Behavioral Regulation in Pre-Kindergarten: The Interplay between Hot and Cool Regulation and the Classroom Context

Megan Thomas

The University of North Carolina at Chapel Hill

Approved By:

Jennifer Coffman, Ph.D.

Peter Ornstein, Ph.D

Cathi Propper, Ph.D

Abstract

One important predictor of school readiness and later academic outcomes is the early development of self-regulation. Self-regulation, particularly executive function has been found to impact not only educational outcomes but more generalized developmental trajectories. The roles of hot and cool regulation in the pre-kindergarten period will be analyzed by exploring the relationships between regulation, the classroom context, and child-level outcomes such as school readiness and task orientation in the classroom environment. Behavioral, cognitive, and observational measures were analyzed in a sample of preschool children across two assessment points, and found potential differential impacts of the preschool classroom context across subgroups of children with varying levels of regulatory abilities. Children's school readiness scores as well as task orientation within the classroom and the child's ability to regulate were moderated by the quality of the preschool classroom. The conclusions drawn from this study were based upon data collected with a small pilot sample of participants as part of a larger, ongoing study and should be further explored in larger, more diverse populations.

ACKNOWLEDGEMENTS

I would like to thank my faculty adviser, Dr. Jennifer Coffman for her support, advice, and mentorship. I have truly enjoyed the incredible opportunity to work in her labs for the past two years. I have appreciated everything she has done for me in completing this project and realizing my academic and personal goals. I am especially thankful for her willingness to answer emails at all hours, edit my work at any point, and generally guiding me throughout my senior thesis project.

I also wish to thank my faculty adviser, Dr. Peter Ornstein for his support, vast experience and knowledge, and allowing me to be a part of his lab during my time at Carolina. I have valued his guidance more than I can express. Dr. Cathi Propper has been invaluable in every step of this project. I owe her a debt of gratitude for all the time she has dedicated to my project and for her mentorship. The advice and feedback she provided me has been helpful beyond measure.

I greatly appreciate the efforts of all of the members of the LEAPS study who made this thesis possible with their tireless efforts in data collection and coding. I especially want to thank Kesha Hudson and Marie Chardon for answering my questions, both large and small, along the way. Additionally, I want to say a special thanks to Dr. Cathi Propper and Omar Shehata for making the task of coding enjoyable and efficient.

I want to express my appreciation to the Psychology Department and Honors Program, specifically Dr. Beth Kurtz-Costes and Dr. Mark Hollins for serving as the Honors Director over this past year. They were always available to listen or provide advice and their guidance helped keep me on track throughout this process.

I extend my gratitude to the children and families that participated in the LEAPS Project. I appreciate the children and their invaluable contribution to this project, as well as their parents who have worked to schedule their children's visits and provide us with help and support throughout this project. I would like to thank the preschool programs and teachers that allowed us to be involved with the children and classrooms.

Next, I thank my friends and family for their encouragement and excitement throughout this process. I am so grateful to my roommates for listening to me practice my presentation repeatedly and to my parents who have always helped keep me focused and grounded. I am grateful for the Morehead-Cain Foundation, trustees and staff for bringing me to Carolina where I have had the most incredible opportunities.

Finally, I would like to acknowledge the support for the LEAPS project from the National Institute of Child Health and Human Development (NICHD) at the National Institute of Health: (1 R21 HD075309-01).

Behavioral Regulation in Pre-Kindergarten: The Interplay between Hot and Cool Regulation and the Classroom Context

A variety of factors have been suggested as possible predictors of school readiness and early academic achievement in preschool-aged children. Such factors include self-regulation, persistence, attentiveness, flexibility, motivation and organization. These factors are collectively referred to as *approaches to learning* (Grining, Votruba-Drzal, Maldonado-Carreno, & Haas, 2010). Research suggests that these approaches to learning may predict academic outcomes throughout early elementary school (Blair & Razza, 2007). More research is needed to clearly understand the relationship between each approach and later academic outcomes. Specifically, more research is needed to understand the individual child-level differences present upon entering kindergarten and how those differences impact academic achievement and create a bidirectional relationship with the classroom context.

Self-Regulation

One important predictor of school readiness and later academic outcomes is the early development of self-regulation. There is evidence suggesting that both behavioral and emotional regulation influence later academic progress (Blair & Razza, 2007). The purpose of the current study was to further define the relationship between an individual's ability to self-regulate and later academic outcomes in the pre-kindergarten classroom. A secondary goal of the study was to understand how this relationship is moderated by the preschool classroom context. Specifically, this study focused on the nuanced differences between hot and cool self-regulation. The strong correlation between self-regulation and more positive academic outcomes creates a need for a better understanding of the cognitive, behavioral, and emotional mechanisms that

underlie this important construct. A better understanding of self-regulation may allow for the development of early curricula and interventions that could have a long-term impact on children's academic development and success.

Self-regulation involves the ability to control, plan, and direct; it is the ability to control and manage behavior and emotions as well as focus attention (Williford, Whittaker, Vitiello, & Downer, 2013). More specifically, self-regulation may be defined as an individual's capacity to utilize emotional, social, and cognitive resources in response to stimulation, both internal and external, so that goals may be achieved (Blair, Calkins, & Kopp, 2010). An exact definition of self-regulation within recent literature is under debate but can be broadly defined as a cognitive construct that encompasses a variety of processes including behavioral regulation, emotional regulation and attention regulation.

Evidence suggests that the ability to self-regulate helps children to focus on classroom activities, follow directions, and control behavior in order to comply with adult demands (Raver, Smith-Donald, Hayes, & Jones, 2005). Behavioral regulation in the classroom is necessary for children to pay attention and inhibit inappropriate behavioral responses (McClelland et al., 2007). Emotional regulation is essential for managing temperament in novel situations, spending time productively, and completing assignments (Graziano, Reavis, Keane, & Calkins, 2007). While the literature makes clear connections between behaviorally-based indices of early self-regulation and successful academic and social outcomes, there is less emphasis on the connection between the early development of emotionally-based regulatory capacities and successful outcomes, although the literature has indicated a potentially important role for emotional regulation in successful classroom adaptation and school transitions (Graziano et al., 2007; Mischel, Shoda, & Rodriguez, 1989; Zelazo & Carlson, 2012).

Children enter kindergarten with a range of levels of self-regulatory abilities. These differences are correlated with academic outcomes and early classroom success (Lin, Lawrence, & Gorrell, 2003). Early success in the classroom may be a predictor of later school achievement not only academically but socially (Caspi, Elder, & Bem, 1987). Children with low levels of self-regulatory abilities are more likely than their well-regulated peers to have poor academic, social, and emotional outcomes (Duncan et al, 2007). Behavioral and emotional regulation are both necessary for the creation of a positive and productive learning environment for children.

The transition from preschool to kindergarten requires that children move from a less structured to more formal learning environment. The more structured kindergarten environment stresses self-control for longer periods of time (Pianta & Rimm-Kaufman, 2006). A study by Rimm-Kaufman and colleagues found that teacher reports concluded that nearly half of kindergarten children did not have competent regulatory capabilities, behavioral or emotional, necessary for school success (2000). This lack of regulatory competencies upon entering the kindergarten year would seem to suggest that more research is needed concerning the development of regulation during the pre-kindergarten period and the mechanisms underlying such development. Increases in the ability to successfully self-regulate have been observed during the preschool years and indicate that this time may be a critical developmental period for effective self-regulatory skills in children (Campbell & von Stauffenberg, 2008).

Components of self-regulation: behavioral and emotional.

Self-regulation has been described in a variety of ways but generally is further classified into sub-categories of regulatory abilities, specifically behavioral regulation, emotional regulation, and attention regulation. These constructs have been indicated as contributors to

academic outcomes and successful preschool to kindergarten transitions (Blair & Razza, 2007). For the purposes of this paper, behavioral and emotional regulation will be furthered discussed.

Emotional regulation refers to an individual's ability to modulate arousal (Calkins & Fox, 2002). More specifically, emotional regulation refers to the ways in which individuals modulate emotional arousal to achieve goals. Typically, individuals will use a variety of strategies to control arousal including approach, avoidance, inhibition, and attention-seeking. Emotion regulation can be observed through the types of behavioral strategies elicited under emotionally demanding circumstances (Calkins & Fox, 2002). Behavioral strategies to manage emotions emerge in the first year of life and continue to develop throughout the pre-kindergarten period. This developmental trajectory of emotional regulation greatly impacts a child's social skills and behavior (Calkins & Fox, 2002).

Behavioral regulation is the ability to control behavior, impulsive responses, and delay gratification (Williford, et al., 2013). Behavioral regulation encompasses a set of skills vital to adapting appropriately to a classroom setting including inhibitory control of behaviors, use of working memory, and attentional focusing (Matthews, Ponitz, & Morrison, 2009). As a measure of cognitive control, behavioral regulation is critical to not only early academic outcomes but also to successful classroom adaptation and functioning (Blair, 2003). Specific aspects of behavioral regulation, as defined by Paris and Newman, are especially important for generalized academic success (1990). These aspects include the ability to plan, control, and reflect as well as becoming personally competent and independent. Other aspects of behavioral regulation including distractibility and persistence are particularly relevant to early academic success and the transition to a formal school setting (Martin, Drew, Gaddis, & Moseley, 1988). In a study

examining behavioral regulation, behavioral regulation predicted outcomes of achievement, based on test scores, through the third grade (Howse, Lange, Farran, & Boyles, 2003).

While literature has implicated emotional regulation as a potential predictor of positive academic outcomes, there has been less focus on emotional components of regulation in the preschool to kindergarten transition than behavioral regulation, creating gaps in the literature. These potential gaps concerning the role of emotional regulation should be more fully explored. In this paper, the divisions of self-regulation will be considered by examining the roles of hot (cognitive) and cool (affective) regulation, which will be described in more detail below. One example from the developmental literature that has begun to examine the distinction between hot and cool contexts concerns the early development of executive function. The dichotomy of executive function will be discussed here to establish a solid theoretical foundation for the exploration of hot and cool regulation in the current study.

Executive function.

Executive function, a dimension of behavioral regulation, has been identified in the literature as being an especially important predictor of academic outcomes and school readiness (Blair & Razza, 2007). Executive function (EF) broadly describes higher-order cognitive processes used to coordinate goal attainment (Dawson & Guare, 2004). Executive function involves planning, reasoning, and the incorporation of thoughtful planning and reasoning into actions. Inhibition, mental flexibility, and working memory have been identified as the main components of executive function (Calkins & Marcovitch, 2010). Inhibition is the process of suppressing a predominant response (Davidson, Amso, Anderson, & Diamond, 2006). The ability to inhibit predominant responses enables individuals to avoid automatic reactions and

restrain habits in order to perform higher order functions such as strategic planning (Dawson et al., 2004). This inhibitory ability helps children to behave adaptively, especially in novel situations, such as the transition from pre-school to kindergarten (Huizinga, Dolan, & van der Molen, 2006). Mental flexibility is the ability to shift cognition between related sets of information which is commonly called upon in basic classroom functioning (Davidson et al., 2006). Working memory is the ability to store information while simultaneously using and manipulating that information for some other purpose; working memory is vital in generalized learning (Davidson et al., 2006). Examples of tasks involving executive function include regulation of goal-oriented behavior, problem solving, and planning (Dawson et al., 2004). According to Monette, Bigras, and Guay executive functions facilitate the conscious control of thoughts and guide behaviors towards future goals (2011).

The development of executive function.

Executive function (EF) begins to develop in early childhood but does not reach full potential until early adulthood (Davidson et al., 2006). Executive function develops rapidly during the pre-kindergarten period. This period of development has been substantiated by the correlation between regulatory development and the growth of neural networks in the prefrontal cortex, the neural area most implicated in higher order cognitive processing, which continues to develop throughout adolescence and into adulthood (Toga, Thompson, & Sowell, 2006; Zelazo & Carlson, 2012).

Early childhood has been identified as the first important developmental period for EF, specifically between the ages of three and five years of age (Anderson, 2002). A study by Diamond and colleagues showed empirically that older preschool children outperformed younger

preschool children on tasks measuring EF suggesting that development of executive function improves throughout the pre-kindergarten years (Diamond, Kirkham, & Amso, 2002). A longitudinal study of EF development between three and five years of age suggested that development of latent executive function abilities improved during this two year time period with greater development between three and four years of age than between four and five years of age (Willoughby, Wirth, & Blair, 2012).

General academic outcomes have been related to executive functioning in children (Blair & Razza, 2007). Reading, writing, and math skills are related to the main components of executive function: inhibition, flexibility, and working memory. St. Clair-Thompson and Gathercole found that the strongest EF indicator of school achievement was working memory (2006). More specifically, working memory was strongly associated with reading and writing skills but not as strongly correlated with mathematic achievement (St. Clair-Thompson & Gathercole, 2006). Inhibition was found to be more likely to predict mathematic ability in preschool-age children according to a study conducted by Espy and colleagues (2004). Inhibition was found to be less associated with reading, writing, and vocabulary skills than with math achievement (Blair & Razza, 2007).

Developmental outcomes.

More than being a reliable predictor of academic outcomes, executive function predicts a range of generalized positive developmental consequences as well (Zelazo & Carlson, 2012). A classic experiment by Mischel and colleagues presented children with a marshmallow and asked the children to delay gratification of eating the marshmallow in order to receive a larger reward at a later point in time (1989). Children who were better able to regulate themselves and delay

gratification were more likely to be well adapted as adolescents, according to parents and peers. Adolescents with higher levels of executive function and delayed gratification as children in the Mischel experiment demonstrated better social competence, concentration, control, and frustration tolerance than did their less regulated child peers (Mischel et al.,1989). Executive function was found to be correlated with a vast array of later lifetime outcomes in children three to eleven years of age (Moffitt et al., 2011). Moffitt and colleagues suggested that physical health, recreational drug use, criminal activity, and economic status could be predicted by childhood measures of executive function (Moffitt et al., 2011). From early educational outcomes to more generalized developmental effects, it is clear that executive function plays an important role in childhood and long-term development.

The literature has drawn clear correlations between executive function and later developmental, social, and academic outcomes (Mischel et al., 1989; Moffitt et al., 2011; Zelazo & Carlson, 2012). The evidence amassed suggests that early individual levels of EF may impact an individual throughout their lifetime through a variety of related consequences (Zelazo & Carlson, 2012). Furthermore, the pre-kindergarten period has been identified as a potential critical period in the development of individual differences in executive function (Zelazo & Carlson, 2012). However, little research has been conducted to identify the specific mechanisms underlying the development of executive function in the pre-k years. Areas of potential interest in understanding this important developmental time may include a stronger understanding of different types of EF: both emotionally motivated EF (hot) and behaviorally motivated neutral EF (cool).

Divisions of executive function: hot and cool.

The main battery of work concerning executive function has been studied in settings that are affectively neutral for participants (Blair & Razza, 2007). However, these situations are not always realistic of the demands placed upon executive functioning. Rather, some situations demand the use of executive function where the circumstances have affective significance or are emotionally motivating. This suggests a role for emotional arousal in EF (Zelazo & Carlson, 2012). Recent research has begun to initially categorize these EF differentiations into categories of 'hot' and 'cool' executive function (Bechara, 2004; Zelazo & Carlson, 2012). While all components of executive function are top-down processes; hot EF processes are motivationally and emotionally significant while cool EF processes are essentially motivationally neutral and strictly cognitively based (Zelazo & Carlson, 2012). Support for this division of executive function can be found in physiological evidence. For instance, hot context tasks have been related to activity in the orbitofrontal cortex while cool context tasks have been associated with activity focused in the lateral prefrontal cortex (Happaney, Zelazo, & Stuss, 2004). The orbitofrontal cortex is involved in mental flexibility, specifically in regards to stimuli with affective significance (Rolls, 2004). Patients with orbitofrontal damage have difficulty successfully completing hot context tasks but are able to perform normatively on traditional (neutral) EF tasks (Bechara, Damasio, Damasio, & Anderson, 1994). The lateral prefrontal cortex has been found to be involved in overall executive control, cognition, and behavioral control (Wagner, Maril, Bjork, & Schacter, 2001). In patients with brain lesions, researchers have been able to study the effects of localized cortical areas on executive function, both hot and cool components. Additionally, physiological markers indicating levels of stress arousal have further supported this dichotomy of executive function (Arnsten & Shansky, 2004).

Historically in developmental and cognitive literature, studies of executive function have primarily focused on the neutral, cognitive processes of cool EF. This traditional focus is easily demonstrable through the battery of standard tests used to measure executive function such as the Color-Word Stroop Task (Stroop, 1935), Wisconsin Card Sorting Task (Grant & Berg, 1948), and the Dimensional Change Card Sort (Zelazo, 2006). Each of these measures focuses on the performance of a cognitive task, such as sorting cards, where rules are established and participants are given feedback throughout the task (WCST; Grant & Berg, 1948). However, none of these tasks involves direct consequences such as rewards or punishment based on the outcome of the participant's performance. Each of these traditional tasks may effectively demonstrate the cognitively-based aspects of EF but essentially ignore the affective components of EF (Zelazo & Carlson, 2012). More recent research has focused on expanding the literature regarding executive function and increasing the battery of tasks available in order to measure hot components of EF as well as the traditional cool components (Zelazo & Carlson, 2012).

The dichotomy of hot and cool executive function postulates that EF is not strictly a cognitive process but also encompasses emotional and motivational components. Furthermore, the construct of hot EF incorporates the idea that motivationally driven contexts will require different mechanisms of top-down processing than standard cool EF components may require (Zelazo & Carlson, 2012). Available measures of hot EF are assessed using a very different battery of tests than the traditional cool EF tasks mentioned previously. These tasks include measures of delay discounting, gambling, and risky decision making (Bechara et al., 1994; Elliot, Frith, & Dolan, 1997; Rogers et al., 1999).

Although it is clear that literature must differentiate between hot and cool components of EF to have a full understanding of self-regulation development, these individual mechanisms do

not function in isolation or independently of one another. Rather, they work together adaptively in a majority of situations outside the laboratory setting (Zelazo & Cunningham, 2007). Situations in life are rarely devoid of affect or motivation; requiring that we utilize both cognitive and motivational aspects of EF to solve problems, make decisions, and regulate behavior. Zelazo and Cunnigham suggest that one of the primary ways in which individuals solve complex emotional problems is to step away from the problem and consider its cognitive components through reflection and contextualization (2007). This problem solving strategy shows integration of both hot and cool EF systems. In a study conducted by Prencipe and Zelazo, the researchers compared three-and-four-year-olds performances on executive function tasks both hot and cool in orientation (2005). When presented with two unequal rewards, one reward being smaller but available immediately while the other reward was larger but delayed, three year-old children were asked to make two decisions. First, the child was asked to select which reward the experimenter should choose. This is an example of the cool component of the task, as the outcome of the decision is not directly emotionally relevant to the child. Second, the child was able to select a personal reward. This portion of the task demonstrated the hot component where the child's answer was a direct reinforcement and was therefore affectively stimulating. The researchers found that three year-olds overwhelmingly stated that the researcher should choose the larger, delayed reward. However, the same children more frequently chose for themselves the smaller, immediate reward (Precipe & Zelazo, 2005). These results suggest that there are in fact some localized differences between hot and cool EF and that the developmental trajectories for each component may be distinct. Additionally, these results suggest an initial timeline for the development of executive function; while cool EF may be

developing during this preschool period, it seems that more affectively hot EF processes may not yet be emergent in three year old children (Prencipe & Zelazo, 2005).

In a similar study of the dichotomy of hot and cool executive function, Carlson and colleagues found that three year old children have some difficulty pointing to a smaller reward in order to get a larger reward (2005). However, in this same experiment, four-year-old children did not have any difficulty pointing to the correct stimuli, the smaller reward, in order to achieve the goal of attaining the larger reward (Carlson, Davis, & Leach, 2005). This study not only further supports the differentiation of components of executive function but also suggests that between the ages of three and four, children begin to experience more hot EF development and are better able to manage motivationally driven cognitive circumstances (Carlson, et al., 2005). While there is some comparative evidence of both hot and cool EF, a clear understanding of the hot component has not fully been established (Bunge & Crone, 2009). Additional research is needed to understand the development of this dichotomy in pre-kindergarten children and its impact on school transition and academic success.

As established with the dichotomous example of executive function, regulatory constructs are not always clearly defined. In general, the current discourse surrounding self-regulation tends to emphasize the cognitive, inhibitory (cool) nature of regulation at the expense of underemphasizing the affective (hot) component of regulation. This perspective leads to one aim of the current study: an exploration of early hot and cool regulation.

Current Study

The aim of the current study is to explore the differences between hot and cool regulation in an effort to further define the relationship between a child's ability to self-regulate and school

readiness in the pre-kindergarten classroom. I hypothesize that measures of hot and cool regulation will be positively correlated but distinctly separate constructs. Children that score higher on tasks of cool regulation will likely score higher on hot regulation tasks as well. I hypothesize that hot and cool regulation will be positively correlated with outcomes, specifically school readiness and task orientation within the classroom. These outcomes together create a more holistic view of a child's ability to successfully transition to the kindergarten classroom than either outcome alone. Task Orientation measures how children regulate to organize themselves around tasks *in the classroom,* thus providing a contextual element that is necessary to understand the transition to kindergarten, but is often overlooked. School readiness is measured with a standardized assessment which allows children's conceptual knowledge to be compared to age-related norms. Finally, I hypothesize that the relationship between self-regulation and school readiness as well as task orientation in the classroom will be moderated by the pre-kindergarten classroom context. These aims will be explored using the pilot portion of a larger, ongoing study. Although the scope of this project may be limited by the size of the pilot sample, the larger project will be able to further investigate these important topics informed by the initial findings of the pilot sample.

A rich basis of literature regarding the connections between self-regulation, executive function, academic outcomes, and the pre-k to formal school transition has been established. Although the literature makes a clear connection between self-regulation and school readiness, the relationship between the hot (affective) components of self-regulation and school readiness outcomes is often less emphasized. The role of the emotional components of regulation in the pre-kindergarten period were analyzed by exploring the relationships between hot and cool

regulation, the classroom context, and child-level outcomes such as school readiness and regulation in the classroom environment.

Methods

Pilot Study

This study is based on data from the initial pilot portion of a larger ongoing study at the University of North Carolina at Chapel Hill: Project LEAPS (Learning, Emotion, and Play in School) a multi-method project focused on self-regulation in preschool that is exploring the roles of child physiology, parents, and teachers. In this ongoing study, participants are assessed on a battery of tasks that measure children's regulation, cognition, and academic abilities. These constructs are explored in both the home and preschool environments.

Participants

Participants were 16 preschool children enrolled in 3 pre-kindergarten classrooms in 2 child-care centers in North Carolina. Participants and their families were recruited through their preschool program and all students in each contributing classroom were invited to participate. Parents of all participants were given a background questionnaire to complete and demographic information was based on these parent-reports. 7 participants were male and 9 participants were female. Children's ages ranged between 4.26 years and 5.49 years with an average age of 4.90 years. Children were predominately Caucasian with approximately 93.75 percent of participants reporting ethnicity as 'white or Caucasian'. The remaining participants reported ethnicity as Asian in an open-ended response format. English was the primary language used by participants. On average, children spent 31.28 hours per week in their respective childcare programs. All children lived in a two parent household. Children were predominantly from educated families

where the primary caregiver held at least a bachelor's degree. Additionally, 92.30 percent of secondary caregivers also completed at least a bachelor's degree and 76.92 percent of all parents had earned a masters or doctoral degree. Children were from middle to high socioeconomic levels with parents reporting joint incomes ranging from $100,000 to $240,000 and an average combined household income of $163,729 per year.

Research Design

Procedures.

The current study uses a subset of the data from the LEAPS research project with a specific focus on the relationship between child executive function as a measure of self-regulation, the preschool classroom context, and school readiness. Data were collected from parents, teachers, children, and outside observers providing ratings of the classroom contextual quality. Children were assessed at two time points within a period of one year. All assessments, except for the live-coded behavioral ratings of the children during their regular day in the classroom were audio and video recorded.

Assessment point one.

During the first assessment point; a group of tasks were administered lasting approximately one hour in the preschool setting. Two research assistants were present at each assessment, followed manualized assessment instructions, and completed assessment training. Tasks of interest to the current study completed at assessment point one included behavioral measures of executive function in both hot and cool contexts; these are outlined below. Additionally, parents completed multiple questionnaires at the first assessment point providing child-level demographic information. Children were observed and rated on a variety of

constructs and behaviors in the classroom context using the inCLASS observational system. The children received small gifts such as a cloth backpack, a book, and crayons for their participation as well as a $10 gift card at this assessment.

Assessment point two.

At the second assessment point; tasks were administered by trained research assistants (RA). One RA was present at each assessment and followed standardized assessment instructions. Child-level behavioral measures of interest that were completed during the second assessment point included measures of general working memory and cognition (*Digit Span),* and school readiness (*The Bracken School Readiness Assessment (BSRA-3)).* In addition to these child-level measures the *Classroom Assessment Scoring System (CLASS)* observations were completed as a non-biased contextual measure of the preschool classroom. Again, children received small gifts including a $10 gift card to compensate their participation.

Measures

Head-Toes-Knees-Shoulders (HTKS)- assessment 1.

The Head-Toes-Knees-Shoulders (HTKS) task measures behavioral regulation and executive function in a cool context (Ponitz, McClelland, Matthews, & Morrison, 2009). HTKS requires children to remember behavioral rules and inhibit predominant responses in order to respond to verbal commands with the opposite action of the command. For example, if the researcher says "touch your toes," the correct response would be for the child to touch their head. The HTKS task is an adaptation of an earlier measure of behavioral regulation, the Head-to-Toes task (McCabe, Rebello-Britto, Hernandez, & Brooks-Gunn, 2004; Ponitz et al., 2009). The HTKS task increased in complexity from the Head-to-Toes task by adding additional commands.

This task is appropriate for early elementary school children, specifically 5 and 6 year olds. To be successful, children must apply cognitive skills and inhibit responses to execute the correct motor movement command in the HTKS task. Such cognitive skills include focusing attention on instructions and commands, using working memory to perform rules while simultaneously processing commands, and inhibiting automatic responses (Ponitz et al., 2009). This task showed reliability and validity with preschool children cohorts (Ponitz et al., 2008).

The HTKS allowed the child to first habituate to the commands used; this habituation process was followed by a trial period. Finally, children were asked to respond to commands with the opposite response during the test period. Correct responses earned 2 points, self-corrected responses earned 1 point, and incorrect responses earned 0 points. Higher overall scores were indicative of higher levels of cool regulation (Ponitz et al., 2009). The Head Toes Knees Shoulders task 'final score' was utilized in data analysis. The final score is a cumulative total of the child's correct responses on the entire assessment which consists of 20 total trials creating a possible range of 0-40 points.

Gift Wrap – assessment 1.

The Gift Wrap task is a subscale from the Preschool Self-Regulation Assessment (PSRA) (Smith-Donald, Raver, Hayes, & Richardson, 2007). In this study the Gift Wrap task is used as a measure of hot self-regulation in based on the motivational and emotional requirement of having the child wait for a gift. In this task the experimenter asks the child to inhibit predominant responses and measures effortful control, the ability to delay gratification, and impulse control (Smith-Donald et al., 2007). Gift Wrap was originally adapted from work by Kochanska and colleagues.

This task contains two parts. First, the experimenter wraps a gift noisily for 60 seconds directly behind the child's back while the child is instructed not to peek. Second, the wrapped gift is left on the table, within the child's reach, while the researcher exits the room for 120 seconds. The child is asked not to touch the gift while the researcher is absent (Murray & Kochanska, 2002; Smith-Donald et al., 2007). During coding, latencies to peek, turn, touch, lift, and open the gift are all recorded. Additionally, a peek score and a touch score are coded based on the degree to which the child peeks while the gift is being wrapped and the degree to which the child touches the gift during the wait period (Smith-Donald et al., 2007). Children who did not peek while the gift was being wrapped were given a peek score of 1 while children who peeked, but not enough to see the gift being wrapped were given a peek score of 2. A peek score of 3 was given to children who peeked enough to see the gift being wrapped, while a score of 4 was coded for children who turned their entire body around in order to see the gift while it was being wrapped. Finally, children who turned their bodies around to watch the gift being wrapped and never turned away from the gift were given a peek score of 5. A peek score of five suggests poor regulatory capacity in a hot context. For the purposes of this paper, the peek score was utilized in data analysis and was double coded to ensure reliability across the sample.

Digit Span – assessment 2.

Digit Span provides a measure of basic memory capacity by assessing deliberate memory for numbers (Bowden, Petrauskas, Bardenhagen, Meade, & Simpson, 2012). Digit Span is a subscale from the Wechsler Intelligence Scales for Children. Digit Span is divided into two parts, Digits Forward and Digits Backward. Both the forward and backward versions of the task were used in this study. In the Digits Forward task children are asked to repeat strings of numbers that increase in length as the assessment progresses. Digits Forward is a simple

assessment of short-term memory capacity. The Digits Backward assesses working memory; children listen to a string of numbers and are then asked to say the numbers in the reverse order.

Children first completed the forward sequence and then the backward sequence. Correct responses were scored as a 1 while incorrect responses were scored as a 0. Each section of the task was terminated when the child missed two number chains consecutively.

Bracken School Readiness Assessment (BSRA-3) – assessment 2.

The Bracken School Readiness Assessment – Third Edition (BSRA-3) is a direct measure of school readiness based on children's conceptual knowledge (Panter & Bracken, 2009). Concepts incorporated in the assessment include color, letter recognition, numbers, counting, size, comparisons, and shapes (Bracken, 2002). The BSRA-3 includes both a verbal and non-verbal assessment of knowledge. The BSRA-3 is administered individually to children in approximately 15 minutes.

The Bracken School Readiness Assessment identifies at-risk preschoolers as children scoring below average normed values. The BSRA-3 was normed on over 1,000 children (Panter & Bracken, 2009). Additionally, this assessment positively predicted performance on intelligence tests such as the Weschler Scales and the Stanford-Binet-IV. Panter & Bracken assessed the validity of the Bracken assessment and found that it was a positive predictor of multiple variables of school readiness including grade retention and teacher readiness ratings (2009). Additionally, the BSRA-3 was found to be a valid predictor of school readiness in children of different genders and ethnicities. BSRA-3 internal consistency is .98 (Panter & Bracken, 2009). A standard score was used for data analysis and is based on the individual

components of the BSRA-3. The standard score is a composite measure across all component constructs that allows a child's score to be compared to normed scores by age on the BSRA-3.

The Individualized Classroom Assessment Scoring System (inCLASS)-assessment 1.

The inCLASS is an observational framework that allows for objective and consistent assessment of three to five year old children's proficiency in the preschool classroom based on three primary developmental domains: Teacher Interactions, Peer Interactions, and Task Orientation. The inCLASS uses a standardized procedure to assess preschool-aged children's competence within the classroom environment (Downer, Booren, Lima, Luckner, & Pianta, 2010). All observers for the inCLASS system underwent extensive training and established reliability between observers. For the purposes of this study only the Task Orientation domain was utilized, because as a measure of how children regulate to organize themselves around tasks in the classroom environment, Task Orientation has been suggested as a potential indicator of future school success. The Task Orientation domain is comprised of three behavioral dimensions: engagement within tasks, self-reliance, and behavior control (Downer, et al. 2010). Only observable aspects of behavioral regulation are considered when assessing each behavioral dimension. For the dimension of engagement within tasks, observers rate how consistently the child is engaged in classroom tasks such as remaining focused, level of excitement for activities, and amount of time spent on tasks (Downer et al., 2010). The dimension of self-reliance measures the amount that a child pursues learning on their own including making use of resources and the teacher in the classroom. The final dimension of the Task Orientation domain is behavior control which measures the child's ability to regulate their behavior within the classroom setting such as controlling their physical movement and verbalizations. A Task Orientation composite was used in data analysis and was created by aggregating the three

component sub-scales to measure children's competence for tasks and learning activities within the classroom. Task orientation scores ranged from 1 – 7 and can be divided into three categories where scores of 1 and 2 are labelled 'low' Task Orientation, scores ranging between 3 and 5 fall into a 'mid-level' Task Orientation category, and finally scores of 6 and 7 are categorized as 'high' Task Orientation. High task orientation scores suggest that a child is controlling their behavior, engaging in classroom tasks, and self-reliant a majority of the time and low task orientation scores imply that a child is rarely engaging in those behaviors in the classroom (Downer et al., 2010).

Classroom Assessment Scoring System (CLASS)- assessment 2.

The Classroom Assessment Scoring System (CLASS) is an observational system used to evaluate the environmental factors of the preschool through third grade classroom context by an outside, unbiased observer (Pianta, La Paro, Hamre, 2008). This system assesses the overall quality of the classroom environment as well as the teacher-student relationship and the techniques used by the teacher in the classroom. The CLASS assesses three dimensions of the classroom to determine overall classroom quality. These dimensions are emotional support, classroom organization, and instructional support. Each dimension is divided into further subscales. Emotional support is comprised of four main subscales including the classroom climate, positive or negative, teacher sensitivity, and regard for student perspectives. Classroom organization consists of subscales including behavior management, productivity, and instructional learning formats. Three subscales combine to create the domain of instructional support: concept development, quality of feedback, and language modeling (Pianta et al., 2008). Each subscale is scored from 1-7 with 7 being the best possible score in that particular category

and 1 being the least positive score. Higher scores for subscales, domains, and the composite CLASS score represent a higher-quality classroom than lower scores.

As an early classroom observational tool, the CLASS enables researches to assess teacher and classroom quality without restriction to specific subject matter. The CLASS observation system can be used during both structured and non-structured activity periods (Pianta et al., 2008). Specifically, within the current study the CLASS observations were used to better understand aspects of the classroom that may impact child-level regulatory capabilities. Researchers observed each participating pre-kindergarten classroom for 2 hours on a variety of different classroom activities including teacher-led whole group activities, small-group activities, and informal classroom time. Scores across the three domains were aggregated into a composite score that was used as a measure of overall classroom quality.

Results

Based on the limited sample size drawn from the pilot study data, the focus of data analysis will be primarily descriptive in nature. First, in order to understand differences between children's regulatory abilities in both hot and cold contexts on the one hand and school-readiness, as well as children's individual ability to regulate in the classroom context on the other hand, descriptive information will be explored for child-level predictor variables, child-level outcome variables, and classroom contextual variables. In order to study the associations between regulatory measures in both hot and cool contexts and not only standard kindergarten readiness skills, but also indices of children's task orientation in the classroom, the relationships between variables will be examined through correlational analysis. The Task Orientation domain was utilized as a measure of how children regulate to organize themselves around tasks

in the classroom environment. Finally, children will be placed into groups based on child-level and classroom context variables and analyzed across outcome dimensions using both descriptive methods as well as Analysis of Variance in order to preliminarily understand potential differential impacts of the pre-kindergarten classroom context.

Descriptive Data

A majority of the total sample (93.8%) completed the Head Toes Knees Shoulders assessment. Moderate variability was found for the Head Toes Knees Shoulders task. As can be seen in Table 1, on average children responded correctly to 62% of HTKS commands, suggesting that the children in this sample generally demonstrated high levels of regulatory abilities in cool contexts (M=23). All participants completed the Gift Wrap assessment. Gift Wrap Peek Scores were distributed across the full range of possible scores on a scale from 1 to 5, with a score of 1 representing children who did not peak at all and a score of 5 representing children who not only peeked at the gift but never turned away from the gift, demonstrating variability in the children's self-regulation in hot contexts. Additionally, significant differences between males and females were seen for Gift Wrap Peek Scores (F= 5.69, p=.032). Females had an average peek score of 1.56 while males had an average peek score of 3.0, meaning female children peeked less often and to a lesser degree than did male children, suggesting that there are potential gender differences for measures of hot regulation. Gender differences were not found in any other measure. As presented in Table 1, performance levels were relatively high across the sample for both regulatory measures, perhaps demonstrating that the sample as a whole is comprised of high regulating children.

As seen in Table 1, this sample was generally high-performing with an average Bracken School Readiness standard score of 111.50 and a range of 34 points demonstrating some variability in kindergarten readiness as well as the sample's general mastery of age-appropriate academic concepts. Although it is vital to understand the cognitively-based standardized component of school readiness, it is not the only construct that has been implicated in a child's ability to succeed in school. Therefore, in addition to this component of school readiness, the children's ability to self-regulate in the classroom context was measured using Task Orientation scores from the inCLASS observation, with most children scoring in the medium to high range with an average score of 5.24 on a scale ranging from 1-7 as seen in Table 1. A score between 5 and 6 indicates that children are able to sustain attention, engage in tasks, take personal initiative, demonstrate independence and patience, and are physically aware of themselves at a moderate to high level most of the time. The sample is likely high performing on a battery of task orientation components including engagement with tasks, self-reliance, and behavioral control within the classroom.

The Classroom Assessment Scoring System (CLASS) dimension scores were aggregated into a composite score across the three primary domains of emotional support, classroom organization, and instructional support. This composite score was used as a broad indicator of the overall quality of the classroom environment. The average CLASS score was high with a mean of 5.05 across classrooms on a rating scale with a highest possible score of 7. A classroom score of 7 would indicate that the classroom and teacher are very organized, as well as highly supportive, both emotionally and in regards to curricula and instruction. The average CLASS score in this study was moderately high, falling in the top 70% of the total range of possible scores. As can be seen in Table 1, there are subtle differences apparent across the three

individual classrooms with individual classroom scores falling within one point of each other on the classroom context composite dimension.

Correlations

Head Toes Knees Shoulders and Gift Wrap Peek tasks were correlated at 0.51. Although, given the small sample size of this study, the relationship was not statistically significant, the correlation did approach significance as seen in Table 2 (r= -0.51, p=.053). This relationship may suggest that while hot and cool regulation are highly related, they may be separate measures of overall self-regulation.

As seen in Table 2, the Gift Wrap Peek score was moderately related to the Bracken School Readiness Assessment (r= -.41) and only slightly correlated with the Task Orientation domain in the classroom (r=-.23). Additionally, the composite scores for Head Toes Knees Shoulders were not highly related to the Bracken School Readiness Assessment (r=-.06) or the task orientation domain (r=-.108). However, components of each outcome measure were found to be significantly correlated with the child-level predictor variables as demonstrated in Table 2. One element of the Bracken School Readiness Assessment, size mastery, was significantly correlated with the HTKS final composite score (r=0.69, p=.005) and the Gift Wrap peek score (r= -.71, p=.002).

Hot and Cool Differences across Groups

In order to explore the potential differential impacts of the preschool classroom context across subgroups of children with varying levels of regulatory abilities in hot and cool contexts, the children were placed first into groups based on their scores on the hot regulatory tasks and classroom context variables and analyzed across outcome dimensions using both descriptive

methods as well as Analysis of Variance to make comparisons across groups. The children were also grouped based on their scores on the cool regulatory task and classroom context variables and analyzed across outcome dimensions. Using two median splits, participants were assigned to groups based on CLASS composite scores and measures of hot and cool regulation: Head Toes Knees Shoulders and Gift Wrap Peek Task. Preschool classrooms were identified as 'low-supportive classrooms' (low class) or 'high-supportive classrooms' (high class) based on the CLASS composite score median. Children were identified as exhibiting low or high hot regulatory abilities based on their performance on the Gift Wrap task. These groups were labeled "low hot regulation." and "high hot regulation." Children were also placed into groups based on their regulation in cool contexts as demonstrated in the HTKS task and labeled "low cool regulation." and "high cool regulation." For example, children scoring low on the HTKS who were also in low supportive classrooms were placed into a group labeled "low class, low cool regulation." Children scoring in the top fifty-percent of scores on the Gift Wrap Peek task who were in low classes were placed into a group labeled "low class, high hot regulation." A total of four groups per regulatory type (hot and cool) were examined as predictors of both the Bracken School Readiness Assessment and the inCLASS Task Orientation observation: 1) low class, low regulation, 2) low class, high regulation, 3) high class, low regulation, 4) high class, high regulation. The number and gender of children in each group are presented in Tables 3 and 4.

Before looking at group differences, groups were first compared using the Digit Span task to ensure that no significant differences in children's working memory and cognitive capacity existed across the groups. Means were compared across groups by scores on the Digit Span forward (F= .063, p=.979) and backward series (F=.501, p=.689) assessments as a function

of cool regulation and the classroom context. Additionally, means for both Digit Span Forward (F=.707, p=.568) and Digit Span Backward (F=2.39, p=.125) were also compared as a function of hot regulation and the classroom context. There were no significant differences found based on the interplay between classrooms and self-regulation in children's working memory or cognitive ability. Next, means were compared across groups by scores on both the Bracken School Readiness Assessment and the inCLASS Task Orientation scores using an Analysis of Variance test. Significant differences across groups were followed up with a post-hoc test.

Cool regulation: Head Toes Knees Shoulders.

Children's school readiness scores on the Bracken School Readiness Assessment (BSRA-3) were compared as a function of children's performance on the Head Toes Knees Shoulders (HTKS) task and their classroom context using the CLASS scores. Means differed descriptively across groups; specifically between the "low class, low cool regulation" and "high class, low cool regulation" groups. As can be seen in Figure 1, children exhibiting high regulation in cool contexts scored high on school readiness measures regardless of the classroom context in which they were placed. Children who were low in regulation in cool contexts but were placed in high-quality classrooms outperformed their peers, not only peers exhibiting low regulation that were in a classroom characterized as lower on the CLASS scale, but also their peers with high cool regulation, thus potentially implicating the class context as playing an important developmental role in preparing children for the kindergarten transition. A one-way ANOVA determined that the difference between groups was not statistically significant in this small sample but trended in the hypothesized direction.

In addition to exploring children's school readiness with a standardized assessment, the participant's abilities to organize themselves in the classroom around learning activities, was explored as a function of the interplay of the children's regulation and the classroom context. Children's Task Orientation scores on the inCLASS assessment were compared as a function of the child's performance on the cool regulatory task: HTKS and their classroom context using CLASS scores. As can be seen in Figure 2, means differed descriptively across groups with the largest difference between the "low class, low cool regulation" group and the "high class, low cool regulation" group. This again suggests that low-regulating children who are placed in a highly supportive classroom outperform their low-regulating peers in classrooms that are rated lower on the CLASS composite score. However, a one-way ANOVA determined that this difference was not statistically significant.

Hot regulation: Gift Wrap peek task.

Children's scores on the BSRA-3 were compared as a function of their classroom and their scores on the regulatory task in a hot context: Gift Wrap Peek. As can be seen in Figure 3, there is a significant difference in school readiness between low regulating children in high and low quality classrooms. It is also notable that children low in regulation in hot contexts that were placed in high-quality classrooms scored higher than children exhibiting high hot regulation in both low and high quality classes. A one-way ANOVA determined a significant difference between groups. A post-hoc comparison using the Fisher LSD test showed that "low class, low hot regulation" and "high class, low hot regulation" groups differed significantly (F=3.52, p=.049). This difference suggests a potential role of the classroom context on children's readiness for kindergarten.

Finally, children's task orientation scores on the inCLASS assessment were also compared as a function of the child's classroom and their performance on the hot regulatory task: Gift Wrap Peek. As can be seen in Figure 4, the greatest difference emerges between the "low class, low hot regulation" group and the 'high class, low hot regulation" group, thus suggesting that children exhibiting low levels of hot self-regulation perform better when placed in classrooms rated higher on the CLASS scale. Additionally, children in the "high class, low hot regulation" group scored higher on measures of classroom Task Orientation than children in the "high class, high hot regulation" group suggesting that the classroom context may play an influential role in moderating the effects of hot regulation on the ability to organize around tasks in the classroom environment. The groups differed descriptively but not significantly.

Taken together, differences across groups may be indicative of an important role of the classroom context on preparing children for the transition from preschool to kindergarten. The interplay between the role of the classroom and early regulation could be especially important in predicting children's school readiness. Particularly important for children who are low on self-regulatory measures, the preschool classroom may act as buffer for the negative impacts of low regulation on kindergarten readiness and Task Orientation within the classroom.

Discussion

This study allowed for the examination of the interplay between child self-regulation in both hot and cool contexts and classroom quality as a predictor of a child's engagement in the classroom and subsequent kindergarten readiness. The preschool period has been identified as a time of rapid development for self-regulation and so in an effort to identify and better understand this important predictor of future academic trajectories, the dichotomy of hot and cool self-

regulation was explored (Zelazo & Carlson, 2012). Of interest, and consistent with study hypotheses, differences were found across classroom quality suggesting a potential moderating role of this contextual variable on the link between hot and cool child regulation on outcomes related to kindergarten readiness. The moderating role of the classroom was particularly salient and significant for regulation in hot contexts. Although the current study was based on pilot data of only 16 children who were fairly homogenous on most demographic factors, important insights and directions for future research may still be drawn from this limited sample.

This research allowed for the exploration of variability in school readiness and children's engagement in the classroom during preschool based on individual-level factors such as hot and cool self-regulation. In order to differentiate between these hot and cool components of regulation two behavioral measures of regulation were selected. Both measures required the child to inhibit predominant responses, however, only the Gift Wrap task had an additional affective component making the task more emotionally-based than the HTKS task where there is only a cognitive inhibitory component without any motivational or affective significance. There was moderate variability in scores for both tasks across the sample suggesting individual differences in regulation. The hot and cool tasks were related at a correlation of r=.5. Although this correlation was not statistically significant in this small sample, this relationship was approaching significance, potentially suggesting that the measures may represent distinct components of one underlying construct, self-regulation.

Both hot and cool measures of regulation were expected to be related to school readiness based on extant literature (Zelazo & Cunningham, 2007). Subscales of the BSRA-3 were associated with both the HTKS and Gift Wrap tasks suggesting that an underlying component of school readiness is significantly related to hot and cool components of self-regulation.

Particularly, the size mastery component of the BSRA-3 was significantly related to both tasks of hot and cool self-regulation. Interestingly, the size mastery component was correlated in opposite directions for the hot and cool tasks, potentially highlighting a separation between the two constructs. While traditionally cool aspects of regulation have been the focus within the literature as a vital predictor of future academic and social trajectories, affective, hot components of regulation, their development, and impact on cognitive outcomes have been given less focus, although a link between the ability to regulate affectively in the classroom and academic performance has been established. Research suggests that children who are able to regulate their emotions effectively within the classroom are more productive and accurate in school (Zelazo & Carlson, 2012). This relationship between school readiness and hot regulation should be further explored in larger and more diverse samples to substantiate the impact of hot regulation on outcomes such as school readiness and task orientation in the classroom. However, these tasks of hot and cool regulation were not significantly correlated with outcome variables. As the relationship between self-regulation and school readiness is well defined in the literature, this lack of a significant relationship may reflect the small sample size of this study (Blair & Razza, 2007). There was no statistically significant relationship between the overall outcome measures: BSRA-3 standard score and the inCLASS Task Orientation domain composite score and the child level predictors.

To understand the role of the preschool classroom on the relationships between a child's regulation and not only their standardized school readiness score but also their ability to orient to tasks and activities *within* the classroom context, children were grouped by regulatory ability and classroom quality, high versus low. Interestingly, descriptive but not significant, differences were found for both school readiness scores and task orientation scores across groups for cool

constructs and are likely attributable to the difference in classroom contexts. There was a significant difference on school readiness scores for children with low regulation in hot contexts dependent upon classroom placement. Children demonstrating low hot regulation in classrooms that were rated higher on classroom quality outperformed their peers in lower quality classrooms on the school readiness assessment. This suggests that children with moderate to poor regulation in hot contexts perform significantly better on the school readiness assessment when exposed to positive and highly supportive preschool classroom contexts.

In addition, this difference provides a potential example of the differential susceptibility model, which suggests that some individuals are more susceptible to their environment, whether positive or negative, than others (Scott & O'Connor, 2012). Literature suggests that more negative and reactive children, perhaps poor regulators, may be more susceptible to the environment (Scott & O'Connor, 2012). In this study, when the low regulating children are placed into a positive preschool classroom context we are able to differentiate their performance from that of their peers. Conversely, children who are low regulators and are in lower-quality preschool classrooms performed the worst on standardized outcomes of school readiness. This finding is important in future research because it demonstrates that with the appropriate contextual support, children with poor hot self-regulation can do as well or better than their peers scoring high on hot self-regulation. Additionally, this further supports the necessity for more research concerning the development of early emotional components of regulation and their importance as predictors of future school readiness and academic performance.

While the remaining differences across groups were not significant, we see a clear trend in the data where children with low regulatory abilities, across both hot and cool contexts, do better on school readiness assessments and measures of in-class self-regulation when they are

placed in highly supportive classrooms. These differences across groups implicate the classroom context as an important component of early academic success. Further research should work to isolate the components of the classroom that impact children's regulatory development so that appropriate interventions can be established in early pre-kindergarten education in order to improve the academic trajectories of young children. Potential classroom components to explore may include elements of emotional support in the classroom, classroom organization, and instructional support.

These findings, drawn here from a small participant sample, may be more robust in larger samples. Additionally, samples with more heterogeneity across demographic variables such as socioeconomic status may demonstrate more variability across both factors of individual regulation as well as outcome measures. Although clear evidence that behaviorally and cognitively based indices of early regulation such as traditionally cool self-regulation are clearly important for successful academic, social, and even economic outcomes is presented in the developmental and cognitive literature, there is less emphasis placed on the connection between the early development of hot regulation and successful outcomes (Mischel, et al., 1989; Zelazo & Carlson, 2012). As suggested here, there is a likely difference between hot and cool components of regulation. This finding is in agreement with the current literature exploring the differentiation of self-regulation and particularly the dichotomy of executive function (Zelazo & Carlson, 2012). This potential division between these hot and cool constructs should be further explored to better understand how both regulatory abilities independently impact the development of overall self-regulation and impact child outcomes. Additionally, this study suggests that the hot component of regulation can be an important possible predictor of school success. It would be prudent to explore these relationships more fully with longitudinal research

in order to understand how this underemphasized concept can impact future trajectories and how aspects of the early classroom context may serve as a protective factor for children with low cool regulatory skills. Finally, more resources and research should be devoted to further exploring aspects of the early classroom context. Specifically, research should work to isolate and understand the particular components of the classroom and teacher-style that make some preschool environments more beneficial to children with lower self-regulatory capacities, while other environments are less constructive in regards to children's individual development and school readiness.

References

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology, 8,* 71-82.

Arnsten, A. & Shansky, R. (2004). Adolescence: Vulnerable period for stress-induced prefrontal cortical function. *In: Adolescent Brain Development: Vulnerabilities and Opportunities,* 143-147.

Bechara, A. (2004). The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition,* 55, 30-40.

Bechara, A., Damasio, A., Damasio, H., & Anderson, S. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50,* 7-15.

Blair, C. (2003). Behavioral inhibition and behavioral activation in young children: Relations with self-regulatoin and adaptation to preschool in children attending Head Start. *Developmental Psychobiology, 42*, 301-311.

Blair, C., Calkins, S., & Kopp, L. (2010). Self-regulation as the interface of emotional and cognitive development: Implications for education and academic achievement. *Handbook of Personality and Self-Regulation,* 64-90

Blair, C., & Razza, R. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Development, 78(2),* 647-663.

Bowden, S., Petrauskas, V., Bardenhagen, F., Meade, C., & Simpson, L. (2012). Exploring the dimensionality of digit span. *Assessment, 20(2),* 188-198. doi: 10.1177/1073191112457016

Bracken, B. A. (2002). Bracken School Readiness Assessment. San Antonio, TX: The Psychological Corporation.

Bunge, S. & Crone, E. (2009). Neural correlates of the development of cognitive control. *In: Ramsey & Ernst's 'Neuroimaging in developmental clinical neuroscience.'* 22-37.

Calkins, S. & Fox, N. (2002). Self-regulatory processes in early personality development: A multilevel approach to the study of childhood social withdrawal and aggression. *Development and Psychopathology, 14,* 477-498. Doi: 10.1017.S095457940200305X

Calkins, S., & Marcovitch, S. (2010). Emotion Regulation and executive functioning in early development: Integrated mechanisms of control supporting adaptive functioning. *In: Child Development at the intersection of emotion and cognition,* 37-57.

Campbell, S., & von Stauffenberg, C. (2008). Child characteristics and family processes that predict behavioral readiness for school. *In: Disparities in school readiness: How families contribute to school, 225-258.*

Carlson, S., Davis, A., & Leach, J. (2005). Less is more: Executive function and symbolic representation in preschool children. *Psychological Science, 16,* 609-616.

Caspi, A., Elder, G., & Bem, D. (1987). Moving against the world: Life-course patterns of explosive children. *Developmental Psychology, 23(2), 308-313.* Doi: 10.1037/0012-1649.23.2.308

Davidson, M., Amso, D., Anderson, L., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations and memory, inhibition, and task switching. *Neuropscyhologia, 44(11),* 2037-2078. Doi: 10.1016/j.neuropsychologia.2006.02.006

Dawson, P., & Guare, R. (2004). Executive skills in children and adolescents: A practical guide to assessment and intervention. *In: The Guilford Practical Intervention School Series, Guilford Press,* New York, NY.

Diamond, A., Kirkham, N., & Amso, D. (2002). Conditions under which young children can hold two rules in mind and inhibit a prepotent response. *Developmental Psychology, 38,* 352-362.

Downer, J., Booren, L., Lima, O., Luckner, A., & Pianta, R. (2010). The Individualized Classroom Assessment Scoring System (inCLASS): Preliminary reliability and validity of a system for observing preschoolers' competence in classroom interactions. *Early Childhood Research Quarterly, 25(1),* 1-16.

Duncan, G., Dowsett, C., Claessens, A., Magnuson, K., Huston, A., Klebanov, P. (2007) School readiness and later achievement. *Developmental Psychology, 43,* 1428-1446.

Elliot, R., Frith, C., & Dolan, R. (1997). Differential neural response to positive and negative feedback in planning and guessing tasks. *Neuropsychologia, 35,* 1359-1404.

Espy, K., McDiarnid, M., Cwik, M., Stalets, M., Hamby, A., & Senn, T. (2004). The contribution of executive functions to emergent mathematic skills in preschool children. *Developmental Neuropsychology, 26(1),* 465-486.

Grant, D., & Berg, E. (1948). A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card sorting problem. *Journal of Experimental Psychology, 38,* 404-411.

Graziano, P., Reavis, R., Keane, S., & Calkins, S. (2007). The role of emotion regulation in children's early academic success. *Journal of School Psychology, 45(1),* 3-19. Doi: 10.1016/j.jsp.2006.09.002.

Grining, L., Votruba-Drzal, C., Maldonado-Carreno, C., & Haas, K. (2010). Children's early approaches to learning and academic trajectories through fifth grade. *Developmental Psychology, 46(5),* 1062-1077. Doi: 10.1037/a0020066

Happaney, K., Zelazo, P., & Stuss, D. (2004). Development of orbitofrontal functions: Current themes and future directions. *Brain and Cognition, 55,* 1-10.

Howse, R., Lange, G., Farran, D., & Boyles, C. (2003). Motivation and regulation as predictors of achievement in economically disadvantaged young children. (2003). *Jounral of Experimental Education, 71(2),* 151-174. Doi: 10.1080/00220970309602061

Huizinga, M., Dolan, C., van der Molen, M. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia, 44(11),* 2017-2036. Doi: 10.1016/j.neuropsychologia.2006.01.010

Lin, H., Lawrence, F., & Gorrell, J. (2003). Kindergarten teachers' views of children's readiness for school. *Early Childhood Research Quarterly, 18,* 1021-1033.

Martin, R., Drew, K., Gaddis, L., & Moseley, M. (1988). Prediction of elementary school achievement from preschool temperament: Three studies. *School Psychology Review,* 17(1), 135-137.

Matthews, J., Ponitz, C., & Morrison, F. (2009). Early gender differences in self-regulation and academic achievement. *Journal of Educational Psychology, 101(3),* 689-704. Doi: 10.1037/a0014240

McCabe, L., Rebello-Britto, P., Hernandex, M., & Brooks-Gunn, J. (2004). Games children play: Observing young children's self-regulation across laboratory, home, and school settings. In DelCarmen-Wiggins & Carter: *Handbook of infant, toddler, and preschool mental health assessment* (pp. 491-521). New York: Oxford University Press.

McClelland, M., Cameron, C., Connor, C., Farris, C., Jewkes, A., & Morrison, F. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43(4),* 947-959.

Mischel, W., Shoda, Y., & Rodriguez, M. (1989). Delay of gratification in children. *Science, 244.*933-938.

Moffitt, T., Arseneault, L., Belsky, D., Dickson, N., Hancox, R., & Harrington, H. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences USA, 108(7).* 2693-2698.

Monette, S., Bigras, M., & Guay, M. (2011). The role of executive functions in school achievement at the end of Grade 1. *Journal of Experimental Child Psychology, 109(2),* 158-173. doi: 10.1016/j.jecp.2011.01.008

Murray, K. & Kochanska, G. (2002). Effortful control: Factor structure and relation to externalizing and internalizing behaviors. *Journal of Abnormal Child Psychology,* 30, 414-503.

Panter, J. E. & Bracken, B. A. (2009). Validity of the Bracken School Readiness Assessment for predicting first grade readiness. *Psychology in the Schools, 46(5),* published online: www.interscience.wiley.com. doi: 10.1002/pits.20385

Paris, S., & Newman, R. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1),* 87-102. doi: 10.1207/s15326985ep2501_7

Pianta, R., La Paro, K., Hamre, B. (2008). Classroom Assessment Scoring System Manual: Pre-K. Paul H. Brookes Publishing Co. Baltimore, MD.

Pianta, R., & Rimm-Kaufman, S. (2006). The social ecology of the transition to school: Classrooms, families, and children. Accessed from McCartney & Phillip's handbook *Blackwell Handbook of Early Child Development*, 490-507.

Ponitz, C., McClelland, M., Jewkes, A., Connor, C., Farris, C., & Morrison, F. (2008). Touch your toes! Developing a direct measure of behavioral regulation in early childhood. *Early Childhood Research Quarterly, 23,* 141-158.

Ponitz, C., McClelland, M., Matthews, J., & Morrison, F. (2009). A structured observation of behavioral self-regulation and its contribution to kindergarten outcomes. *Developmental Psychology, 45(3),* 605-619. doi: 10.1037/a0015365

Prencipe, A., & Zelazo, P. (2005). Development of affective decision-making for self and other: Evidence for the integration of first- and third-person perspectives. *Psychological Science, 16,* 501-505.

Raver, C., Smith-Donald, R., Hayes, T., & Jones, S. (2005). Self-regulation across differing risk and sociocultural contexts: Preliminary findings from the Chicago School Readiness Project. *Conference for the Society for Research in Child Development;* Atlanta, GA.

Rimm-Kaufman, S., Pianta, R., & Cox, M. (2000). Teachers' judgments of problems in the transition to kindergarten. *Early Childhood Research Quarterly, 15,* 147-166.

Rogers, R., Everitt, B., Baldacchino, A., Blackshaw, A., Swainson, R., Wynne, K. et al. (1999). Dissociable deficits in the decision-making cognition of chronic amphetamine abusers, opiate abusers, patients iwht focal damage to the prefrontal cortex, and Tryptophan-depleted normal volunteers: Evidence for monoaminergic mechanisms. *Neuropsychopharmocology, 20,* 322-339.

Rolls, E. (2004). The functions of the orbitofrontal cortex. *Brain and Cognition, 55,* 11-29.

Scott, S. & O'Connor, T. (2012). An experimental test of differential susceptibility to parenting among emotionally-dysregulated children in a randomized controlled trial for oppositional behavior. *Journal of Child Psychology and Psychiatry,* 53(11). 1184-1193.

Smith-Donald, R., Raver, C., Hayes, T., & Richardson, B. (2007). Preliminary construct and concurrent validity of the Preschool Self-regulation Assessment (PSRA) for field-based research. *Early Childhood Research Quarterly, 22,* 173-187.

St.Clair-Thompson, H., & Gathercole, S. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *The Quarterly Journal of Experimental Psychology, 59(4),* 745-759.

Stroop, J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Toga, A., Thompson, P., & Sowell, E. (2006). Mapping brain maturation. *Trends in Neurosciences, 29(3),* 148-159.

Wagner, A., Maril, A., Bjork, R., & Schacter, D. (2001). Prefrontal contributions to executive control: fMRI evidence for functional distinctions within lateral prefrontal cortex. *Neuroimage; 14,* 1337-1347. Doi: 10.1006/nimg.2001.0936

Williford, A., Whittaker, J., Vitiello, V., & Downer, J. (2013). Children's engagement within preschool and their development of self-regulation. *Early Education and Development; 24(2),* 162-187. Doi: 10.1080/10409289.2011.628270

Willoughby, M., Wirth, R., & Blair, C. (2012). Executive function in early childhood: longitudinal measurement invariance and developmental change. *Psychological Assessment, 24(2),* 418-431.

Zelazo, P., & Carlson, S. (2012). Hot and cool executive function in childhood and adolescence: development and plasticity. *Child Development Perspectives, 6(4),* 354-360.

Zelazo, P., & Cunningham, W. (2007). Executive function: Mechanisms underlying emotion regulation. *In: Handbook of emotion regulation,* 135-158. New York.

Zelazo, P. (2006). The dimensional change card sort: A method of assessing executive function in children. *Nature Protocols, 1,* 297-301.

Table 1.

Descriptive Data for Head, Toes, Knees, Shoulders, Gift Wrap, Bracken School Readiness Assessment, inCLASS Task Orientation, and CLASS

Scale	M (SD)	Min.	Max.
Behavioral Regulation: Cool EF HTKS Score	23.00 (12.68)	0.00	37.00
Emotional Regulation: Hot EF Gift Wrap Peek Score	2.19 (1.38)	1.00	5.00
School Readiness: BSRA-3 Score	111.50 (12.14)	93.00	127
School Readiness: BSRA-3 Size Mastery	74.75 (12.89)	55	91
Classroom Task Orientation: inCLASS Score	5.24 (0.84)	3.67	6.53
Classroom Context: CLASS Composite Score	5.05 (0.29)	4.78	5.40

Table 2.

Summary of Intercorrelations for Scores on the HTKS, Gift Wrap, BSRA-3, and inCLASS Task Orientation

Measure	1	2	3	4	5
1. Cool EF: Head Toes Knees Shoulders	_	-.51	-.06	.687**	-.108
2. Hot EF: Gift Wrap Peek Score	-.51	_	-.41	-.71**	-.23
3. School Readiness: BSRA Standard Score	-.06	-.41	_	.56*	.17
4. School Readiness: BSRA Size Mastery	.69**	-.71**	.56*	_	.05
5. Task Orientation: inCLASS	-.11	-.23	.17	.05	_

Note: ** Correlation is significant at the 0.01 level. * Correlation is significant at the 0.05 level.

Table 3.

Summary of Descriptive Data for School Readiness Outcomes (BSRA-3) as a Function of Preschool Classroom Context (CLASS) and Measures of Hot and Cool Regulation (Gift Wrap Peek, HTKS)

	Class Context by Hot Emotional Regulation		Class Context by Cool Behavioral Regulation	
	N	Gender	N	Gender
Low Class, Low EF (0)	5	F: 1 M: 4	5	F: 3 M: 2
Low Class, High EF (1)	5	F: 5 M: 0	4	F:3 M: 1
High Class, Low EF (2)	4	F: 2 M: 2	4	F: 2 M: 2
High Class, High EF (3)	2	F: 1 M: 1	2	F: 1 M: 1

Note. F= female, M=male

Table 4.

Summary of Descriptive Data for Task Orientation Outcomes (inCLASS) as a Function of Preschool Classroom Context (CLASS) and Measures of Hot and Cool Regulation (Gift Wrap Peek, HTKS)

	Class Context by Hot Emotional Regulation		Class Context by Cool Behavioral Regulation	
	N	Gender	N	Gender
Low Class, Low EF (0)	5	F: 1 M: 4	5	F: 3 M: 2
Low Class, High EF (1)	5	F: 5 M: 0	4	F:3 M: 1
High Class, Low EF (2)	4	F: 2 M: 2	4	F: 2 M: 2
High Class, High EF (3)	2	F: 1 M: 1	2	F: 1 M: 1

Note. F= female, M=male

Figure 1.

Group Comparison of School Readiness Scores (BSRA-3) as a Function of Preschool Classroom Context (CLASS) and Cool Regulation (HTKS)

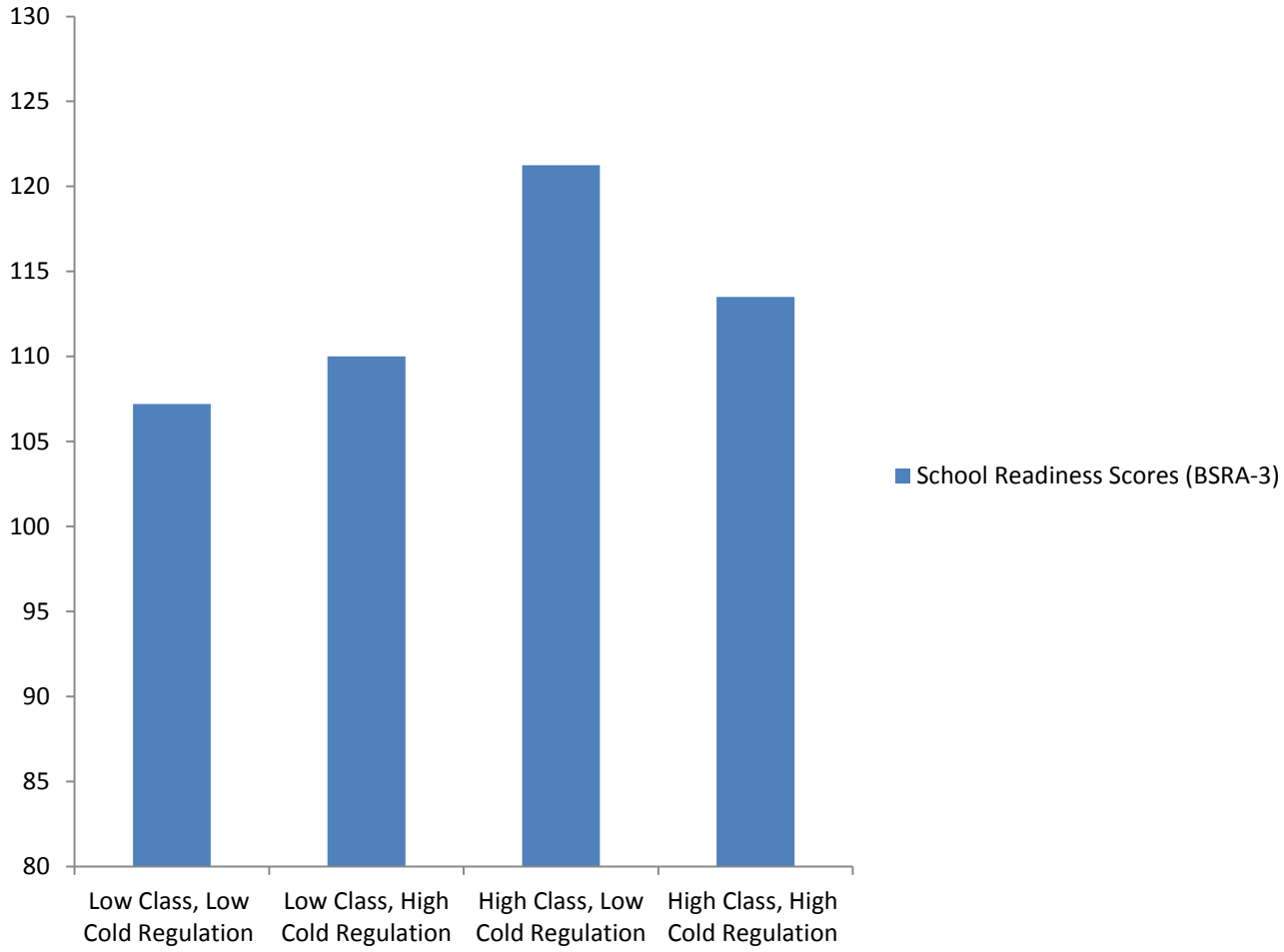


Figure 2.

Group Comparison of Classroom Task Orientation (inCLASS) as a Function of Preschool Classroom Context (CLASS) and Cool Regulation (HTKS)

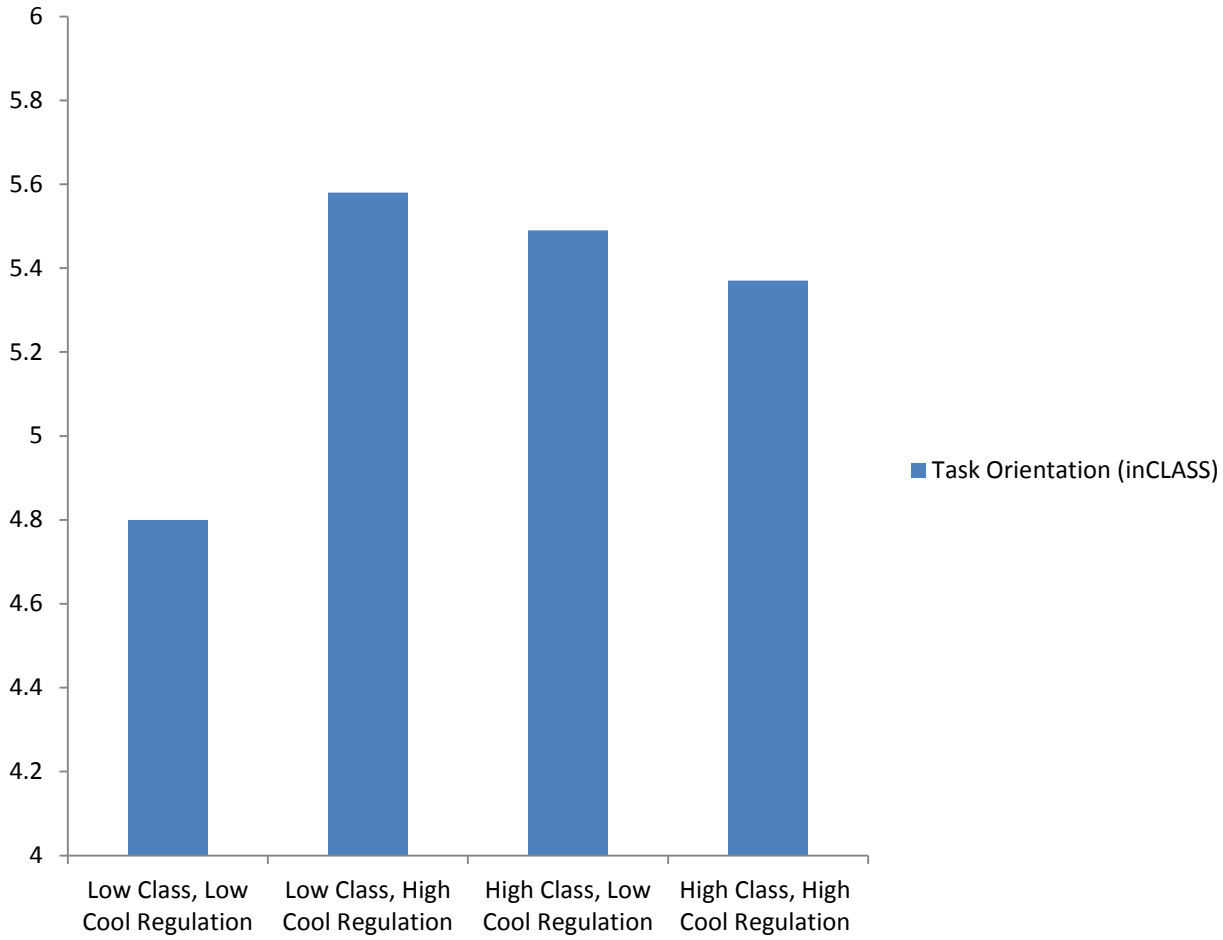
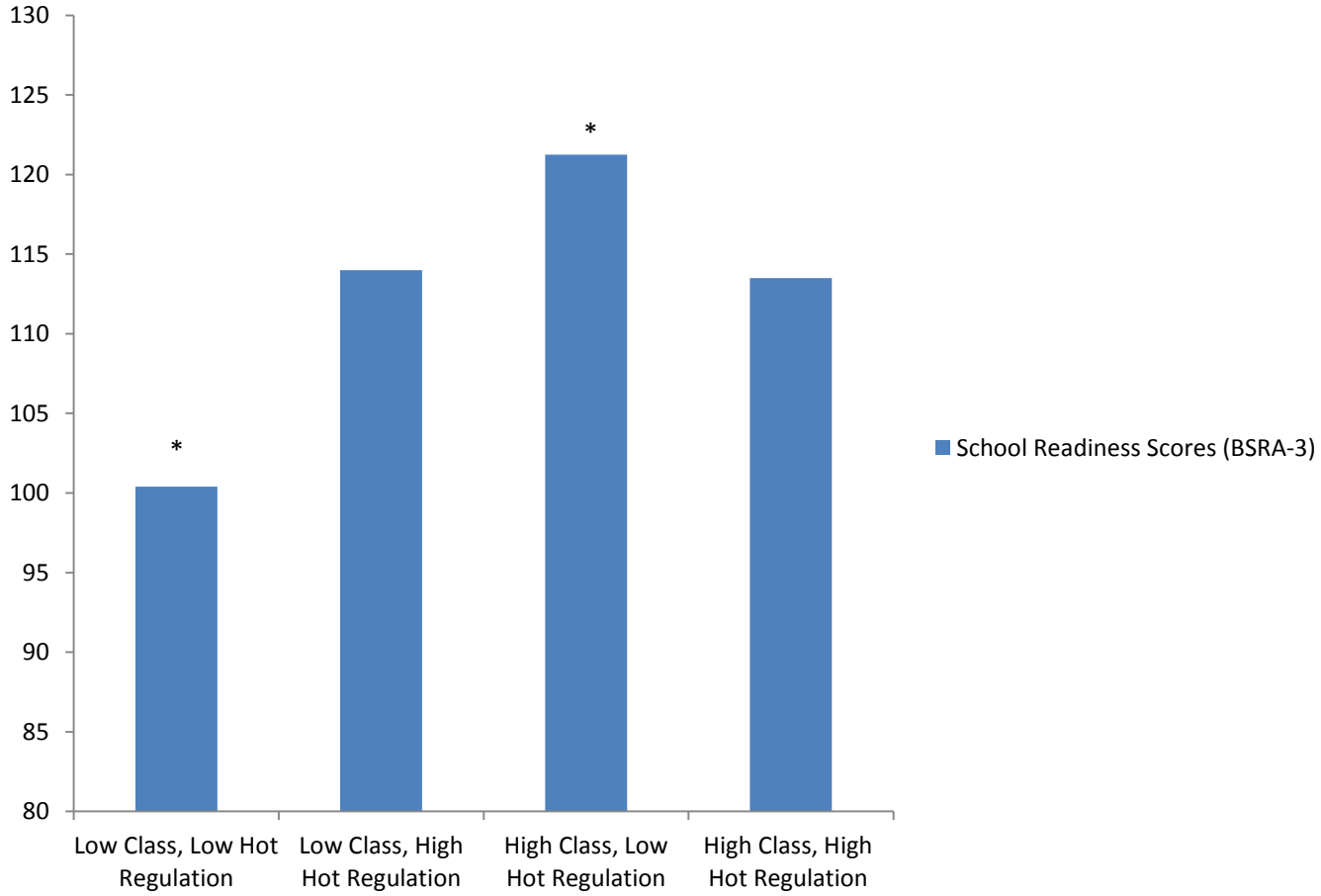


Figure 3.

Group Comparison of School Readiness Scores (BSRA-3) as a Function of Preschool Classroom Context (CLASS) and Hot Regulation (Gift Wrap Peek Scores)



**Denotes a significant difference between groups.*

Figure 4.

Group Comparison of Classroom Task Orientation (inCLASS) as a Function of Preschool Classroom Context (CLASS) and Hot Regulation (Gift Wrap Peek Scores)