacity to deal with future desires of both self and other that develops during the fourth year of life. The authors proposed "that such a capacity is best explained in terms of the development of the child's ability to simulate conflicting mental states in the imagination" (Thompson et al., 1997, p. 209). The results of this study suggest that 4-year-olds have the ability to imagine various mental states which conflict with their own current states and involve a non-current situation while 3-year-olds do not.

Prencipe and Zelazo (2005) used similar methodology in their study of affective decision making for the self and other. This study also indicated that age plays a role in the ability to delay gratification. The results from this study differed from those of Thompson et al. in that older children (4-year-olds) were more likely to choose a delay reward from themselves but less likely to choose the delay reward when choosing for the experimenter. Prencipe and Zelazo suggested that three-year-olds were less likely to choose impulsively for others because they had difficulty adopting the experimenter's perspective (i.e., her desire for immediate gratification). They proposed that 4-year-olds performed comparably when choosing for themselves and for others because they are able to integrate first- and third- person perspectives and approach motivationally significant decisions are not made exclusively by emotion or by exclusively by reason. Additionally, a small difference between males and females suggest that females may be slightly better at delaying reward (Prencipe & Zelazo, 2005).

Developmental trends have also been observed in behavioral inhibition research. Behavioral inhibition emerges during the third year of life (Posner & Rothbart, 2000). Masters and Binger (1976) demonstrated developmental improvements in children's inhibitory control between age 2 to 3 and age 3 to 4 with their study of children's ability to cease playing with an attractive toy when instructed and their ability to resist resumption of play for a delay period. Kochanska, Murray and Harlan (2000) developed a battery measuring five inhibition behaviors: delaying, slowing down motor activity, suppressing or initiating activity to signal, lowering the voice and effortful attention. They showed significant improvement in inhibition between 22 and 33 months of age, with girls consistently outperforming boys (Kochanska et al., 2000). This developmental

change was demonstrated in Russell et al.'s study (1991) of 3- and 4- year olds children's performance on the "windows" task in which they were rewarded when they pointed to a box which they could see was empty and not rewarded when they pointed to a box in which they could see candy. The 3 year-old children were unable to inhibit the tendency to point to the baited box.

Zelazo, Frye, and Rapus (1996) found that younger children successfully demonstrate knowledge of rules but then fail to use that knowledge to their guide behavior. Their study used a dimensional change card sort task that required switching between two incompatible pairs of rules. For example, children are asked to sort a deck of cards by one dimension (i.e. color, shape, number, and size) and after several trials of sorting cards by one dimension, the children are told to switch and sort the cards according to another dimension. Studies using this task reveal an important limitation of 3-year-olds' rule use; they are able to use the first pair of rules with which they are provided but they persist in sorting cards according to these first rules on the postswitch phase despite being told the new rules on every trial. Preservation on the first pair of rules occurred despite a child's ability to correctly answer explicit questions about the postswitch rules. In contrast, 4- and 5-year-olds tend to switch immediately to the new pair of rules on the postswitch trials. The younger children could demonstrate understanding and memory of the rule and yet had difficulty switching, whereas the older children used their knowledge of the postswitch rules to guide their behavior.

In their research on the relationship between executive functioning and theory of mind, Carlson and colleagues distinguished between two different types of tasks used to assess inhibitory control in preschool-aged children. The first includes measures of a

child's ability to "delay, temper or altogether suppress an impulsive response when a tasks calls for it" (Carlson & Moses, 2001; p. 1033). For example, Kochanska et al. (1996) used one of these "delay tasks" called *Gift Delay* in which an experimenter tells blindfolded children not to peek while they noisily wrap a present for them. These tasks are often measured by the latency of delay and/or by assigning scores based on the degree of different rule violations (e.g. adjusting blindfold, peeking at gift, touching gift, etc.). The second category includes measures that require children to respond a certain way in the face of a highly salient, conflicting response option. The Stroop color-word task is an exemplar of such "conflict" tasks. In the Stroop task, color words (e.g., the words "red" or "blue") are printed in the ink of another color and participants are instructed to report the color of the ink rather than the word. This requires that subjects inhibit a natural tendency to attend to the words and ignore the color of the ink when reading (Stroop, 1935). Whereas "conflict" tasks require the inhibition of an inappropriate prepotent response whilst activating a conflicting novel response, "delay" tasks require participants to simply inhibit responding. Carlson and his colleagues suggest this is an important distinction among inhibitory control measures because while both tasks require inhibition, the "conflict" tasks impose more working memory demands.

Using Stroop paradigm, Gerstadt et al. (1994) developed a conflict measure for children. The Day-Night task is a simplified version of the adult Stroop and requires the respondent to inhibit their natural tendency to give a different verbal response. The Day-Night task instructs children to say "night" when presented with a card with a brightly colored sun and say "day" to cards with a moon and stars. Several studies suing this measure indicate that children under the age of five evidence more difficulty exercising

inhibitory control over their behavior (Gerstadt et al., 1994). Carl & Moses (2001) used a variation the Day-Night test called the Snow and Grass test to measure of inhibitory control. In this test, children responded by pointing instead of speaking and are instructed to point to a white card when the examiner says "grass" and point to a green card when the instructor says "snow."

Other variations of classic inhibition tasks were used by Carlson, Moses & Breton (2002) in their study of the contributions of inhibitory control and working memory to the relationship between executive function and theory of mind. They administered multitask batteries measuring theory of mind and inhibitory control to preschool children. The inhibitory control battery consisted of conflict inhibition and response inhibition tasks including *Bear/Dragon, Whisper* and *Gift Delay*. The *Bear/Dragon* task is a simplified version of "Simon Says" in which children are required to selectively suppress commanded actions. The *Whisper* task called for voluntary lowering of the voice in which children were asked to whisper the names of familiar and unfamiliar cartoon characters. The unfamiliar characters were included so that when a familiar character would appear, children might be more tempted to shout out its name. Children's performance on these tasks was compared to their performance on theory of mind measures that included two tasks of false-belief understanding. For these tasks, children were first presented with scenarios in which different characters had access to different information and then asked questions about what individual characters might think. The results of this study showed that that inhibition uniquely predicted false belief. Children's performance on the conflict tasks but not delay tasks strongly predicted their false belief understanding. The authors attributed the difference in the predictive power

of the inhibitory control measures to the different working memory demands of conflict tasks and delay tasks. Although working memory did not predict false belief over and above inhibitory control, the authors proposed that the combination of working memory and inhibition are critical for mental state attribution (Carlson, Moses & Breton, 2001).

In their study of inhibitory self-control in preschool children, Reed, Pien and Rothbart (1984) attempted to determine whether there is a relationship between an individual's skills at a variety of different types of inhibition and sought to identify a cluster of these inhibitory behaviors. Forty children, aged 40 to 49 months were tested on tasks designed to require verbal, motor and internal inhibition. The verbal regulation tasks included a simplified version of "Simon-says," and a pinball game. The pinball game was modeled after Luria's bulb press task and asked the children to pull back on a handle to activate the pinball toy but then wait until the experimenter said, "Go!" before shooting the ball. The Simon-says task required children to inhibit a response in the face of strong activating stimuli (i.e. instruction to respond). The drawing task was used as a measure of motor inhibition and required children to draw straight lines and start and stop at required places. The task that measured internal inhibition used the spontaneous alternation paradigm. For this task, children were given instructions on how to operate switches in order to make the same picture appear or to make a different picture appear. Results indicated high, significant correlations between the pinball, Simon-says and alternation tasks. The correlations suggest that the tasks measure a general ability for verbally regulated inhibition in children. An investigation of the effects of age and sex showed a significant improvement in inhibitory ability with age on every measure. The effect of gender did not reach a level of significance.

In study of impulsivity of preschoolers, Olson (1989) set out to examine the extent to which individual measures of impulsivity clustered into meaningful higher order dimensions, how different measures of impulsivity were related to social competence and whether there is long-term stability or change in performance. The performance tests of impulse control included a measure of cognitive impulsivity, motor impulsivity and delay of gratification. Other instruments included a vocabulary test, teacher rating scale and measures of social competence. Measures were repeated at 1-year follow-up to assess long-term stability or change. Results from this study were consistent with previous research and showed that different measures of impulsivity were largely independent. Cognitive inhibition and motor inhibition scores clustered together in a single factor and delay of gratification variables comprised a second independent factor dimension. These findings suggest that, by the onset of early school-age, two different subtypes of impulsivity may exist: a "cognitive" dimension indexing ability to inhibit overt behaviors in highly structured task situations and a "delay" dimension indexing compliance with social expectations for "correct" behavior. Measures of impulsivity and social competence were significantly intercorrelated, supporting previous findings that impulsive behavior has significant implications for social adjustment, particularly risk of being disliked by peers. However, this relationship did not hold true for all measures. Indices of peer rejection and deviant social problem solving were most consistently correlated with delay ability and ratings social cooperativeness. Longitudinal analyses of stability versus change in individual patterns of impulse control further supported the distinctiveness of different impulsivity measures. Results suggested that the simple ability to inhibit gross and fine motor movements remained fairly stable over time.

Measures of motor inhibition were the only to show individual differences with significant long-term stability. However, the findings indicated a substantial amount of individual change and reorganization in more complex social-behavioral and cognitive aspects of impulse control (Olson, 1989).

The preschool findings support a conception of impulsivity as a multidimensional construct that cannot be fully captured with single measures (Raffaelli et al., 2005). In particular, the findings support the empirical distinction between "social" and "cognitive" dimensions of impulsivity, as the latter had little relationship with measures of social competence.

The Role of Language

Acquisition of language plays a crucial role in the development of self-regulation. Many developmental psychologists and neuropsychologists highlight the importance of language as a mediator in self-regulation because language facilitates conceptual and abstract thinking (Vygotsky, 1964). Language allows an individual to "refer backward in time and project forward into the future, allowing more adequate learning from past experience and planning for the future" (Bronson, 2000, p. 71). Pavlov highlighted the importance of language in his proposed theory that human behavior is regulated at two levels. The first level, shared with other animals, is called the first signal system in which behavior is a function of unconditioned reflexes and conditioned responses. The second signal system, present only in humans, is based on symbolic capacity that allows human behavior to become more flexible by increasing the speed of information of conditioned responses. According to Pavlov, the second signal system is a more flexible and faster route to the same basic processes and assumes control over the first rather than

replacing it (Pavlov, 1961). Vygotsky proposed that a child's gradual shift from external to internal control is positively related to the developing ability for verbal self-regulation. From this position, higher mental functioning first appear on the social level and only later on the individual level. Early in childhood, the speech of adults helps in the regulation of children's behavior. Later, children are able to regulate their own behavior by means overt speech and still later, a child's covert (internalized) speech serves this function (Vygotsky, 1967). The development of private, internalized speech is believed to facilitate this change towards increased individual control.

Language assists internal thought, reflection and planning by facilitating the child's mental considerations of alternatives before acting. Private speech also provides a means for self-questioning through language, creating an important source of problem solving ability as was as a means of formulating rules and plans (Barkley, 1997b). Language moves from being primarily a means of communication with others to one of communication with the self to facilitate problem solving. More specifically, self-directed speech can be used to simulate responses to a hypothetical scenario and test them out before one is selected and performed.

Vygotsky (1962) suggested that self-speech (thinking and giving oneself directions in words) begins during preschool years and is critical for the development of self-regulated behavior. Overt speech typically increases until about age 7, when it declines and becomes internalized in silent thought (or subvocal speech). As children grow older, they gradually become able to use self-speech to consciously understand situations, focus on problems and overcome difficulties. Bickhard (2005) suggests children (and adults) use verbal supports for ongoing activities ("self-scaffolding") in

both task and social situations and proposed that self-scaffolding is central and essential for cognitive control. The young child's speech during tasks or fantasy play can often reveal the presence of self-organizing and self-regulating strategies. Self-regulatory skills continue to develop throughout childhood because many of the cognitive capacities that have been linked to effective adult self-regulation (e.g. long-term planning, goal setting) do not fully mature until later childhood or adolescence (Bronson, 2000).

Inhibition and Moral Development

Murray and Kochanska (2002) demonstrated that effortful control underpins the developing internalization of conduct standards. Early differences in effortful control have been linked to aspects of moral conduct including empathy, rule violation in the absence of surveillance, self-control in the face of temptation and substance use (Kochanska, Murray & Coy, 1997). In the early stages of a developing conscience, children have an eager and willing stance towards parental socialization but conscience emerges as result of a complex interplay between a child's temperamental individuality and socialization in the family.

Koschanska and Aksan (2006) use the constructs of conscience or morality to describe some of those autonomous inner guiding systems independent of external control. Borrowing from the social-domain theory, their conceptualization of conscience focuses on the cognitive representations of moral rules. Moral conduct often requires that a child refrain form an act he or she desires but has been prohibited from performing and sustain a mundane or aversive activity that he or she has been requested to do. Kochanska reasons that effortful control is an important temperamental underpinning of children's emerging ability to regulate their conduct in ways that are compatible with

broader values of society. Kochanska, Coy and Murray (2001) make an important distinction between compliance and internalization of rules. They explain that compliance happened in the presence of a parent, teacher or other socialization agent. Internalization, on the other hand is autonomous, internally regulated, rule compliance that occurs even without a socialization agent. Compliance is the first step in the unfolding process towards internalization (Kochanska et al., 2001).

Behavioral Inhibition, Classroom Behavior and Academic Performance

Kindergarten curriculum in the United States has become increasingly rigorous over the past decades (Rimm-Kaufman et al., 2009). Learning standards brought about by the No Child Left Behind legislation "have shifted focus away from children's social and emotional skills and towards the enhancement of children's academic skills" (Rimm-Kaufman, et al, 2009, p. 958). The present study focuses on kindergarten students because it is during the early years of formal education that school children learn a variety of self-regulatory skills that they continue to build upon throughout their development. The transition from preschool to a more structured kindergarten environment can be stressful and emotionally challenging for children. In a study examining children's adaptive behaviors in the kindergarten classroom, Rimm-Kaufman and colleagues (2009) found that children's self-regulation upon the transition to kindergarten and teacher-implemented classroom management were associated with teachers' reports of children's behavioral self-control, cognitive self-control, and work habits later in the school year. This association makes sense given that kindergarten children are at an age when many aspects of self-control are newly emerging and they are

highly dependent on the external environment to help support adaptive learning behaviors (Bronson, 2000).

The transition into kindergarten may be particularly difficult for children who have not mastered skills needed to thrive in formal schooling. Research on school readiness indicates that higher self-regulation skills upon entering kindergarten appear to ease children's adjustment to the demands of the kindergarten classroom and contributes to later self-control (Rimm-Kaufman, et. al, 2009). Kindergarteners who enter school without adequate social and self-regulatory skills are at significantly greater risk for difficulties, including peer rejection and low academic achievement. There is strong evidence that learning behavioral self-regulation and social-emotional competence predicts early academic achievement and these skills are found in resilient children. Children's behavioral regulation has been shown to predict early achievement throughout elementary school, even after controlling for IQ (McClelland et al., 2007). A large body of research indicates that economically disadvantaged students enter school with weaker learning-skills when compared to their more affluent peers and they are at much greater risk for school failure (Howse, Lange, Farran & Boyles, 2003).

In a study of school readiness and self-regulation involving children in Head Start, Blair, Granger and Razza (2005) found that a change in cortisol and performance on executive function tasks related positively to objective measures of academic ability in kindergarten. The Committee on Integrating the Science of Early Childhood Development also maintains that multiple aspects of children's learning-related skills (including the areas of executive functioning, behavioral self-regulation, and social-emotional competence) are necessary for early school success (Shonkoff & Phillips,

2000). Results from a National Center for Education Statistics survey of kindergarten teachers' opinions of characteristics considered essential or very important for school readiness, indicated a clear concern about children's ability to regulate their behavior. In addition to remarking on the importance of children being able to follow directions, teachers consistently endorsed characteristics such as being able to communicate wants, needs, and thoughts verbally, to be enthusiastic and curious about learning, and sensitive to others children's feelings as important for being ready to start kindergarten. Comparatively few teachers certified academic skills such as knowing letters of the alphabet or being able to count to 20 as critical indicators of readiness (Lewit & Baker, 1995).

To be successful in school settings, children must determine what is important to focus on, tune out irrelevant information, and inhibit the tendency to respond too quickly or to be too distracted by other stimuli. Children with higher behavioral regulation are likely better able to attend to specific cues, remember instruction, stay on task, tune out irrelevant information, and process information necessary to complete tasks, all of which contributes to their ability to succeed in school settings and perform well academically. In one study, children's gains in behavioral regulation (including attention, inhibitory control and working memory), tested by a Head-Toes-Knees-Shoulders task, over the preschool year predicted the gains they made in emergent literacy, math and vocabulary (McClelland et al., 2007). Using the same measure, another study found that behavioral self-regulation, predicted children's reading, math and vocabulary in kindergarten and gains made over the school year in math achievement (Ponitz, McClelland, Matthews & Morrison, 2009). Other research identified behavioral regulation (as measured by the H-

T-K-S task) as part of a learning-related skill construct (including behavioral regulation and social competence), significantly predicted children's academic skills between kindergarten and sixth grade (McClelland et al., 2006).

In a cross-cultural study, Lan, Legare, Ponitz, Li, and Morrison (2011) investigated the link between different subcomponents of executive function and academic achievement in Chinese and American preschool children. Three components of executive functioning including working memory, inhibition and attentional control abilities were compared with academic achievement in reading, counting and calculation. Inhibition was measured using the H-T-K-S task. In both countries, inhibition was found to uniquely predict performance on math achievement tasks (Lan et al., 2011).

Hughes et al. (1998) study of preschoolers identified as "hard to manage" suggested both direct and indirect links between executive dysfunction and disruptive behavior. Results indicated an association between poor executive functioning and externalizing disorders, however the association was less pronounced after differences in verbal ability and social background (e.g. intact vs. single-parent family, parent education, etc.) were taken into account. Behavioral regulation may be important variable that mediates the relation between emotional regulation and academic achievement (Howse, Calkins, Anastopoulus, Keane & Shelton, 2010.

Research has identified classroom quality (i.e. emotional support, classroom management and instructional support) as an important contributor to children's adaptive classroom behavior (Rimm-Kaufman et al., 2009). Classroom management, as opposed to other aspects of classroom quality, appeared to show the strongest link to children's self-control, work-habits, and engagement in the classroom. Well-managed classrooms

are characterized by stable daily routines, proactive approaches to discipline, close monitoring to keep students engaged in academic work and use of hands-on activities that are inherently interesting to children (Rimm-Kaufman et al., 2009).

Developmental outcomes are not determined exclusively by the child or by the environment; rather, it is the interaction between the child and the learning environment that affects developmental outcomes. Research suggests reciprocal associations between inhibitory control and child-teacher conflict across elementary-school years (Berry, 2012). This study found that lower levels of inhibitory control were associated with higher subsequent levels of teacher-child conflict while higher levels of teacher-child conflict were associated with lower subsequent levels of inhibitory control. This evidence suggests direct relations between inhibitory control and teacher-child conflict such that early inhibition problems "set the stage for classroom experiences that fail to support or actively undermine children's abilities to develop more effective skills over time" (Berry, 2012, p. 66). Alternatively, Liew et al. (2010) found that positive student-teacher relationships may compensate for child deficits in self-regulation. Results indicated that children with low effortful control performed just as well academically as children with high effortful control when paired with a positive and supportive teacher, and children with high effortful control performed similarly regardless of the teacher. Thus, effortful control can swerve as a protective factor for children without the presences of a positive and supportive teacher and supportive teachers may serve to compensate for children with self-regulatory difficulties by fostering student's autonomy that would subsequently benefit their future academic achievement.

Previous studies of the relationships between direct measures of self-regulation and classroom behavior identified two areas for further research. First, it remains unclear as to whether the self-regulatory abilities measured in the laboratory are the same abilities required for success in the classroom. McClelland and Cameron (2011) noted that "relatively little research has examined the associations among multiple measures in different settings (for example classroom ratings of behavior and performance on laboratory tasks) (p. 37)." Second, existing research has not established a clear link between the behaviors measured by laboratory tasks and the classroom behavior. For example, Blair (2003) found that preschoolers' on-task behavior (rated by teachers) was not significantly correlated with executive function performance on tasks of inhibitory control. Contextual differences may account for the lack of correspondence between teacher ratings and behavioral measures. Experimental tasks often measure individual aspects of self-regulation (e.g. inhibitory control, working memory, attention); however, in naturalistic contexts, these skills are rarely used in isolation. In the classroom, children must coordinate multiple self-regulation skills in order to accomplish specific tasks like waiting one's turn to play with a desired toy or following instructions for an academic activity (McClelland & Cameron, 2011).

GOAL OF THE PRESENT RESEARCH

The goal of the present research is to study the association between direct measures of behavioral inhibition (inhibition of prepotent response, motor inhibition, and delayed gratification) and the classroom behavior (rated by teachers) of kindergarten children.

Research Question 1: Does gender effect performance on behavioral inhibition tasks and teacher ratings of classroom behavior? It is expected that girls will outperform boys on the measures of behavioral inhibition and teacher ratings of classroom behavior.

Research Question 2: Are there associations between direct measures of inhibition? It is hypothesized that there are significant associations between all direct measures of inhibition.

Research Question 3: Which behavioral inhibition variables are most influential in predicting task orientation and behavioral control in the classroom? This research question was explorative in nature; therefore, no specific predictions were made.

CHAPTER III

METHOD

Participants

Participants included 5-6 years old kindergarten students (*N*=64), 35 boys and 29 girls, from two public elementary schools in Augusta County, Virginia. The schools were located in Fort Defiance, Virginia (population 780) and Stuarts Draft, VA (population 9,235). Despite the difference in the population density of the two towns, the schools were demographically similar in that the students are primarily from Caucasian, working-class families. Enrollment data from 2012 indicate the student populations in both schools have a Caucasian ethnic majority above 90% (school 1: 90.8%; school 2: 91.7%) and approximately 42% of enrolled students (school 1: 42.1%; school 2: 42.8%) are eligible for free or discounted school lunch (www.nces.ed.gov).

Protection of Participant Rights

Prior to this study, a consent form was sent home with all kindergarten students in each school to explain the study and request permission for participation. With one exception, all students who returned a signed parent consent form were included as a participant in the study. The study was explained to the children prior to their participation and they were informed that they could withdraw from the study at any time if they feel uncomfortable. Data was collected at the schools, in a hallway between the kindergarten classrooms. The assessments took place during elective activities (i.e. gym, music or art class) to ensure participants were not absent during any academic instruction.

No identifying information was collected; instead, each child was given a participant ID for research purposes.

Measures

Inhibition of prepotent response

The inhibition of the prepotent response was measured using the conflicting stimulus paradigm. The classic example of a conflict measure is the Stroop color-word task, created by J. Ridely Stroop (1935). In this task, color words (e.g. the words "red" or "yellow") are printed in the ink of another color. Participants are asked to name the color of the ink rather than the printed word. To respond correctly, participants must inhibit the prepotent response to read the name of the word and instead produce the name the color of ink (Stroop, 1935).

In the present study utilized two versions of the Stroop that were specifically adapted for the assessment of children. The first measure, called the Day and Night test (Gerstadt et al., 1994) included two consecutive trials, first the naming trial and then the inhibition trial. Testing materials for the Night and Day test consisted of two, 8 x 11 inch laminated stimulus cards depicting a series of randomly alternating sun and moon images. The practice card showed a series of five images and the test card showed a series of 25 images. Participants demonstrated their comprehension of instructions on practice items prior to both trials. On the naming trial, participants were instructed to point to the images and name them by saying "day" for the image of the sun and saying "night" for the image of the moon and stars. For the inhibition trial, the child was instructed "to play the game in the opposite way" by saying "night" for the image of the sun and saying "day" for the image of the moon and stars. Because children associate the

sun with daytime and the moon with nighttime, this task requires them to inhibit their natural tendency to give a different verbal response. Performance on this task was measured by the number of correct responses.

The second measure of the inhibition of prepotent response was the Yes or No test (Krasil'nikova, in Burmenskaya, Karabanova, & Liders, 1990). For this measure, children were asked a list 25 questions. Twenty questions provoked an answer of "yes" or "no" (e.g. "Do you go to kindergarten?"; "Do you like ice-cream?") and five filler questions provoked an alternate response (e.g. "Are you a boy or a girl?"; "What color is grass?"). Children were instructed to answer the questions without using the words "yes" or "no" in their responses. The examiner modeled an answer that avoids using "yes" or "no," by responding with a complete sentence that echoes the question (e.g. Q: "Do you like ice-cream" A:"I do not like ice-cream"). In other words, the Yes or No test required participants to inhibit his or her prepotent response of "yes" or "no." Performance on this task was measured by the number of incorrect responses.

Motor Inhibition

Motor inhibition was measured using a task called Draw-a-Line-Slowly (D-A-L-S). For this task, participants first practiced drawing straight lines with a ruler and a pencil on a blank piece of paper. The children were then presented with two test trials. On the first trial, the child was presented with a 6-inch dotted line and instructed to use the dots, instead of the ruler, to help them draw a straight line. On the second trial, the child was presented with a second 6-inch dotted line and instructed to draw a straight line "a slowly as you can." The coding included the duration (in seconds) for two trials.

Performance on this task was determined by subtracting the completion time for the first trial from the completion time for the second trial of the
D-A-L-S task (Maccoby et al, 1965).

Delayed Gratification

For the present study, children were presented with 8 brief scenarios in which they were asked to choose between a small, immediate reward (one candy, one toy, one game, one cupcake, etc.) and a larger, delayed reward (three candies, two toys, two fun games, etc.). Participants were presented with 4 scenarios at the beginning of the assessment, and 4 scenarios at the end of the assessment. The 4 scenarios at the end of the assessment offered the children larger delayed rewards (four candies, three toys, three fun games, etc.) The total number of delayed choices across 8 situations determined the participant's performance on this measure.

Classroom Behavior

Classroom behavior was measured using The Teacher-Child Rating Scale, 2.1 (T-CRS 2.1; Hightower, et al., 1986). The child's teacher or another professional who has had four to six weeks of ongoing contact with the child at school should complete the T-CRS 2.1. In this study, the children's kindergarten teachers completed the T-CRS 2.1 for each participant.

The Teacher-Child Rating Scale, 2.1 (T-CRS 2.1) is a 32-item measure assessing positive and negative aspects of socio-emotional school adjustment for children in preschool to sixth grade. Items are grouped into four empirically derived domains of child adjustment. The four domains include: Task Orientation, Behavior Control, Assertiveness, and Peer Social Skills. Each of these scales contains 8 items; four

positively worded items and four negatively worded items. For example, within the Behavior Control domain, a positively worded item is "*Tolerates Frustration"* and a negatively worded item is "*Overly aggressive to peers (fights)."* Ratings are based on a 5-point Likert scale, ranging from 1= Strongly Disagree to 5 = Strongly Agree. The Task Orientation domain assesses a child's ability to focus on academic task and includes statements such as, *"Functions well even with distractions*," *"Has poor concentration, limited attention span," "Completes schoolwork,"* and *"Has difficulty following directions."* The Behavior Control domain measures a child's skill in tolerating and adapting to his or her own limitations or limits imposed by the school environment; it includes items such as, *"Copes well with failure," "Defiant, obstinate, stubborn," "Accepts imposed limits,"* and *"Disruptive in class."* The Assertiveness domain assesses a child's interpersonal functioning and confidence in peer relations and includes statements such as, *"Defends own views under group pressure" "Anxious, worried," "Participates in class discussion"* and *"Withdrawn."* The Peer Social Skills domain measures the child's likeability or popularity among peers. Examples of items within the Peer Social Skills domain include, *"Well liked by peers" "Lacks social skills with peers," "Classmates like to sit near this child"* and *"Has trouble interacting with peers"* (Kelley, Reitman & Noel, 2003

CHAPTER IV

RESULTS

Descriptive statistics yielded the following results: On the Night and Day measure, participants had a mean of 21.24 correct responses (*SD* = 4.99) out of a maximum score of 25 responses, they had a mean of 10.81 incorrect responses (*SD* = 7.63) out of a maximum of 20 responses, and a mean of 6.42 (*SD* = 1.97) delayed responses out of a maximum of 8 responses. Finally, participants yielded a mean of 17.36 seconds (*SD* = 14.7) for the difference in time between the two D-A-L-S trials. Descriptive statistics are presented in Table 1.

Table 1

Descriptive Statistics for Participant Performance on Four Inhibition Measures

	Night/Day Correct	D-A-L-S Time	Yes/No[a]	Delayed Gratification
Mean	21.24	17.36	10.81	6.42
Median	23.00	14.00	12.00	7.00
Mode	24.50	8.00	20.00	8.00
Std. Deviation	4.99	14.71	7.63	1.97
Range	25.00	62.00	20.00	7.00
Minimum	0.00	-1.00	0.00	1.00
Maximum	25.00	61.00	20.00	8.00

Note. Multiple modes exist. The smallest value is shown.
[a] Performance on the Yes or No task was measured by the number of incorrect responses.

Teachers' T-CRS 2.1 ratings on the Task Orientation domain had a mean of 27.88 (*SD* = 10.11) ratings on the Behavioral Control domain had a mean of 29.28 (*SD* = 6.70), ratings on the Social Skills domain had a mean of 31.35 (SD = 7.80) and ratings on the Assertiveness domain had a mean of 30.44 (*SD* = 6.65). Descriptive statistics for the teacher ratings on the four domains of classroom behavior are presented in Table 2.

Table 2

Descriptive Statistics for Teacher Ratings of Classroom Behavior Variables

	Task Orientation	Behavioral Control	Assertiveness	Social Skills
Mean	27.88	29.28	30.44	31.36
Median	29.00	30.00	32.00	34.00
Mode	40.00	25.00[a]	32.00[a]	40.00
Std. Deviation	10.11	6.70	6.65	7.80
Range	37.00	29.00	24.00	26.00
Minimum	10.00	11.00	16.00	14.00
Maximum	40.00	40.00	40.00	40.00

Note. Multiple modes exist. The smallest value is shown.

Analysis of values for skewness and Kolmogorov-Smirnov's test of normality indicated violation of univariate normality for Night/Day correct responses, D-A-L-S and Delayed Gratification. The negative skew on the Night/Day correct responses and the Delayed Gratification variables were transformed using the Reverse and Logarithm procedure. The positive skew of the D-A-L-S variable was transformed using the Square Root procedure.

Research Question 1: Does gender effect performance on behavioral inhibition tasks and teacher ratings of classroom behavior?

Results for girls and boys performance on the inhibition tasks are presented in Table 3. A one-way ANOVA indicated no statistically significant effect of gender on the Night and Day F (1, 62) = 3.78, p = .057, the D-A-L-S F (1, 60) = .50, p = .481, and the Delayed Gratification tasks F (1, 62) = 1.53, p = 0.220. Gender appears to have a significant effect on performance on the Yes and No task F (1, 62) = 5.27, p = .025, η^2 = .08; however, when the alphas is adjusted (.05/4 variables), the effect becomes insignificant. Although the gender differences on this task did not rise to the level of statistical significance, it is worth noting that the girls in this sample made fewer errors (M = 8.48, SD = 7.27) when compared to the boys (M = 12.74, SD = 7.5).

Table 3

Mean and Standard Deviations for Gender and Behavioral Inhibition Tasks

	Girls		Boys	
	M	*SD*	*M*	*SD*
Yes/No	8.79	7.58	12.53	7.27
Night/Day Correct	22.29	4.68	20.25	5.12
D-A-L-S	17.03	12.19	17.55	16.46
Delayed Gratification	6.38	2.01	6.50	1.95

Results for the teacher ratings of classroom behavior for girls and boys are presented in Table 4. A one-way ANOVA indicated no statistically significant effect of gender on classroom behavior the four rating scale variables of Task Orientation F (1, 62)

= 2.32, p = .133, Behavioral Control F (1, 62) = .31, p = .582, Assertiveness F (1, 62) = 1.41, p = .240, and Social Skills F (1, 62) = .525, p = .471.

Table 4

Mean and Standard Deviations for Gender and Classroom Behavior Ratings

	Girls		Boys	
	M	*SD*	*M*	*SD*
Task Orientation	29.52	9.20	26.58	10.59
Behavioral Control	29.93	6.49	28.78	6.82
Assertiveness	31.28	6.14	29.67	6.98
Peer Social Skills	32.31	6.81	30.61	8.41
Classroom Behavior Total	123.03	24.12	115.64	28.61

Research Question 2: Are there associations between direct measures of inhibition?

Pearson product-moment correlation coefficients were computed to assess the relationship between the behavioral inhibition measures. Correlations between the children's performance on the Yes and No, Night/Day, D-A-L-S and Delayed Gratification tasks are presented in Table 5. Analysis did not show statistically significant correlations among the direct behavioral measures of inhibition of proponent response, motor inhibition and delayed gratification (i.e. Yes and No, Night/Day, D-A-L-S, Delayed Gratification tasks).

Table 5

Correlations Between Inhibition Variables

	Yes and No	Night/Day Correct	D-A-L-S	Delayed Gratification
Yes and No	-	0.17	-0.20	0.14
Night/Day Correct	-	-	-0.08	0.17
D-A-L-S	-	-	-	-0.02
Delayed Gratification	-	-	-	-

Note. The negative signs on the Night/Day and Delayed Gratification values should be interpreted as positive as these variables were transformed using the reverse procedure.

Research Question 3: Which behavioral inhibition variables are most influential in predicting Task Orientation and Behavioral Control in the classroom?

Before proceeding to main analyses, pearson product-moment correlation coefficients were computed to assess the relationship between the performance on inhibition measures and teacher ratings of classroom behavior. Correlations between the performance on inhibition measures and teacher ratings of classroom behavior are presented in Table 6. There was a positive correlation between performance on the D-A-L-S task and teacher's ratings on both the Task Orientation, r (62) = .34, p = .008 and Social Skills domains, r (62) = .29, p = .02. A negative correlation was found between the number of incorrect responses on the Yes or No task and teacher's ratings on the Task Orientation domain, r (62) = -.25, p = .042. There was also a positive correlation between student performance on the Night and Day task and teacher's ratings on the Behavioral Control domain, r (62) = .38, p = .002.

Table 6

Correlations Between Inhibition Variables and Classroom Variables

	Task Orientation	Behavioral Control	Assertiveness	Social Skills
Yes and No Incorrect	-0.26*	-0.13	-0.20	-0.10
Night/Day Correct	-2.37	-0.38**	-0.27	-0.22
D-A-L-S	0 .34**	0.13	0.24	0.29*
Delayed Gratification	-0.20	-0.20	-0.22	-0.10

Note. The negative signs on the Night/Day and Delayed Gratification values should be interpreted as positive as these variables were transformed using the reverse procedure.
* Correlation is significant at the $p < .05$ level (2-tailed)
** Correlation is significant at the $p < .01$ level (2-tailed)

Multiple regression analysis was conducted to determine which behavioral inhibition variables predict Task Orientation in the classroom. Inspection of residual scatterplots indicated no significant violations of linearity, normality and homoscedasticity. Tolerance statistics indicated no multicollinearity among the independent variables and no multivariate outliers were detected by the Mahalonobis distance test.

Regression results indicate that the overall model significantly predicts task performance, $R^2 = .18$, $R^2_{adj} = .13$, $F\ (4, 57) = 3.22$, $p < .05$. The model accounts for 18.4% of variance in Task Orientation and is a significant fit to the data. A summary of regression coefficients presented in Table 7 indicates that performance on the D-A-L-S task was a significant predictor of Task Orientation, $t\ (57) = 2.47$, $p < .05$. The positive

beta value (.30) indicates a positive relationship between performance on the D-A-L-S task and tasks orientation in that as performance on the on the D-A-L-S task improves, the teacher's ratings on Task Orientation improve too. Performance on the Delayed Gratification and Night and Day tasks were not significant predictors of Task Orientation.

Table 7

Regression Analysis for Behavioral Inhibition Variables and Task Orientation

	B	*β*	*t*	*p*	Biv. *r*	Partial *r*	Part *r*
Yes and No	-0.13	-0.10	-0.80	0.43	-0.20	-0.11	-0.10
Night/Day Correct	-3.76	-0.125	-1.01	-0.33	-0.20	-0.12	-0.12
D-A-L-S	1.72	0.30	2.47	0.02*	0.34	0.31	-0.30
Delayed Gratification	-5.34	-0.169	-1.36	0.18	-0.22	-0.18	0.16

Note. The negative signs on the Night/Day and Delayed Gratification values should be interpreted as positive as these variables were transformed using the reverse procedure.
* $p < .0$

Multiple regression analysis was conducted to determine which behavioral inhibition variables predict Behavioral Control in the classroom. Inspection of residual scatterplots indicated no significant violations of linearity, normality and homoscedasticity. Tolerance statistics indicated no multicollinearity among the independent variables and no multivariate outliers were detected with the Mahalonobis distance test.

Regression results indicate that the overall model significantly predicts Behavioral Control $R^2 = .17$, $R^2_{adj} = .11$, $F(4,57) = 2.93$ $p < .05$. The model accounts for

17.1% of variance in Task Orientation and is a significant fit to the data. A summary of regression coefficients is presented in Table 8 and indicates that performance on the Night and Day task was a significant predictor of Behavioral Control, t (57)= -3.00, $p <$ .01. The Night and Day variable was transformed using the reverse procedure, therefore; negative values should be interpreted as positive. The beta value (-.375) indicates that as performance on the Night and Day task improves, teacher ratings on Behavioral Control also improve. Performance on the D-A-L-S and the Delayed Gratification tasks were not significant predictors of Behavioral Control.

Table 8

Regression Analysis of Behavioral Inhibition Variables and Behavioral Control

	B	β	t	p	Biv. r	Partial r	Part r
Yes and No	-3.33	-0.00	-0.03	0.98	-0.09	-0.00	-0.00
Night/Day Correct	-7.67	-0.38	-3.00	0.00*	-0.40	-0.37	-0.36
D-A-L-S	0.38	0.10	0.80	0.43	0.13	0.11	0.10
Delayed Gratification	-1.27	-0.06	-0.48	0.64	-0.15	-0.06	-0.06

Note. The negative signs on the Night/Day and Delayed Gratification values should be interpreted as positive as these variables were transformed using the reverse procedure.
* $p < .0$

Chapter V

DISCUSSION

Self-regulation is an important set of skills that has been linked to school adjustment, academic achievement and positive peer relationships in elementary school children (McClelland et al., 2007b). At the same time, poorly regulated children are at greater risk for emotional and conduct problems and school dropout in late childhood and adolescence (Eisenberg et. al, 2000). This study examined the association between direct measures of behavioral inhibition and (inhibition of prepotent response, motor inhibition and delayed gratification) and classroom behavior in 5 to 6-year-old kindergarten children.

The first goal of the research was to explore gender differences on behavioral inhibition tasks and teacher ratings of classroom behavior. The results showed no statistically significant effect of gender on the Night and Day, D-A-L-S and Delayed Gratification tasks. Previous research has found gender differences in inhibitory control and other regulatory abilities. For example, in a study of inhibitory control and emerging internalization, Kochanska et al. (1996) found gender differences with girls outperforming boys on a multi-task inhibitory control battery that included the D-A-L-S task and a delayed gratification task. Matthews, Ponitz and Morrison (2009) had similar findings: Girls significantly outperformed boys on two measures of self-regulation including an objective direct measure of inhibition of prepotent response (Head-Toes-Knees-Shoulders task) and a teacher report of classroom self-regulatory behavior (the Child Behavior Rating Scale) (Matthews et al., 2009). In the present study, girls made

fewer errors than boys on the Yes or No task though the gender differences in performance did not rise to the level of statistical significance when the alpha level was adjusted. A gender effect favoring female participants on this task may be explained by girls' more advanced language skills during childhood. While the Night and Day task and the Yes or No task both require the inhibition of prepotent response, the Yes or No task requires stronger language abilities to produce a correct response. A correct response on the Yes or No task is not simply one word (i.e. "night" or "day") but rather a complete sentence (i.e. "I do like ice cream," "Flowers do not bloom in the spring). As girls tend to acquire language earlier and tend to be more talkative than boys, girls may be expected to perform better than boys on a task that requires an elaborate verbal response (Gleason & Ely, 2002).

It is important to mention that overall children's performance was weaker and more variable on the Yes and No test when compared to the Night and Day measure. Participants performed near ceiling on the Night and Day task; however, they had difficulty with the Yes and No test as indicated by the mean number of errors (10 out of 20). In the present study, the results from the Night and Day task were consistent with previous research findings in that participants made few errors and there was little variability in performance. Research literature indicates that children begin to perform near ceiling on the Night and Day task by age 6 (Gerstadt et. al, 1994). The participant's discrepant performance on these two tasks may be attributed to a difference in difficulty. The Night and Day task requires children to remember one rule (to say the opposite) and inhibit their dominant response. Task demands for the Yes and No measure, on the other hand, are more complex. The Yes and No task requires children not only to remember

the rules (don't say "yes" or "no") and inhibit their dominant response, but also to formulate a verbal response to questions asked.

In the present study, no significant gender differences were found in teacher ratings of classroom behavior. This finding was surprising given that several studies have shown such differences from both parent and teacher behavioral ratings. For example, in a longitudinal study examining the developmental course of self-regulation, mothers consistently rated girls significantly higher than boys in regulation of affect, attention and behavior (Raffaelli, Crockett & Shen, 2005). In a study of adaptive classroom behavior, teachers reported that boys showed less behavioral and cognitive self-control, less positive work-habits and more time off-task in the classroom when compared to girls (Rimm-Kaufman et al., 2009). These gender differences in behavior appear to be stable throughout childhood. For example, in a longitudinal study lasting over a period of 8 years, teachers rated girls higher in self-regulation (e.g. attentiveness, tasks persistence, eagerness to learn) than boys in a sample of nationally representative kindergarten students (Xue & Meisels, 2004). One explanation of a lack of convergence between the finding from the present research and previous research is the sample size. The previous studies included 36 (Rimm-Kaufman et al., 2009) to 3,090 teachers (Xue & Meisels, 2004) while the present study had only six kindergarten teachers to complete behavioral ratings scales. It is possible that the increased number of respondents revealed gender differences that could not be seen given the smaller group of respondents.

An examination of the relationship performance on direct measures and teacher ratings showed positive correlations between children's performance on the measure of motor inhibition (D-A-L-S task) and teacher's ratings on the Social Skills and Task

Orientation domains of the T-CRS 2.1. The correlation between performance on the motor inhibition task and rating on the Social Skills domain reaffirms previous findings that impulsive behavior is associated with weaker social competence (Olson, 1989). The correlation between motor inhibition and Task Orientation suggests that weak motor inhibition interferes with their ability to focus on schoolwork.

Significant correlations were also found between student performance on a measure of inhibition of prepotent response (Night and Day task) and teacher ratings on the Behavioral Control domain, and between performance on a different measure of inhibition of prepotent response (Yes and No task) and teacher ratings on the Task Orientation domain. It is curious that tasks that are intended to measure the same dimension of inhibition would correlate with different domains of classroom behavior. Perhaps just as the "Yes and No" task is more complex and demanding when compared to the "Night and Day" task, the Task Orientation domain taps into more developmentally advanced behavior than the Behavioral Control domain. The Behavioral Control items appear to relate to a child's response to external regulation (e.g. *"accepts imposed limits;" "defiant, obstinate, stubborn;" "disruptive in class"*). Alternatively, the Task Orientation items relate to more internal regulation and independence in the classroom (e.g. *"a self-starter;""works well without adult support;""underachieving, not working to ability")*. These findings are consistent with previous research demonstrating that children who performed well on a measure requiring the opposite of a dominant response also earned higher teacher ratings of classroom behavioral regulation (Ponitz et al., 2007).

The present study included an examination of the relationship among the direct measures of behavioral inhibition (i.e. Yes and No, Night and Day, D-A-L-S, Delayed Gratification). Surprisingly, the results did not show any significant correlations among the direct measures of inhibition though previous research findings have demonstrated such correlations. For example, in a study of children ages 2 to 4, Kochanska et al. (1996) found high consistency in a battery of multiple inhibitory control measures with including delaying, slowing down motor activity, initiating and inhibiting response to signal, lowering voice volume and reflective information processing.

The third research question asked which behavioral inhibition variables (e.g. motor inhibition, inhibition of prepotent response or delayed gratification) were most influential in predicting Task Orientation and Behavioral Control in the classroom. Results demonstrated that only performance on motor inhibition task (D-A-L-S) was a significant predictor of Task Orientation in the classroom. Regression analysis showed a positive relationship between performance on the D-A-L-S task and Task Orientation. The D-A-L-S task measures the slowing down of motor activity. Research literature has proposed that executive functions, including inhibitory control, "support the cognitive and behavioral self-regulation and facilitate planning, problem solving and the initiation and maintenance of goal-directed behavior" (Berry, 2012, p. 67). Similarly, it is likely that a child's ability to control their motor activity (i.e. sitting in their seat, sitting still, raising their hand before speaking, etc.) is associated with his or her ability to focus on academic tasks. The Task Orientation scale measures a student's ability to pay attention, follow directions and work well even with distractions. As multiple researchers have identified inhibitory motor control as a core deficit of Attention-Deficit Hyperactivity

Disorder, it is appropriate that performance on a measure of motor inhibition can predict a child's ability to concentrate and resist distraction in the classroom (Lijffijit et al., 2005).

Out of four variables (Night and Day, Yes or No, Delayed Gratification, D-A-L-S) performance on the Night and Day task only was a significant predictor of teacher ratings of Behavioral Control. Regression analysis showed a positive relationship between performance on the Night and Day task and Behavioral Control. Previous studies arrived at similar findings. For example, in their study of self-regulation and adaptive behaviors in the kindergarten classroom, Rimm-Kaufman and colleagues (2009) found that children's self-regulation was associated with teacher's report of behavioral self-control.

Implications for School Psychology Practice

The importance of behavioral regulation for school readiness and academic achievement is well documented (McClelland et al., 2007; Shonkoff & Phillips, 2000). Existing research indicates that self-regulation is most "pliable and subject to change in early and mid-childhood" (Rimm-Kaufman et al., 2009, p. 969). Early elementary school is a critical period when children are most sensitive to environmental influences that foster or hinder the development of self-regulatory skills. It is also a time when children establish a pattern of learning-related behaviors they carry into consecutive years of education. In fact, "previous research has found that children's academic performance remains on an extremely stable trajectory after the first grade" (Howse, Calkins, Anastopoulos, Keane, & Shelton, 2010). Therefore, it is essential for parents, teachers, and schools to establish practices that promote self-regulation. For example, measures of

behavioral inhibition could easily be included in kindergarten screenings commonly used to assess different developmental capacities for school readiness. Similarly, early elementary school psychoeducational evaluations can incorporate behavioral inhibition measures in order to identify deficits and enact appropriate interventions. The measures utilized in the present study have the potential for future use on a larger scale because they are brief, inexpensive and require minimal training to administer. Although there are no established norms for these measures, school-based norms would not be difficult to collect and examiners could initially compare a child's performance to their classroom or same age/grade peers.

School psychologists can help children develop the learning related skills that have been linked to school success through parent education and teacher training (McClelland & Cameron, 2011). Parents can support the development of self-regulation at home by modeling appropriate behavior during everyday activities. An adult talking aloud as they perform a skill not only explains the steps required for a task, but helps children begin to understand what intentional, deliberate behavior looks like.

Research indicates that parent's who support their child's autonomy and independent choices tend to have children with higher self-regulation than parents who emphasize compliance and following rules (Bernier et al., 2010). Parents can help children move away from other-regulation towards self-regulation by scaffolding developmentally appropriate skills.

School-based self-regulation interventions can range from an easily implemented set of circle-time games to large-scale programs that often require extensive teacher training and materials (Tominey & McClelland, 2011). Research examining the effects

of classroom-based interventions aimed at improving inhibition control indicates that daily inhibition exercise appears to enhance inhibition development "much as physical exercise builds bodies" (Diamond et al., 2007). The most successful programs include repeated practice and the progressively increase the challenge to inhibition skills (Diamond & Lee, 2011). Tominey and McClelland (2011) demonstrated the positive effects of circle games to improve behavioral self-regulation in preschool. The games used in this study offered children opportunities to practice inhibitory control behaviors by starting and stopping to different cues (verbal and visual), performing specific behaviors in response to cues and performing opposite behaviors. For example, in the *Red Light, Purple Light* game, a teacher acts as a stoplight by standing at the opposite side of the room from the children and holding up different-colored construction paper circles to represent stop and go. The children respond to specific color cues (e.g. blue is stop and orange is go) and then opposite cues (e.g. orange is go and blue is stop) as well as to different shapes representing stop and go (e.g., any color square is stop and any color circle is go). Researchers found that participation in the treatment group significantly predicted gains in self-regulation for children with low levels of these skills (Tominey & McClelland, 2011).

Tools of the Mind curriculum developed Bodrova and Leong's (2006) also foster self-regulation skills in young children. It is based on the Vygotsky idea about the role of play in self-regulation. The curriculum promotes self-regulation skills children through the use of private speech (telling oneself out loud what one should do), scaffolding, mature make believe play and memory and attention exercises that are interwoven into academic activities. Play, including imaginative play as well as rule-based games like the

ones described earlier, is central to the Tools curriculum. Play is believed to help children act in more mature ways and use more mature mental functions that foster self-regulation. Students first must create a play plan and plan each scenario, to deciding on role, actions and use of props before it is acted out. Through play, children have the opportunity to practice inhibition skills because to stay in the play, children must abide by the rules.

In the classroom, teachers can have children practice motor inhibition by playing "stop and go" or "freeze" games in which children stop and start different actions, as directed by a leader (www.toolsofthemind.org). For example, in the *Freeze Game* children dance to music and freeze when the leader stops the music. The game alternates between slow and fast songs with children dancing slowly to slow songs and quickly to fast songs. The game then has children respond to opposite cues by dancing quickly to slow and slowly to fast songs (Tominey & McClelland, 2011). Children can practice cognitive inhibition skills with games that require them to pay attention to specific attributes of something while ignoring other attributes. For example when reading a story about animals, teachers can ask children to clap when they see a picture of an animal with a tail. The game can be made more challenging if there is more than one rule (i.e. clap your hands when you see an animal with a tail, snap your fingers when you see animal that has spots), (www.toolsofmind.org).

Adults play a vital role in helping young children develop self-regulation skills. Therefore, it is essential that teachers and parents understand the importance of self-regulation. Teacher training and parent education on self-regulation can help adults

adopt developmentally appropriate expectations and learn strategies to teach self-regulation skills.

Limitations and Directions for Future Research

There are a number of limitations to the present study. The primary limitation is the small sample size. The small sample of mostly white, working-class children from two rural schools significantly limits the extent to which findings generalize across demographically variable regions. In addition to generalizability, the small sample size raises caution in interpreting regression analyses results. Although the participants in this study were recruited from mainstream education classrooms and presumed to have cognitive functioning within the average range, this study did not formally control for IQ.

With the proliferation of different self-regulation training programs, it is important to understand the relationship the between the assessment measures and the classroom behaviors these programs intent to target. Reliable and valid assessment of these skills are needed to identify children with weak self-regulation skills, monitor developmental progress of individual children and evaluate intervention efficacy by monitoring progress of children in these programs. There have been considerable methodological challenges in the study of self-regulation in school contexts. Much of the research on self-regulation has relied on parent or teacher ratings of children's behavior that are subject to observer bias. Direct observational measures are often impractical for school-based research because they are part of longer batteries intended for the laboratory. Existing research recognizes the benefit of multi-method batteries that combine direct behavioral measures, teacher reports and classroom observations in order to provide a complete picture of self-regulation and classroom behavior (McClelland &

Cameron, 2011). However, further research is needed to ensure ecological valid measurement of inhibition.

Appendix A

Behavioral Inhibition Measures Protocol

School_____
protocol_____
Age_____
Gender ____ male ____female
# of siblings_____
Family ____ intact _____ one parent

Delayed gratification task: Part 1

I want to ask you several questions (underline child's responses)

1. Imagine, that you can get one candy now. But, if you wait, you will get three candies later.

   Which do you choose: **one candy now** OR **three candies later**?

2. Imagine that you can get a fun toy today. But, if you wait you can get two fun toys later.

   Which do you choose: **one toy today** OR **two toys later**?

3. Imagine you can get one cupcake now. But, if you wait you can get three cupcakes later.

   Which do you choose: **one cupcake now** OR **three cupcakes later**?

4. Imagine your can get one fun game now. But, if you wait you can get two fun games later.

   Which do you choose: **one game now** OR **two games later**?

# of delayed responses for part 1_____

Night-and-Day Test

Show the child pictures with day and night. Say: "We are going to play a game called "Night-and-Day. I will show you how to play this game." Using practice items, point to the pictures and name them. Ask the child to do the same. After that ask the child: "Do you understand how to play this game?" If the child says "Yes", proceed with the test items; if the child does not understand the task, repeat explanation.

Test 1: "After I say "Go" start here and go this way (show from the left to the right), this row, then this row until you finish this page. Do you understand?"
If the child answers "Yes" , say "Go" and start timing.

Record time in seconds
Test 1_____ time in seconds

Test 2. (Inhibition): "Now, you are going to play this game in the opposite way. When you see a picture of Night you say "Day", when you see a picture of Day say "Night." Let's try! Show the child practice items and ask to name those items in the opposite way. Practice until the child understands this task.

"Now you understand how to play this game. When I say "Go" you have to start here and go this way (show from the left to the right), this row, and then this row until you finish this page. Do you understand?" "Go!"

Start timing after you say, "Go." Record correct answers in the table.
Each correct answer receives 1 point. For incorrect answer, record "0."
If child correct him/herself, give .5 points.

N D N N D

D N D D N

N D N N D

D N D D N

D D N N D

Record time in seconds
Test 2_____ time in seconds

Total number of correct responses for test 2_____

Draw-a-Line-Slowly (DALS)

Present child with a pencil and separate sheet of paper for this task.

Trial 1: "Now I want you to practice drawing a straight line. Take this pencil and draw a straight line using these dots to help you."

Record time in seconds
Trial 1 _____time in seconds

Trial 2: "Here is another set of dots. This time I want you to draw a straight line but I want you to draw it in just as slowly as you can. Remember, draw it very slowly."

Record time in seconds
Trial 2 _____time in seconds

_____ - _____ = _____
Trial 2 time Trial 1 time

“Yes and No” Test

“We are going to play another game. I will ask you questions and you will answer them. This game has a rule: You cannot say ‘Yes’ or ‘No.’ For example, if I ask you ‘Do you have toys?’ you cannot say ‘Yes’ you should say ‘I have toys.’ Or if I ask you ‘Do people walk on the ceiling?’ you cannot say ‘No,’ instead you should say ‘People do not walk on the ceiling.’ Remember, you cannot say ‘Yes’ and ‘No.’ Do you understand the game?”

If the child has difficult time understanding the instruction, the instruction is repeated. If the child understands the task, proceed with the task items. (NOTE: 20 questions provoke child to say, “Yes” and “No”; 5 questions are filler questions).
Circle incorrect answers. Each incorrect answer is scored 1.

	Incorrect answers	**Points**
1. What is your name?	-	-
2. Are you a boy or a girl?	-	-
3. Do you go to kindergarten?	**yes/no**	Remind
4. Do you like school?	**yes/no**	
5. Do you live far away from the school?	**yes/no**	
6. Do you like ice-cream?	**yes/no**	
7. What color is ice-cream?	-	-
8. Have you eaten chocolate ice-cream?	**yes/no**	
9. Can you walk on your hands?	**yes/no**	
10. Can you fly?	**yes/no**	
11. Do dogs play with toys?	**yes/no**	
12. Can we see sun at night?	**yes/no**	
13. Is a mouse afraid of a cat?	**yes/no**	
14. Do you like to visit the dentist?	**yes/no**	
15. What color is grass?	-	-
16. Do doctors cut people’s hair?	**yes/no**	

17. Is your name….(give a wrong name)?	**yes/no**	
18. Can a cow fly?	**yes/no**	
19. Are you sleeping now?	**yes/no**	
20. Do you go to school?	**yes/no**	
21. Do you wear shoes?	**yes/no**	
22. Is grass white?	**yes/no**	
23. Do flowers bloom in the winter?	**yes/no**	
24. What color are bananas?	-	-
25. Is snow black?	**yes/no**	

Total incorrect answers_____

Delayed gratification task: Part 2

I want to ask you some questions (underline child's responses)

1. Imagine, that you can get one candy now. But, if you wait, you can get four candies later.

   Which do you choose: **one candy now** OR **four candies later**?

2. Imagine that you can get a fun toy today. But, if you wait you can get three fun toys later.

   Which do you choose: **one toy today** OR **three toys later**?

3. Imagine you can get two cupcakes now. But, if you wait you can get three cupcakes l later.

   Which do you choose: **two cupcakes now** OR **three cupcakes later**?

4. Imagine your can get one fun game now. But, if you wait you can get three fun games later.

   Which do you choose: **one game now** OR **three games later**?

# of delayed responses for part 2_____

Score for part 1____ + Score for part 2_____ =_____ (total)

Appendix B

Parent/Guardian Informed Consent
Please Return by May 29, 2013

Identification of Investigators & Purpose of Study
Your child is being asked to participate in a research study conducted by Samantha Tynan and Dr. Elena Savina from James Madison University. The purpose of this study is to determine if the children's impulse control is associated with how they behave in the classroom (e.g., follow teacher's instruction, focus attention, and relate to peers). This study will contribute to the researcher's completion of her doctoral dissertation.

Research Procedures
Should you decide to allow your child to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. The study will take place in the XX Elementary school building. The children will participate in a brief assessment of impulse control that includes four interactive, enjoyable tasks. The performance on these tasks will later be compared to their teacher's ratings of the children's behavioral control, attention, and social skills. Teacher ratings of classroom behavior will be collected using the Teacher-Child Ratings Scale 2.1.

Time Required
Participation in this study will require 10-15 minutes of your child's time and his/her participation will not interfere with any academic instruction.

Risks
The investigator does not perceive more than minimal risks from your child's involvement in this study (that is, no risks beyond the risks associated with everyday life).

Benefits
This research will benefit professional understanding of the relationship between self-regulation and classroom behavior and inform classroom interventions for children with poor behavioral inhibition.

Confidentiality

The data obtained in study will be treated in confidential manner. The results of this project will be coded in such a way that the child's identity will not be attached to the final form of this study. All data will be stored in a secure location accessible only to the researcher and after 3 years, it will be destroyed. Only the averaged data will be presented at a dissertation defense meeting and professional conferences. The researcher also retains the right to use and publish non-identifiable data.

Participation & Withdrawal

Your child's participation is entirely voluntary. He/she is free to choose not to participate. Should you and your child choose to participate, he/she can withdraw at any time without consequences of any kind

Questions about the Study

If you have questions or concerns during the time of your child's participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

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Questions about Your Rights as a Research Subject

Dr. David Cockley
Chair, Institutional Review Board
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Giving of Consent

I have read this consent form and I understand what is being requested of my child as a participant in this study. I freely consent for my child to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form.

I certify that I am at least 18 years of age.

_____

Name of Child (Printed)

_____
Name of Parent/Guardian (Printed)

_____ _____
Name of Parent/Guardian (Signed) Date

_____ _____
Name of Researcher (Signed) Date

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