MINDFULNESS AND MIND-WANDERING: THE IMPACT OF BRIEF INTERVENTIONS ON CHILD AFFECT, AROUSAL, AND COGNITION

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DEDICATION

For my mother, Jeanne Spann, who raised me with the virtues of patience, humility, curiosity, and perseverance. Your love brought me here. Thank you, mom.

Abstract

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The ability to self-regulate is critical for healthy development and life success. Recent evidence from the field of contemplative science suggests that mindfulness may enhance self-regulation among children and adolescents. It is unclear whether beneficial effects are only realized when practiced over time or if changes can occur within short time frames. This research adds to the growing literature on mindfulness and self-control by testing whether brief mindfulness practice produces changes in self-control compared to similarly restful states. The current study also explored mechanisms by which practicing mindfulness may impact self-control, specifically focusing on positive affect and arousal. A between-subjects, pre-post intervention design was used to test whether engaging in mindfulness practice, compared to mind-wandering and silent reading, produced positive changes in child affect, arousal, and self-control. Results revealed no direct impact of mindfulness on self-regulation, but children reported lower arousal as a result of mindfulness practice. Additionally, the relationship between arousal and self-control was significant only within the mindfulness condition, in which self-control was highest for those with average levels of arousal. Findings are discussed, new hypotheses are offered, and suggestions for future research are presented.

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Chapter 1

Introduction

> "The brain can only assume its proper behavior when consciousness is doing what it is designed for: not writhing and whirling to get out of present experience, but being effortlessly aware of it."
>
> -Alan W. Watts (1951)

The ability to control one's thoughts, emotions, and behaviors is an essential skill for a healthy and flourishing life (Moffitt et al., 2011). Supporting the developing capacity for successful regulation is a worthy endeavor in that effective self-control[1] contributes to a wide variety of adaptive outcomes such as academic success (Blair & Razza, 2007; Duncan et al., 2007), better mental and physical health (Moffitt et al., 2011), success in the workplace (Bailey, 2007), and richer and more positive interpersonal relationships (Ayduk et al., 2000). Findings from studies of early-emerging self-regulatory skills show that self-control is a stronger predictor of school readiness than IQ (Blair & Razza, 2007) and teachers often report that the most essential ingredient of success in kindergarten and early elementary school is the degree to which children can sit and pay attention (e.g., McClelland et al., 2007). Moreover, a recent longitudinal study spanning 32 years and examining over 1,000 individuals reported that, after accounting for social class and IQ, individual differences in self-control during childhood predict better physical and mental health, less criminal behavior, and greater wealth in adulthood (Moffitt et al., 2011). Conversely, failures in self-control result in a variety of difficulties that are highly consequential. Problems such as aggressive behaviors (Spann & Gagne, 2015), financial negligence (Moffit et al., 2011), substance abuse (Hester & Garavan, 2004; Ivanov,

[1] The terms self-control and self-regulation are used interchangeably; both refer to the use of voluntary self-governance to advance longer term goals despite pre-potent automatic responses in the moment (Duckworth & Kern, 2011).

Schulz, London, & Newcorn 2008), school dropout (Moffitt et al., 2011), and violent crime (Broidy et al., 2003) are rooted in failures to self-regulate.

Considering the breadth of positive outcomes related to self-regulation as well as the widespread consequences of self-control failure, a significant challenge is to identify means of cultivating this essential skill. Fortunately, research suggests that self-control is remarkably malleable in childhood (e.g., Diamond, Barnett, Thomas, & Munro, 2007; Diamond & Lee, 2011; Rueda, Posner, & Rothbart, 2005) and, in fact, the benefits of targeted interventions on social and emotional learning have been shown to be mediated by training-related improvements in self-control (Riggs, Greenberg, Kusche, & Pentz, 2006). Researchers have identified several activities that can improve children's self-control over time, including computerized training (Bergman-Nutley et al., 2011; Holmes, Gathercole, & Dunning, 2009), music training (Rauscher et al., 1997), and aerobics (Tuckman & Hinkle, 1986). In their review of interventions shown to aid in self-regulation development, Diamond and Lee (2011) argued that targeting self-control exclusively as a means of improvement may be less effective than addressing both the cognitive and social-emotional aspects of children. One potential intervention that addresses self-regulation as well as social and emotional skills lies in the construct of mindfulness, which first emerged in the field of clinical psychology (e.g., Segal, Williams, & Teasdale, 2002) but has received noticeably less consideration from developmental psychologists.

Mindfulness is frequently defined as enhanced attention to the present moment, including thoughts or emotions occurring internally without placing judgment on the moment (Brown & Ryan, 2003; Kabat-Zinn, 1994). The past decade has seen a surge of interest in the topic of mindfulness which has resulted in a dramatic rise in studies and funded research on the use of mindfulness practices (Greenberg & Harris, 2012). In adults, there is a large body of evidence that supports the use of mindfulness practices as a way to increase attention and self-control (Chambers, Lo, & Allen, 2008; Jha, Krompinger, & Baime, 2007; MacLean et al., 2010; Ortner, Kilner, & Zelazo, 2007; Tang, Yang, Leve, & Harold, 2012; Tang et al., 2007; Zylowska et al., 2008). Similarly, among children and adolescents, a growing amount of empirical results suggest mindfulness interventions increase attention and self-control over time (Bergen-Cico, Razza, & Timmins, 2015; Flook et al., 2010; Napoli, Krech, & Holley, 2005; Schonert-Reichl et al., 2015). A recent meta-analysis found that across seventeen longitudinal mindfulness interventions, children and adolescents showed significantly stronger gains in self-controlled behavior compared to control interventions (Spann, Gagne, & Kenworthy, 2016). Although research has found mindfulness practices assisting self-control over time, there is an absence of research investigating whether and how mindfulness practices impact attention and self-control in the short-term. More importantly, there is a paucity of empirical studies with children that investigate short-term interventions to improve self-control capacity. The study described here aims to fill these research gaps by examining whether mindfulness meditation can boost child self-control in one four-minute practice session.

1.1 Mindfulness and Short-Term Self-Control Improvement

Mindfulness training, whether short or long-term, involves mental exercises intended to strengthen the ability to pay attention to present experience. The majority of published work on mindfulness meditation has investigated mindfulness interventions lasting weeks or months (e.g., Flook et al., 2010; Schonert-Reichl et al., 2015). When long-term mindfulness training is employed, interventions adopt, or are modeled from, either Mindfulness-Based Stress Reduction (Kabat-Zinn, 1990) or Mindfulness-Based Cognitive Therapy (Segal et al., 2002). Both are widely accepted programs that involve stress education, therapy, and meditations. In a fewer set of studies, very brief training has been used. In these cases, mindfulness can best be viewed as a state, not different from what would occur in response to a short-term cause of emotion. Empirical studies with adults support the idea that even briefly introduced states of mindfulness can enhance self-control. For example, individuals made mindful by participating in a raisin-eating task (Kabat-Zinn, 1990) displayed less aggressive behavior after a social-rejection feedback than participants in a control condition, resisting an impulse to aggress against the person who delivered the negative feedback (Heppner et al., 2008). Yusainy and Lawrence (2015) compared a one-time, fifteen-minute mindfulness meditation to a control condition where participants listened to educational excerpts. Those who engaged in mindfulness meditation behaved less aggressively than those in the control condition and they showed better performance on a measure of self-control (i.e. handgrip perseverance). Most relevant to the current study, Friese, Messner, and Schaffner (2012) found that a brief period of mindfulness meditation counteracted the effects of self-control depletion. The brief mindfulness exercise led those with depleted cognitive resources to perform similarly on a self-control task compared to a control condition that did not exert self-control prior.

Two possible explanations of the effect of brief mindfulness practice on self-control were suggested by Mrazek, Smallwood, and Schooler (2012). First, repeatedly bringing attention to a specific stimulus (e.g., the breath) when the mind has wandered may cause distracting thoughts to be less salient when they are continually ignored, thus allowing for greater self-regulation of attention. A second explanation is that brief mindfulness practice increases awareness of mind-wandering, which ultimately aids in the redirection of attention to the task at hand. These two explanations are not incompatible. Limited research has investigated the effects of brief training in mindfulness (i.e., lasting only several minutes) on self-control and no publicly available study has attempted to examine this among children.

1.2 Defining and Measuring Self-Control

Investigating the impact of any intervention on self-control should carefully consider how the concept of self-control is defined and measured. Self-control is a multidimensional construct with different domains, including cognitive, affective, and behavioral control (Baumeister, 2014; Duckworth, Gendler, and Gross, 2014). Depending on the theoretical tradition of the researcher, a variety of synonymous terms are used to refer to self-control. Whether using the term self-regulation, willpower, effortful control, inhibitory control, or its converse, impulsivity, researchers are generally referring to the ability to override an automatic response in favor of a more appropriate response (Diamond & Taylor, 1996; Mischel, Ebbensen, & Zeiss, 1972; White et al., 1994; Whiteside & Lynam, 2001). Due to the fact that research on self-control is examined through a number of lenses, the measurement approaches to capturing the construct are extensive and diverse. Consider the following scenarios: refraining from eating one marshmallow now for the opportunity to eat two marshmallows later, responding to questionnaire items such as “I say inappropriate things” and “I have trouble concentrating”, inhibiting a response from hitting a key when a target appears on a computer screen, suppressing a tendency to laugh when watching a funny video, and choosing between a hypothetical $1 right now or $5 in a week. Fortunately, although there are numerous distinct measures, a meta-analysis of the convergent validity among self-control tasks found a medium mean effect size across all measures (Duckworth & Kern, 2011). Additional evidence from a meta-analysis on the ego-depletion effect found that depletion in self-control did not significantly vary due to the type of self-control task used (Hagger, Stiff, Wood, & Chatzisarantis, 2010). Thus, although substantial measurement variation exists, there is adequate convergence among self-control measures.

Four methodological traditions approach the measurement of self-control in distinctive ways: (1) executive functioning tasks, (2) delay of gratification tasks, (3) self-report questionnaires, and (4) informant-report questionnaires, with the most commonly used measures falling under the umbrella of executive functioning (Duckworth & Kern, 2011). With its roots in neuropsychology, executive functioning (also called cognitive control) refers to a family of deliberate control processes necessary for goal-directed control of thoughts, behaviors, and emotions (Diamond, 2013; Zelazo et al., 2013) that are essential for thinking, concentrating, and planning. The three core executive functions of cognitive flexibility, inhibitory control, and working memory are thought to underlie the higher-order cognitive abilities of reasoning and problems solving (Diamond, 2013). Additionally, executive attention, which comprises attentional processes that are under cognitive control, significantly overlaps with the construct of executive function (Zelazo et al., 2013). Measures of executive attention, such as the Eriksen Flanker task (Eriksen & Eriksen, 1974) and Dimensional Change Card Sort task (DCCS; Zelazo et al., 2013) are also used as measures of self-control, as well as executive functioning more broadly. The DCCS, which was used in the present study, is the most widely used measure of executive control in children (Beck, Schaefer, Pang, & Carlson, 2011).

Any single executive functioning task often involves multiple core functions at the same time. In the DCCS, for example, children must suppress the learned tendency to match an image by the image's shape when instructed to match by the image's color. In order to actively override the learned automatic response of matching by shape, however, the child must have the working memory capability to remember the rules and know that a more suitable response is required. In addition, children must have the cognitive flexibility to shift between rules rather than perseverate. Indeed, younger children who have yet to develop the capacity for cognitive flexibility are unable to shift flexibly between rules (Zelazo et al., 2013). The DCCS, then, requires working memory, inhibitory control, and cognitive flexibility—all of which combine to indicate effective self-control.

1.3 Trait and State Self-Control

Self-control has both trait and state aspects. As a trait, it is assumed that individual differences in self-control arise from a combination of genetic and environmental factors (Beaver, Ratchford, & Fergusson, 2009; Rothbart, 1989) and emerge around the end of the first year of life (Kochanska, Murray, & Harlan, 2000). Differences in temperamental self-control are assumed to be moderately heritable (Gagne, Saudino & Asherson, 2011), develop early in life, and be reasonably stable over time (Larsen & Buss, 2005). Self-control depends on the development of the prefrontal cortex and seems to improve most rapidly during early childhood (e.g., Diamond, Barnett, Thomas, & Munro, 2007; Rueda, Posner, & Rothbart, 2005), although it is clear self-control and the prefrontal cortex continue to develop into adolescence and adulthood (Zelazo, Carlson, & Kesek, 2008). While children increase in self-regulation as they age, the relative degree of self-control possessed by one individual is fairly stable as children develop. That is, there appears to be continuity in self-controlled behavior, whereby children with less ability to self-regulate grow into adulthood demonstrating a variety of outcomes (e.g., lower educational achievement, worse health, more crime) related to poor self-control (Ayduk et al., 2000; Moffitt et al., 2011).

Despite trait stability, the capacity for self-control oscillates throughout the day as an individual depletes energy resources in response to the need for inhibition and other demands on self-regulation. The state of diminished self-regulation resulting from prior exertion of self-control is referred to as ego depletion (Baumeister, Bratslavsky, Muraven, & Tice, 1998)—a term used by Baumeister and colleagues in deference to Freud's ideas that energy is a fundamental constituent of the self (Baumeister, 2014). This concept of energy led to the strength model of self-control (Baumeister, Vohs, & Tice, 2007), a theory positing that all variations of voluntary effort—including cognitive, emotional, and behavioral—draw at least somewhat on a shared pool of energy. The strength model of self-control assumes that regulation in different domains relies on a common, limited resource (Baumeister et al., 2007). According to the strength model, exercising self-control exhausts this resource to a certain degree and increases chances of self-control failure in subsequent tasks requiring regulation.

The simple ego depletion effect has been well replicated with numerous self-control procedures, as supported by a meta-analysis that included over one hundred experiments across many laboratories (Hagger et al., 2010). Results from these experiments demonstrate that using self-control is depleting. If you inhibit yourself from an automatic impulse or desire, you are less able to exert self-control in the next situation. Just as there are numerous self-control measures, there are extensive situations and tasks that lead to self-control depletion. To illustrate, consider the following tasks: refraining from laughing during a humorous video clip, avoiding the thought of white bears when told to do so, suppressing stereotypical thoughts of prejudiced groups (e.g., homosexuals, the elderly), refraining from pressing a key when a target appears on a screen, performing arithmetic calculations while standing on one leg, and resisting temptation to cheat on a quiz. Although quite unique, each of the aforementioned tasks involves conflict and the need to suppress a natural tendency.

Along with the strength model of self-control, ego depletion can be explained by decreases in motivation. As suggested by Hagger et al. (2010), individuals may have perceptions of fatigue which may, in turn, produce decreases in motivation to exert future regulation leading to subsequent self-control failure. When a reward or outcome isn't judged to be worth the effort, individuals tend to lose motivation and stop persisting. A motivation-only explanation of the ego-depletion effect suggests that decreased regulatory capacity is separate from self-control resources. Indeed, findings from both the ego depletion and mental fatigue literatures support this account in which people, when given sufficient incentives, perform equally well on short-term tasks regardless of their state of mental fatigue (Boksem, Meijman, & Lorist, 2006; Lorist, Boksem, & Ridderinkhof, 2005; Tops, Lorist, Wijers, & Meijman, 2004; Muraven & Slessareva, 2003). Thus, a loss in motivation can contribute to an explanation of the ego-depletion effect. According to the strength model, the two explanations for ego depletion—limited resource and motivational accounts—are not irreconcilable. Both the strength model and the motivation-only model suggest that engaging in a depleting task causes fatigue that results in decreased motivation to use self-control. Whereas the motivation-only account suggests that fatigue causes a perceived imbalance between the effort needed to exert self-regulation and the value of doing so, the strength model suggests that this imbalance results from lowered capacity to give self-control resources for the task at hand and increased desire to conserve those resources (Hagger et al., 2010). The limited resource account of ego depletion therefore suggests that increased motivation will counteract self-control failure only to the extent that some resources remain available.

1.4 Relationships between Self-Control, Affect, Arousal

Engaging in self-control tasks is fatiguing and may cause negative affect (Leith & Baumeister, 1996; Tice, Bratslavsky, & Baumeister, 2001) and research has shown that inducing positive affect may counteract the negative effects of self-control depletion (Tice, Baumeister, Shmueli, & Muraven, 2007). Positive emotions can undo some of the harmful physiological effects caused by negative emotions (e.g., Fredrickson, 2001; Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000) or even create an upward spiral of positive affect (Fredrickson & Joiner, 2002).

Additionally, cognitive processes are intimately linked to internal bodily states (Critchley & Harrison, 2013). Mental activities that require high cognitive demands are known to influence the autonomic nervous system (ANS), divided into the parasympathetic nervous system (PNS) and sympathetic nervous system (SNS). Heart rate (HR) and heart rate variability (HRV) are often used as biomarkers of the ANS. HRV, in particular its high-frequency component, is a marker of the PNS activity (Camm et al., 1996; Reyes del Paso et al., 2013) and related to a variety of psychological factors, including attention, working memory, and emotion regulation (Thayer & Lane, 2009). Previous studies provide evidence that increased PNS activity is linked to improved cognitive control during performance of cognitive tasks (Hansen, Johnsen, & Thayer, 2003; Overbeek et al., 2014). Furthermore, internal bodily states are also linked to emotions. Fredrickson & Levenson (1998) showed that positive emotions speed recovery from the harmful cardiovascular impact of negative emotions. Participants were shown a fear inducing filmstrip, after which they watched other filmstrips that elicited either positive, neutral, or negative emotions. Participants who viewed the films that induced positive emotions showed the most rapid return to their baseline levels of cardiovascular activation. Spontaneous smiling had similar effects. The implication is that one of the functions of positive emotions is to return the person to a neutral physiological state and undo the cardiovascular effects of negative emotions.

If one of the roles of positive emotion is to return the body to its neutral state, it is plausible that positive emotion can counteract the negative effects of ego depletion. Positive affect may lead to renewed vigor toward tasks such that individuals increase their motivation to use self-control in their pursuit (Hagger et al., 2010). Over four studies, Tice et al. (2007) showed that inducing positive mood between two self-regulation tasks improved participants' performance compared to participants who performed the same self-regulation tasks but did not undergo a positive mood induction. While there is some contradictory evidence that inducing a positive mood does not promote better self-control (Schmeichel & Vohs, 2009), tests of positive affect induction as a mechanism for increasing self-control are relatively scarce. Additional empirical investigations are warranted to resolve the inconsistency.

1.5 Dual-Process Theories of Self-Control

Several theories have attempted to explain the phenomenon of self-control from the cognitive control perspective (e.g., Baddeley & Hitch, 1994; Barkley, 1997; Rueda et. al., 2005), which presume self-controlled behavior emerges from top-down executive control processes. Recently, there is increasing attention directed toward the interaction between executive control processes and emotionally arousing, automatic influences and the resulting impact on self-controlled behavior. Rather than emphasizing the dominance of one system over the other, some have argued that self-controlled behavior emerges as a function of changes in the interaction between regulatory and automatic influences (Blair & Diamond, 2008; Duckworth & Steinberg, 2015; Zelazo & Lyons, 2012). Two theories, the dual influence framework and the iterative reprocessing model, have framed self-regulatory behavior as a function of both cognitive control and impulsigenic influences.

The dual influence framework (Duckworth & Steinberg, 2015) proposes a functional model of self-control, whereby volitional processes are distinguished from automatic processes (e.g., anxiety, arousal, anger). Whereas deficits in self-control are typically attributed to underdeveloped regulatory processes, these deficiencies may have more to do with impulsigenic tendencies. This can be seen among individuals demonstrating equivalent levels of cognitive control, but differing in self-controlled behavior depending on the reward or temptation (Duckworth & Steinberg, 2015). Although relatively little is known about automatic influences such as anxiety and arousal on self-control, there is evidence to suggest that changes in the type and strength of motivational drives contribute to changes in self-regulatory capacity as children and adolescents develop (Spear, 2000). For instance, changes in motivational drives during adolescence increase the likelihood of risk-taking under some circumstances (Steinberg, 2007).

Relatedly, the iterative reprocessing model includes an account of both regulatory and automatic influences on self-controlled behavior (Cunningham & Zelazo, 2007, 2010). The iterative reprocessing model proposes that iteratively reprocessing information via neural circuits in the prefrontal cortex (Badre & D'Esposito, 2007; Botvinick, 2008; Christoff & Gabrieli, 2000) is critical for maintaining overt goals in working memory that work to influence self-control. In addition, the reprocessing of information parallels practices of reflection, which allows individuals to redirect and put experiences into perspective (Zelazo & Lyons, 2012). As children develop, they are progressively able to reflect on their experiences, leading to deeper representations of a situation. It has been determined that the neural regions supporting reflection are strengthened by repeated use (Stiles, 2008). The control processes that are reinforced by use, however, interact with automatic influences. Quick, automatic responses created in the amygdala are eventually fed to the prefrontal cortex where simple rules are reprocessed and formulated into higher order rules that control and engage other neural regions in a regulatory fashion (Zelazo & Lyons, 2012). Thus, the regulatory influence is elicited by automatic responses from the amygdala.

From the perspective of the dual influence framework and iterative reprocessing model, and as the authors of these models have suggested, an effective intervention for nourishing the development of self-control would engage the regulatory processes while lessening potential automatic influences on self-control. Mindfulness is one practice that has the potential to improve self-control through regulating both cognitive and emotional aspects of individuals.

1.6 Mindfulness as an Intervention to Increase Self-Control

Contemporary researchers define mindfulness as paying attention to the present moment, including thoughts and emotions, with acceptance, curiosity, and kindness (Brown & Ryan, 2003; Kabat-Zinn, 1994). The construct of mindfulness falls under the umbrella of contemplative science, which is the result of a multidisciplinary effort to understand the mind-body system through contemplative practices (Roeser & Zelazo, 2012). Mindfulness is essentially an embodied practice, emphasizing the dynamic interaction of the mind-body system via techniques such as meditation and yoga (Burke, 2014). Mindfulness meditation trains skills by applying restraint on ordinarily uncontrolled mental or physical activities (Mind and Life Education Research Network [MLERN], 2012), encouraging the use of voluntary control in order to focus attention on certain objects (e.g., the breath) or thoughts (e.g., kindness to others).

Defining mindfulness in a single account is fairly contradictory in that it is difficult to understand unless it is experienced (Burke, 2014). Mindfulness has been described as both a process and an outcome, but is best defined as a way of being (Burke, 2014; Kabat-Zinn, 1994). At its core, mindfulness means awareness (Kabat-Zinn, 1994). The practice of being mindful involves repeatedly bringing attention to the present moment, focusing and refocusing on present moment experience whenever the mind wanders. A fundamental goal of mindfulness practice is to become fully aware of the moment-to-moment fluctuations both internally and in the environment while simultaneously embracing an accepting viewpoint toward whatever arises in the present. The acceptance/nonjudgmental component of mindfulness does not suggest that individuals no longer have judgments. Rather, and somewhat paradoxically, it is an attempt to suspend judgments of how judgmental one is being, and it is assumed that paying attention in this way brings greater clarity, acceptance, and kindness to the present moment. In this way, engaging in formal mindfulness practices such as mindfulness meditation involves much more than simply relaxation. Relaxation is a by-product of mindfulness practice, but it is certainly not the goal.

The rapid growth in popularity of mindfulness practice over the past fifteen years has extended its applications in medicine to many other fields, including psychology, neuroscience, business, sports, the military, and education. The growing interest is supported by evidence that mindfulness practice is beneficial for several populations, such as individuals with cancer, fibromyalgia, chronic pain, anxiety, and depression (see Grossman et al., 2004 for a review). In adults, mindfulness has been shown to improve health and well-being by reducing stress, anxiety, and depression, as well as fostering social connection and enriched interpersonal relationships (Ludwig & Kabat-Zinn, 2008; Ruff & Mackenzie, 2009). In addition, there is a large body of empirical research to suggest that mindfulness leads to improvements in sustained attention (Jha et al., 2007; Kaul, Passafiume, Sargent, & O'Hara, 2010; MacLean et al., 2010), and executive function and self-regulation (Chambers et al., 2008; Ortner et al., 2007; Tang et al., 2012; Tang et al., 2007; Zylowska et al., 2008).

Schools throughout the United States are incorporating mindfulness meditation into educational curricula with the goal of enhancing self-awareness and self-regulation of attention, emotions, and behavior (Greenberg & Harris, 2012; MLERN, 2012). School-based mindfulness programs typically use practices that direct attention to a specific "anchor" where children are asked to focus attention to the anchor (e.g., breath or sound) whenever the mind wanders. Child and adolescent mindfulness programs often adapt practices from adult mindfulness programs such as Mindfulness-Based Stress Reduction (Kabat-Zinn, 1990), an eight-week program that involves stress education, therapy, and meditations. Some of the programs adopt daily practice (Schonert-Reichl & Lawlor, 2010) or weekly sessions (Broderick, 2005), and many incorporate mindful awareness into activities such as walking and eating (Meiklejohn et al., 2012).

Research has shown that children and adolescents freely engage in mindfulness activities and enjoy doing so (Broderick & Metz, 2009; Schonert-Reichl & Lawlor, 2010; Burke, 2010). Adult mindfulness practices require adaptation for children (Roeser & Peck, 2009) and several have been adapted for use with younger populations to create developmentally appropriate ways to train the core aspects of mindfulness. Such tailored practices take a variety of forms, including physical activities involving set postures or sequences of movements (such as yoga), various forms of sitting meditation, the arts, and even activities in nature (Roeser & Peck, 2009). Although mindfulness practices may take several forms, programs typically emphasize yoga and/or meditative practice. Most mindfulness interventions with children, although adapted from adult practices, have been developed specifically for use in school-based environments. At their core, these interventions emphasize noticing one's moment-to-moment experiences, monitoring and redirecting attention when it has wandered, and observing one's thoughts and feelings in a nonjudgmental manner.

Mindfulness interventions with children and adolescents, like adults, typically occur in small-group environments and include a number of practices such as body scans, breathing exercises, and sitting meditations (Zelazo & Lyons, 2012). One major difference between adult and child mindfulness practices is the length of individual lessons or activities. While adults may be able to attend to their breathing for 30-45 minutes, young children may only accomplish this for 3 minutes (Burke, 2010). Movement-based activities like yoga are readily adopted mindfulness practices for children because remaining stationary for long periods can be so difficult for young children that it restricts their capacity to practice mindfulness (e.g., Kaiser-Greenland, 2010). Teachers often use props to help children understand the goals of mindfulness exercises, such as placing a stuffed animal on the child's stomach while instructing them to rock the animal to sleep with slow and soft breaths (Kaiser-Greenland, 2010). Having children focus their attention on subtle bodily sensations like their breath may underlie the capacity for awareness of emotions and thoughts (Zelazo & Lyons, 2012). For example, children may be told that, just like floats pass by in a parade, thoughts pass through the mind and some of the thoughts (floats) may be more interesting than others. However, the teacher instructs them that they can simply observe the thoughts as they pass, just as they would not jump onto a float at a parade (Saltzman & Goldin, 2008).

1.7 The Effects of Mindfulness on Affect and Arousal

How mindfulness meditation may function to increase attention and self-control in the short-term is an unexplored topic, particularly among children. To date, no investigation has compared mindfulness, mind-wandering, and subsequent affect and self-control among children. Evidence from short-term intervention studies with adolescents and adults suggests positive mood is increased when practicing mindfulness. Using a non-clinical adult sample, an investigation of mindfulness and affect found that those who engaged in a brief period of mindfulness showed less negative affect compared to those who received a distraction or rumination induction (Broderick, 2005). Additionally, Hilt and Pollak (2012) demonstrated that a brief period of mindfulness was successful in getting adolescents out of ruminative states. Using adults formerly suffering from depression, other studies have shown that both mindfulness and distraction inductions result in less intense negative affect compared to a rumination induction (Huffziger & Kuehner, 2009; Singer & Dobson, 2007). Furthermore, Erisman and Roemer (2010) compared a one-time, ten-minute mindfulness exercise to viewing educational videos on affect and emotion regulation. Results revealed that those who experienced mindfulness reported significantly greater positive affect in response to a positive film clip compared to the control condition.

Two studies with adults have directly compared the effects of mindfulness meditation and mind-wandering on affect. Arch & Craske (2006) examined affective responses to pictures after participants underwent a fifteen-minute mindfulness meditation, mind-wandering, or worrying induction. The mindfulness group showed consistent, moderately positive responses to neutral pictures before and after the manipulation, while the mind-wandering and worry groups showed significantly more negative responses to the neutral pictures. Moreover, the mindfulness group reported lower negative affect after the pictures compared to the worry group, and a greater willingness to view optional negative pictures than the mind-wandering group, which, together, may indicate more adaptive responding to negative stimuli. Similarly, Kiken and Shook (2011) compared the effects of a fifteen-minute mindfulness meditation to mind-wandering on negativity bias, or the tendency to weigh negative information or events more heavily than positive. Individuals engaging in mindfulness showed significantly less negativity bias and higher levels of optimism compared to those who mind wandered. Together, these findings suggest mindfulness (as compared to mind-wandering) may lead to a more positive mood and better affective regulation broadly.

In addition to changes in positive affect, contemplative practice is often associated with a relaxed state of body (Lumma, Kok, & Singer, 2015). In studies comparing meditation to baseline measures of cardiovascular activity, many have found that attention-focused types of meditation show an increase in PNS activity as assessed by increases in heart rate variability or decreases in heart rate (Krygier et al., 2013; Libby et al., 2012; Takahashi et al., 2005; Wu & Lo, 2008; Zeidan et al., 2010). It has been shown that other types of meditation, other than mindfulness meditation, impact bodily states differently. In compassion meditation, for example, Lutz and colleagues showed this meditation led to an increase in heart rate compared to a baseline condition. This suggests an activation of the sympathetic nervous system during compassion meditation (Lutz et al., 2009). Together, these findings suggest that mindfulness practice may lead to lower physiological arousal compared to similarly restful states. Considering that increased PNS activity is linked to improved cognitive control (Hansen et al., 2003; Overbeek et al., 2014), mindfulness practice may lead to improved self-regulation by lowering physiological arousal.

The links between affect, arousal, and self-control, together with findings that mindfulness influences both affect and arousal, has important implications for the current study. If in fact short-term mindfulness practice increases self-control, does mindfulness increase self-control by first increasing positive affect and lowering arousal? The mechanisms by which mindfulness influences self-control warrants further investigation.

1.8 Mind-Wandering: Consequences, Benefits, and Comparison to Mindfulness

Whereas mindfulness involves focused attention to the present moment, mind-wandering is a state where attention is directed to internal thoughts unrelated to the present moment. Mind-wandering is an extremely common experience where attention moves from the immediate external environment to internal thoughts (Mooneyham &

Schooler, 2013). The act of mind-wandering is a universal phenomenon, supported by findings from one study estimating that individuals are engaged in mind-wandering approximately 50% of their waking life (Killingsworth & Gilbert, 2010). Mind-wandering involves a decoupling with experience, in which individuals show diminished responsiveness to the external world (Schooler et al., 2014), and is associated with abundant internal activity that typically involves thinking about the future (Smallwood & Schooler, 2006) and/or thinking about oneself (Schooler, Reichle, & Halpern, 2004). It is clear that there are many costs to mind-wandering while engaged in a task, including reduced working memory (Mrazek et al., 2012), increased impulsivity (Smallwood et al., 2004), impaired reading comprehension (Schooler et al., 2004; Smallwood et al., 2008), and negative affect (Killingsworth & Gilbert, 2010). However, when we are not engaged in a task, mind-wandering may bring certain benefits arising from internal reflection (Immordino-Yang, Christodoulou, & Singh, 2012). When wakefully resting, the brain engages the so-called default mode (DM) network of neural processing that is typically suppressed when attention is focused. The DM network is a collection of brain regions that is typically more active at rest than during explicit cognitive tasks. The DM network is associated with activity in the midline of the cerebral cortex that generates narratives about an individual's experiences and is strongly associated with mind-wandering (Christoff et al., 2009; Mason et al., 2007). Training in mindfulness can reduce activation of the DM network. Reduced DM activation was observed among both long-term meditators (Brefczynski-Lewis et al., 2007) and individuals who completed a two-week mindfulness meditation intervention (Tang et al., 2009).

In a landmark study employing experience-sampling techniques, Killingsworth and Gilbert (2010) administered probes to participants using a web-based cell phone application at random times as they went about their daily lives. The authors found that participants reported being less happy when mind-wandering compared to being on-task. Additionally, time lag analyses suggested that mind-wandering preceded negative affect not vice versa. Importantly, even when participants were letting their minds wander about pleasant topics, their moods were never better than when they were on-task, suggesting that mind-wandering is deleterious regardless of the pleasantness of the thoughts. However, in a replication study by Franklin et al. (2013), participants were similarly probed asking whether they were mind-wandering, but as an additional measure, individuals were also asked to rate their mind-wandering thoughts on how interesting and useful they were. Results showed that the effect of mind-wandering on subsequently reported mood depended on the interest level and usefulness of the thought that was rated. Participants' positive moods were associated with how interesting and useful they viewed their thoughts. Further analyses suggested that highly interesting wandering thoughts were correlated to greater positive mood than on-task thoughts. However, highly useful thoughts did not show a stronger association with positive mood than on-task thoughts. Importantly, findings indicated that overall on-task reports had higher positive mood ratings than off-task reports. Together, these findings suggest that remaining on task is associated with more positive mood, but the benefit of mind-wandering may occur through daydreaming about personally interesting thoughts.

Several recent studies have suggested potential benefits of mind-wandering. A substantial amount of cognitions that arise when we let our mind wander involve future states (Baird, Smallwood, & Schooler, 2011; Smallwood et al., 2009). If mind-wandering typically involves future-oriented thoughts, combined with thinking about oneself (Schooler et al., 2004), one enormous benefit to mind-wandering may be planning of personally relevant future goals, termed autobiographical planning. Thinking self-related, prospective thoughts during mind-wandering has been demonstrated in recent findings

(Baird et al., 2011; Smallwood et al., 2009), suggesting mind-wandering allows for goal-directed, personally relevant planning for the future. In addition, there is a somewhat controversial link between mind-wandering and creativity. Several empirical studies have suggested this relationship. Individuals with attention deficit hyperactivity disorder (ADHD), who typically display high amounts of mind-wandering during tasks, tend to score higher on creativity measures in the laboratory (White & Shah, 2006) and on questionnaire items reflecting achievement in the creative arts (White & Shah, 2011). The effects of mind-wandering on creativity are often studied using an incubation paradigm—that is, problem solving following a break from the problem. One meta-analysis on the positive effects of a break from a challenging problem on later creative problem solving concluded that these so-called incubation effects are larger when individuals engage in undemanding rest tasks (Sio & Ormerod, 2009). The benefits of mind-wandering on creativity are typically observed when mind-wandering occurs in the incubation period (Baird et al., 2012) and one recent empirical study suggested that mind-wandering during the course of creative idea generation is negatively related to creativity (Hao, Wu, Runco, & Pine, 2015). Taking into consideration the finding that mind-wandering occurs more often in undemanding tasks compared to demanding tasks (Smallwood et al., 2009), the potential benefits of mind-wandering to creativity may occur in incubation periods with low demanding tasks.

In sum, relaxing and letting your mind wander may produce benefits in the short term. In typical studies examining the effects of brief mindfulness interventions, a relaxation, or mind-wandering, condition is used to represent a neutral mental state (Arch & Craske, 2006; Kiken & Shook, 2011). Considering the above evidence, however, mind-wandering can potentially lead to certain benefits when task demands are low—i.e. creativity and positive mood. An unanswered and vital empirical question that remains is whether mindfulness meditation leads to short-term improvements in self-control compared to similar restful states such as mind-wandering.

In one relevant study with adults, participants were assigned to conditions in which they completed either eight minutes of mindful-breathing or one of two control conditions: passive relaxation or reading (Mrazek et al., 2012). In the mindfulness condition, participants were instructed to sit in an upright position while focusing their attention on the sensations of their breath without trying to control the rate of respiration. Participants were asked to return their attention to the breath anytime they became distracted. Those in the passive rest condition were instructed to relax without falling asleep—a task that is highly associated with mind-wandering. Participants in the reading condition were asked to browse a popular local newspaper. Following the manipulation, all participants performed the sustained attention to response task (SART), and results revealed that, relative to the two control conditions, those who engaged in mindfulness meditation exhibited enhanced self-control as measured by behavioral markers of inattention (e.g., fewer errors of commission and lower reaction time variability). To date, no study among children has examined the effects of a brief mindfulness exercise as compared to mind-wandering on affect, arousal, and self-control.

1.9 The Current Study

There are widespread consequences of self-control failure and recent findings with adults suggest that mindfulness meditation may enhance self-control in the short term (Friese et al., 2012; Mrazek et al., 2012; Yusainy & Lawrence, 2015). Additionally, mindfulness meditation is being implemented in school settings across the United States with little empirical findings demonstrating support of these practices. Among children, no study has investigated the effect of a brief mindfulness intervention (i.e., lasting only several minutes) on emotional, cognitive, and behavioral functioning. Furthermore, it is clear that the study of mindfulness meditation warrants more rigorous research with randomized, controlled trials using active control conditions and careful selection of validated objective measures of self-control (Greenberg & Harris, 2012; MLERN, 2012). If the goal is to attribute positive outcomes of mindfulness interventions to the active ingredient of mindfulness—present moment awareness—it is vital to use comparison groups that allow for such a conclusion. Furthermore, exploring the mechanisms of change is crucial to our full understanding of the relationship between mindfulness and self-control.

In an attempt to fill these research gaps, the current study sought to examine whether children who experienced a brief mindfulness meditation would have increased self-control, and, if so, whether the benefits were significantly greater than similar tasks not involving mindfulness. Two active control conditions were included in order to rigorously test whether any potential beneficial effects were due to present moment awareness. Both mind-wandering and silent reading were used as control conditions. The current study employed an experimental, between-subjects, pre-post intervention design to test the following predictions.

1.9.1 Hypothesis 1

Children engaging in mindfulness meditation would show significantly better self-control than children engaged in either mind-wandering or silent reading.

1.9.2 Hypothesis 2

The experimental condition would impact child affect. Children participating in mindfulness meditation would report significantly higher positive mood than children engaged in either mind-wandering or silent reading.

1.9.3 Hypothesis 3

Children participating in mindfulness meditation would report significantly lower arousal than children engaged in a silent reading condition. Children engaged in mindfulness meditation would not differ in arousal from children who engaged in mind-wandering.

1.9.4 Hypothesis 4

It was expected that positive affect and arousal act as mediators of the effect of mindfulness meditation on self-control performance. Specifically, it was expected that increases in positive mood and lower arousal would result from engaging in mindfulness, which would then lead to enhanced self-control.

Chapter 2

Methods

2.1 Recruitment

Children ages 7 to 12 years were recruited from the Research and Learning Center at the Fort Worth Museum of Science and History between the months of December 2015 and March 2016. Study staff approached parents with children at the museum and asked the families if they would like to participate in a research study on attention and self-control. Written informed consent was obtained from parents as well as children. No compensation was given to families for their participation. The study was approved by the University of Texas at Arlington Institutional Review Board. Prior to participation, parents and children were encouraged to ask any questions and they were informed that they did not need to perform any procedures that made them feel uncomfortable. Parents and children were also told that they would not be penalized in any way for withdrawing participation at any time during the study.

2.2 Participants

An a priori power analysis produced a needed sample size of 244 children, assuming a medium effect size of .20, an alpha of .05, and power of .80. Initially, 252 children met the age range. Nine children were removed from the final sample. Six of the nine terminated the study before completing the first DCCS task and were not randomly assigned to an intervention. One was removed from the mindfulness condition because the Mp3 device containing the recording was stolen during his first task and he could not complete the experiment. Another case was removed from the mindfulness condition because her younger sister distracted her during the entire experiment. The final case was removed from the mind-wandering condition, because his father prompted all of his responses on both DCCS tasks. After removing these nine children, the final sample included 243 children. Of the 243 (M = 120, F = 123), there were 82 children in the mindfulness condition, 79 in the mind-wandering condition, and 82 in the silent reading condition. Please refer to Table 2-1 for demographics of study participants.

Table 2-1 Demographic Characteristics of Study Participants

Gender	*n*	%
Boys	120	49.40
Girls	123	50.60
Race	***n***	**%**
White	171	70.40
Black or African American	12	4.90
Asian	18	7.40
Native Hawaiian or Other Pacific Islander	4	1.60
More than one race	4	1.60
Other	32	13.20
Ethnicity	***n***	**%**
Not Hispanic or Latino	172	70.80
Hispanic or Latino	71	29.20
Family Income	***n***	**%**
Less than $10,000	4	1.60
$10,000 to $14,999	4	1.60
$15,000 to $24,999	8	3.30
$25,000 to $34,999	19	7.80
$35,000 to $49,999	18	7.40
$50,000 to $74,999	47	19.30
$75,000 to $99,999	41	16.90
$100,000 to $149,000	47	19.30
$150,000 to $199,000	21	8.60
$200,000 or more	14	5.80
Not reported	21	8.20

2.3 Measures

2.3.1 Dimensional Change Card Sort

The Dimensional Change Card Sort (DCCS; Zelazo et al., 2006) is the most widely used measure of executive control (Beck et al., 2011), tapping attention, inhibitory control, and cognitive flexibility. The DCCS is a 5-minute computerized task in which two presented target pictures vary along two dimensions (e.g., shape and color). Administered on an iPad, children were asked to match a series of bivalent test pictures (e.g., yellow balls and blue trucks) to the target pictures, first according to one dimension (e.g., color) and then, after a number of trials, according to the other dimension (e.g., shape). “Switch” trials were employed, in which the participant must change the dimension being matched. For example, after four consecutive trials matching on shape, the child may be asked to match on color on the next trial and then go back to shape, thus requiring the cognitive flexibility to quickly choose the correct stimulus (Figure 2-1).

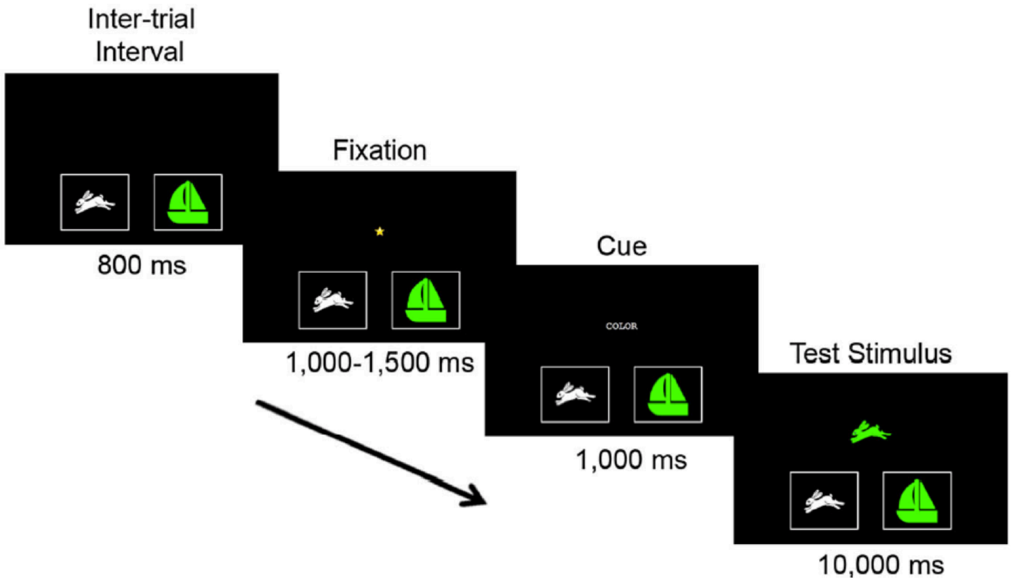

Figure 2-1 Example of DCCS Switch Trial Procedure Delivered on iPad

The DCCS contains thirty trials in total. Although there were eight practice trials, after completion of the experiment, numerous children reported feeling as though they did better on the second test due to the intial uncertainty about the test. To control for the adjustment to the first test, the first ten trials were removed from each test. Removing the first ten trials provided a more accurate assessment of the child's change in score over time, because it removed the error associated with adjusting to the first test. The need to control for this adjustment period was confirmed by examining correlations and paired *t*-tests comparing scores with the full thirty trials to scores with the first ten trials removed. For the first DCCS test, the correlation between scores on the full test and scores with the first ten trials removed was $R(233) = .88$. For the second test, the correlation between scores on the full test and scores with the first ten trials removed was $R(233) = .93$. Additionally, paired *t*-tests revealed that, for the first test, scores with the full thirty trials were significantly lower ($M = 8.07$, $SD = 1.38$) than scores with the first ten trials removed

(*M* = 8.22, *SD* = 1.21), *t*(234) = -3.49, *p* = .001. For the second test, there was no difference between scores with the full thirty trials (*M* = 8.16, *SD* = 1.20) and scores with the first ten trials removed (*M* = 8.18, *SD* = 1.19), *t*(234) = -0.66, *p* = .51. This supports the assertion that there is at least a small amount of error introduced by including scores from all trials. Therefore, scores were calculated based on performance on the last twenty trials of each DCCS test.

Scoring was based on a combination of accuracy and reaction time where higher scores indicate better performance. A two-vector scoring method was employed that used accuracy and reaction time. The vectors ranged in value from 0 to 5, forming a computed score ranging from 0 to 10 when the vectors were combined. For any given child, accuracy was considered first, and if accuracy levels were less than or equal to 80%, the final computed score was equal to the accuracy score. If accuracy levels for the participant reached more than 80%, the reaction time score and accuracy score were combined.

The accuracy vector was comprised of accuracy points. For every correct behavioral response, a participant received a value of 0.167 (5 points divided by 30 trials). The score is taken out of thirty trials, rather than twenty, because based on guidelines from the NIH Toolbox (Casaletto et al., 2015), children of this age automatically receive points for ten correct trials. Thus, DCCS Accuracy Score = (0.167 * Number of Correct Responses).

The reaction time vector was generated from the median reaction time score on switch trials (non-dominent dimension/dimension cued less frequently). Median reaction time values were computed using only correct trials with reaction times greater than or equal to 100ms and reaction times no larger than 3 standard deviations away from the child’s mean reaction time for switch trials. Because reaction time data tends to have a positively skewed distribution, a log (Base 10) transformation was applied to each child's median reaction time score. Participants with median reaction times that fell outside of the validated minimum (500ms) and maximum (3,000ms) reaction time, but within the allowable range (100ms-10,000ms) were truncated (i.e., reaction times between 3,000ms and 10,000ms were set to 3,000ms). Log values were then algebraically rescaled from a log(500)-log(3000) range to a 0-5 range using the following formula:

$$\text{DCCS Reaction Time Score} = 5 - \left(5 * \left[\frac{\log RT - \log(500)}{\log(3000) - \log(500)}\right]\right)$$

Again, these reaction time scores were combined with the accuracy scores for children who achieved the accuracy criterion of greater than 80%. Children who failed to reach the criterion received their accuracy score as their total computed score.

2.3.2 Self-Assessment Manikin

The Self-Assessment Manikin (SAM; Bradley & Lang, 1994) visually displays graphic characters arrayed along a continuous nine-point scale (Figure 2-2). For affect, the SAM ranges from a frowning, unhappy figure to a smiling, happy figure. For arousal, the SAM ranges from a sleepy figure with eyes closed to an excited figure with eyes open. The SAM is a widely used measure of affective response (Bradley & Lang, 1994). Experimenters asked the children to show them how they were feeling while pointing to the five faces. Children were told that choosing the sad face on the far left would mean they felt the saddest they could feel, whereas choosing the happy face on the far right would mean they felt the happiest they could possibly feel. Choosing the face in the middle would mean they felt neither happy nor sad at the moment. They were shown the nine dots below the faces and told they could be at any point along the way. The children were instructed to "point to the circle" that represented how they felt. Experimenters then asked the children to show them how much energy they had. Children were told that choosing the person on the far left would mean they felt the lowest amount of energy they could possibly feel and were close to falling asleep. Choosing the person on the far right would mean they had the most energy they could possibly have. Children were told that choosing the person in the middle would mean they had neither low energy nor high energy. Again, the children were shown the nine dots and told they could be at any point along the way. They were instructed to “point to the circle” that represented their energy level.

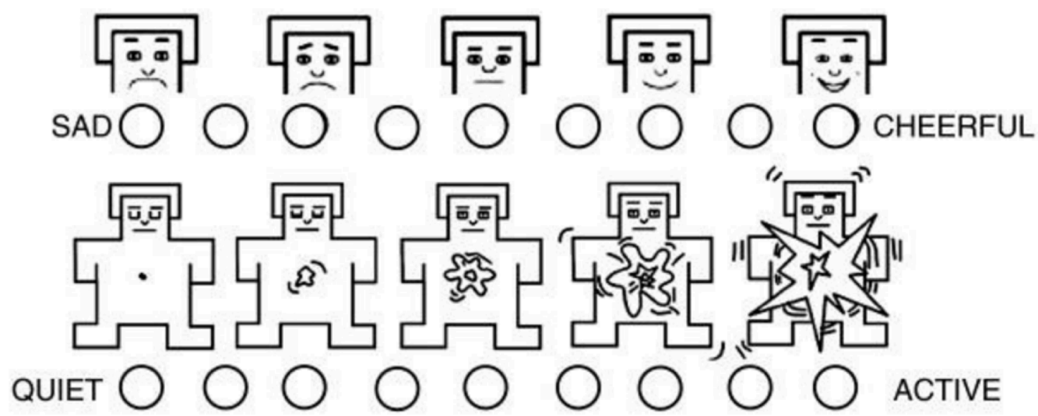

Figure 2-2 Self-Assessment Manikin

2.3.3 Covariates

2.3.3.1 Parent-reported Child Self-Control

Parents were asked to complete a brief questionnaire regarding their child’s self-control. For children 7-9 years of age, parents completed the Temperament in Middle Childhood Questionnaire (TMCQ; Simonds & Rothbart, 2004). For children 10-12 years of age, parents completed the Early Adolescent Temperament Questionnaire (EATQ; Ellis & Rothbart, 2001). The inhibitory control subscales of these questionnaires were used and can be found in Appendix A. Both questionnaires use a five-point rating scale to rate child behaviors from “almost always untrue” to “almost always true”. Scores were derived for each participant by summing the items and dividing by the number of items receiving a numerical response. Higher scores reflect greater self-control.

Of the 243 participants, 141 parents completed the TMCQ and 96 parents completed the EATQ. Parents of six children in the age range for the TMCQ and a parent of one child in the age range for the EATQ did not complete the questionnaire. Reliabilities of the TMCQ and EATQ in the current study were .73 and .66, respectively. The average score for the TMCQ was 3.47 (*SD* = .64), and the average score for the EATQ was 3.49 (*SD* = .73). The TMCQ and EATQ were used to create one variable—parent-reported child self-control—to represent each child's global self-control.

2.3.3.2 Maternal Education

Families reported the education level of the child's mother using the NIH Toolbox Application. Options ranged from grade levels to high school graduate, GED, some college credit but less than one year, one year of college, two years of college, three years of college, Associates degree, Bachelor's degree, Master's degree, Doctorate degree, and Professional degree (e.g., MD, DDS, JD). These categories were recoded to reflect years of education. For example, high school graduate and GED were given values of 12, Associate's degree a value of 14, Bachelor's degree a value of 16, Master's degree a value of 18, and Professional and Doctorate degrees values of 20. Values in years of education ranged from 6 to 20.

2.4 Intervention

The intervention occurred for four minutes. Children were randomly assigned to one of three groups: mindfulness meditation, mind-wandering, or silent reading. All children were instructed to sit on a cushion with their legs crossed, close their eyes, and place their hands wherever they felt comfortable. Noise-cancelling headphones connected to an Mp3 player were placed over the child's ears in all three conditions.

2.4.1 Mindfulness Meditation

Children in this condition listened to a guided mindfulness meditation practice (Appendix B). The meditation was modeled after Susan Kaiser Greenland's meditations with the Inner Kids Program used in multiple mindfulness interventions with children (e.g., Flook et al., 2010). The meditation instructed them to focus their attention to their breath, guiding them to continuously bring their attention back to their breath when they found their mind wandered.

2.4.2 Mind-wandering

Children in this condition listened to an exercise instructing them to relax and let their mind wander (Appendix B). The initial instructions for this condition were identical to the mindfulness meditation instructions. The key difference occurred at the one-minute mark, where children were encouraged to let their mind wander to wherever it wanted to go. They were instructed to sit in silence and daydream.

2.4.3 Silent Reading

Silent reading has been suggested as an effective control condition for mindfulness interventions (Allen et al., 2012). Silent reading has also been used as a control condition for children in other mindfulness interventions (e.g., Flook et al., 2010). Children in this condition chose from three educational books to read. The books were from Scholastic Discover More and children had three options: *Rainforest*, *Polar Bears*, and *Minerals and Rocks*. Children wore noise-cancelling headphones while reading, but unlike the other two conditions, did not hear a voice with instructions. Before they began reading, they were instructed to sit quietly and read whichever of the three books they preferred. They could switch between books if they chose.

2.4.4 Manipulation Check

Children were asked the following question: “What were you thinking while you were [listening to the recording/reading]?” The purpose of this question was to ensure the children in the mindfulness condition were actually thinking and attending to their breath. Text from the manipulation check was analyzed with Linguistic Inquiry and Word Count Software (LIWC; Pennebaker, Booth, Boyd, & Francis, 2015). Specifically, the use of body words was examined, including words such as “breath” and “breathing”. LIWC analysis provided results in the form of percentage of words used, but since there were a substantial number of children who reported zero body words, this variable was recoded into *present* or *not present*. Frequencies of use of body words (present or not present) were compared to experimental condition. Shown in Table 2-2, the use of body words was significantly related to experimental condition, $\chi^2(2, N = 243) = 57.03, p < .001$. Children in the mindfulness condition used body words significantly more than expected by chance, while children in the mind-wandering and silent reading conditions used body words significantly less than expected by chance.

Table 2-2 Use of Body Words During Manipulation Check

	Use of Body Words			
	Not Present		Present	
Condition	*n*(%)	z	*n*(%)	*z*
Mindfulness	48 (58.5%)	-2.50	34 (41.5%)	5.60
Mind-wandering	74 (93.7%)	1.00	5 (6.3%)	-2.20
Silent Reading	81 (98.8%)	1.50	1 (1.2%)	-3.40
Total	203 (83.5%)		40 (16.5%)	

Note: Percentage refers to percentage of children within each experimental condition.

2.5 Procedure

Data collection occurred at the Research and Learning Center at the Fort Worth Museum of Science and History. Refer to Figure 2-3 for a graphical display of the procedure. After signing informed consent documents, children began completing the DCCS while their parents completed the demographic and child self-control measures. For the demographics, parents reported the child's gender, birthday, any medical diagnoses, the child's mother's education level, and family income. The demographic and self-control questionnaires took less than five minutes to complete. During this time, children completed the first DCCS, which lasted approximately five minutes. Immediately following the DCCS, children self-reported affect and arousal using the SAM, which lasted approximately one minute. Children were then randomly assigned to one of three conditions: mindfulness meditation, mind-wandering, or silent reading. The manipulation occurred for four minutes. Immediately following the manipulation, children completed the SAM for the second time and answered the question for the manipulation check. Lastly, all children completed the DCCS. The entire experiment was completed by each family in twenty minutes.

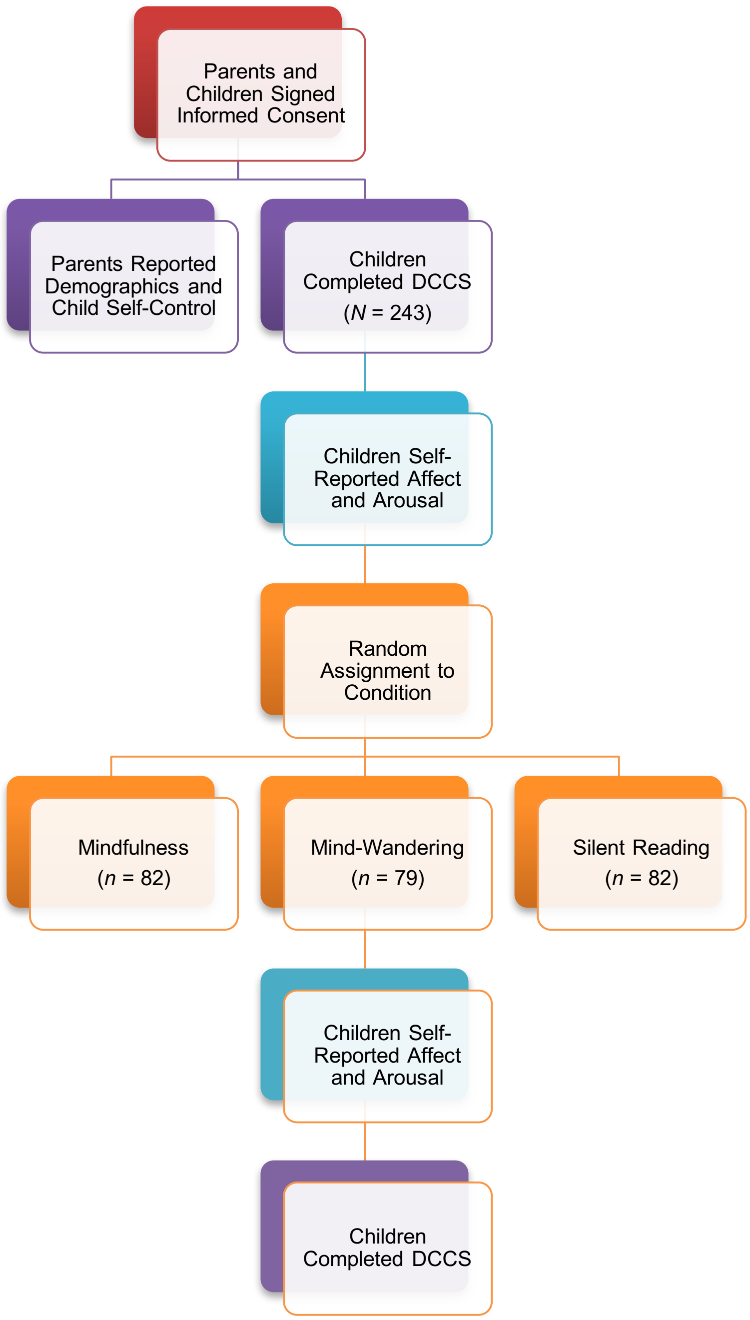

Figure 2-3 Procedure for Experiment Completed in Twenty Minutes

Chapter 3

Results

3.1 Data Screening

Prior to formal hypothesis testing, data were screened to ensure that all assumptions were met for subsequent analyses. Maternal education was slightly negatively skewed with two outliers greater than three standard deviations from the mean. These mothers reported six and seven years of education, respectively. A square transformation resulted in a significantly positively skewed distribution, so rather than a transformation, the outliers were changed to a value of nine (one below the next most extreme), so that they would remain deviant, just not quite so extreme (Tabachnick & Fidell, 2013, p. 77). This led to a normal distribution for maternal education. Parent-reported child self-control had one outlier, but since this variable met the assumption of normality and the outlier was within three standard deviations of the mean, no transformations were applied. Affect before and after the intervention were negatively skewed and both were square transformed. These variables were more normally distributed after transformation and the transformed versions were used in subsequent analyses. Scores on the DCCS at both time points were negatively skewed and subsequent square and cube transformations were applied. The cube transformation resulted in a normal distribution. There were three outliers for both DCCS time points, but these outliers were valid scores within three standard deviations of the mean. Age as well as arousal at both time points were normally distributed with no outliers. Means, standard deviations, skewness, and kurtosis values for all continuous variables reported in the analyses are provided in Table 3-1.

Table 3-1 Descriptive Statistics for Study Variables

Study Variables	*n*	*M*	*SD*	Skewness	Kurtosis
Age	243	9.67	1.59	0.28	-0.91
Maternal Education	237	15.04	2.40	0.04	-0.65
Parent-reported Child Self-Control	236	3.48	0.68	-0.23	-0.23
Affect Time 1_a	243	54.70	21.85	-0.06	-1.35
Affect Time 2_a	237	54.83	22.06	-0.15	-1.15
Arousal Time 1	243	6.13	2.25	-0.33	-0.61
Arousal Time 2	237	5.54	2.49	-0.27	-0.89
DCCS Time 1_b	242	587.71	200.75	-0.22	0.15
DCCS Time 2_b	236	580.59	206.14	-0.05	0.05

Note: $_a$Square Transformation; $_b$Cube Transformation

Data were also screened for missing values using SPSS Missing Values Analysis. Data were missing for six variables: parent-reported child self-control (2.9%), maternal education (2.5%), affect and arousal post-intervention (2.5%), DCCS pre-intervention (0.40%), and DCCS post-intervention (2.9%). Using Little's MCAR test, missing values could not be assumed missing completely at random, $\chi^2(109) = 158.98$, $p < .001$. However, because scores could be predicted from other variables in the dataset, missing values were assumed missing at random (Tabachnick & Fidell, 2013, p. 63) Subsequently, missing values were imputed using the expectation-maximization (EM) algorithm. All statistical analyses were conducted with both the dataset including missing values as well as the dataset including imputed values. There were no differences in any of the models between the two sets of data. Thus, the original dataset with the small amount of missing data was used for all analyses and listwise deletion for each analysis was employed.

3.2 Data Analytic Strategy

Initially, bivariate relationships and gender differences were examined with Pearson's *R* correlations and independent samples *t*-tests. Next, hypotheses one through three were tested with mixed analyses of covariance (ANCOVA). For hypothesis one, experimental condition was included as the between-subjects independent variable and scores on the DCCS before and after the intervention served as the repeated-measures variable. Gender, age, and parent-reported child self-control served as covariates. For hypotheses two and three, experimental condition served as the between-subjects independent variable and scores on affect and arousal, respectively, before and after the intervention were used as the repeated-measures variable. Gender and age served as covariates in these two models. The assumptions of homogeneity of variance and homogeneity of regression slopes were met for all three analyses.

Hypothesis four was proposed to be tested with a mediation model, but given the results of hypotheses one through three, a mediation model was not tested. Subsequently, and described in detail below, a hierarchical polynomial regression analysis was used. Post-intervention arousal, the squared version of arousal, experimental condition, and the interactions between both versions of arousal and experimental condition served as the primary independent variables. Post-intervention DCCS scores served as the dependent variable. Covariates in this regression model included scores on pre-intervention DCCS, age, gender, parent-reported child self-control, and maternal education. The assumptions of homoscedasticity and multivariate normality were met for the mutliple regression analyses.

3.3 Correlations and Gender Differences

A summary of means, standard deviations, and intercorrelations among all variables in the analyses is presented in Table 3-2. Age was significantly related to affect, arousal, and DCCS scores at both time points, in which older children reported lower affect and arousal and performed better on the DCCS. Higher maternal education was associated with higher parent-reported child self-control and lower arousal at both time points. Higher parent-reported child self-control was significantly related to higher DCCS scores at both time points as well as lower post-intervention arousal. Affect and arousal were positively correlated at both time points.

An examination of bivariate scatterplots to test linearity among the variables revealed multiple curvilinear relationships. There were quadratic relationships between affect and DCCS scores as well as arousal and DCCS scores, where those high and low in affect and arousal performed lower on the DCCS than those reporting mid-range in affect and arousal. The relationship between arousal and DCCS scores is shown in Figure 3-1. Four points were chosen to display this relationship as these four points cover the full range of valid arousal scores. That is, the arousal scale ranged from one to nine, where very low arousal is equal to just below a value of one and high arousal is equal to just above a value of eight. These quadratic relationships were confirmed with polynomial regression analyses. The curvilinear relationship between affect and DCCS scores was signficant above and beyond the linear relationship, $b = -1.26$, $SE = .52$, $t(230) = -2.43$, $p = .02$. Similarly, the curvilinear relationship between arousal and DCCS scores was significantly stronger than the linear relationship, $b = -5.46$, $SE = 2.14$, $t(230) = -2.55$, $p = .01$.

Table 3-2 Correlations Among Study Variables (*N* = 221)

				Pre-Intervention			Post-Intervention		
	Age	Maternal Education	Parent-reported Child Self-Control	DCCS Time 1	Affect Time 1	Arousal Time 1	Affect Time 2	Arousal Time 2	DCCS Time 2
Age	--	-.04	.03	.38**	-.25**	-.18**	-.21**	-.14*	.27**
Maternal Education		--	.16*	.13*	-.07	-.17*	-.01	-.14*	.06
Parent-reported Child Self-Control			--	.22**	.06	-.06	.05	-.10	.16*
DCCS Time 1				--	-.08	-.06	-.07	-.06	.66**
Affect Time 1					--	.30**	.50**	.27**	-.02
Arousal Time 1						--	.20**	.50**	.06
Affect Time 2							--	.40**	-.02
Arousal Time 2								--	.11
DCCS Time 2									--

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

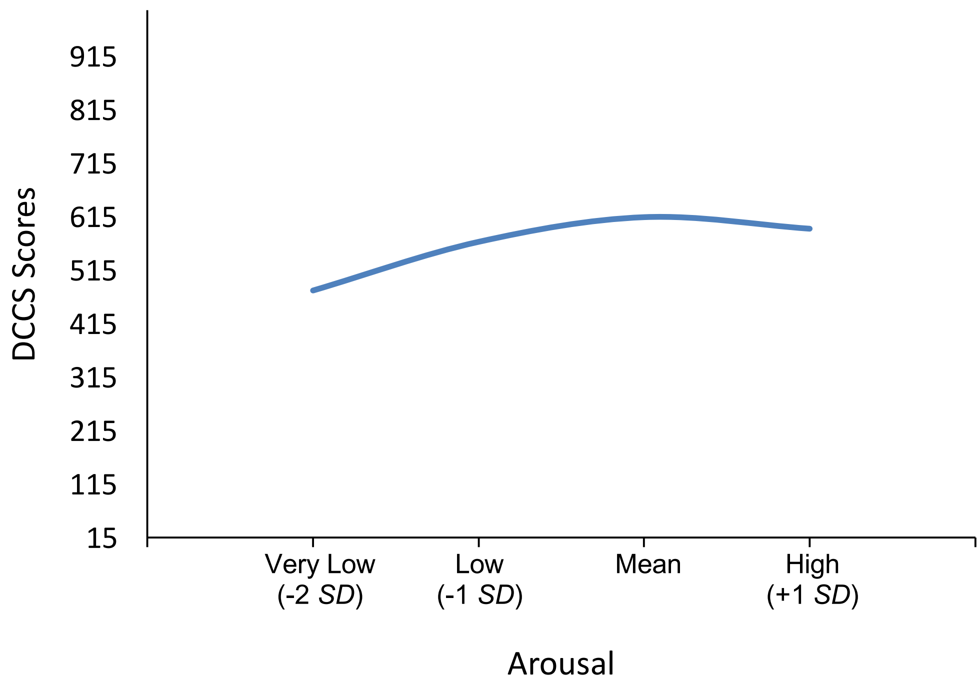

Figure 3-1 Significant Curvilinear Relationship Between Post-Intervention Arousal and DCCS Scores

Additionally, there was a significant curvilinear relationship between affect and arousal post-intervention, b = .93, SE = .20, $t(236) = 4.62$, $p < .001$. Those with lower and higher arousal levels reported higher affect than those with average levels of arousal (Figure 3-2). Further examination of this relationship revealed that the point at which affect was lowest in the sample was at an arousal value of 3.29. From that point, lower arousal was related to greater affect. An examination of simple slopes revealed that the relationship between arousal and affect was significant at very low levels of arousal, b = -4.31, SE = 1.79, $t(233) = -2.40$, $p < .05$, low levels of arousal, b = 4.20, SE = 0.53, $t(233) = 7.99$, $p < .01$, and high levels of arousal, b = 8.83, SE = 1.25, $t(233) = 7.07$, $p < .01$.

The simple slope was not significant at mean levels of arousal. Thus, at lower levels of arousal, arousal and affect were inversely related, whereas at higher levels of arousal, arousal and affect were positively related.

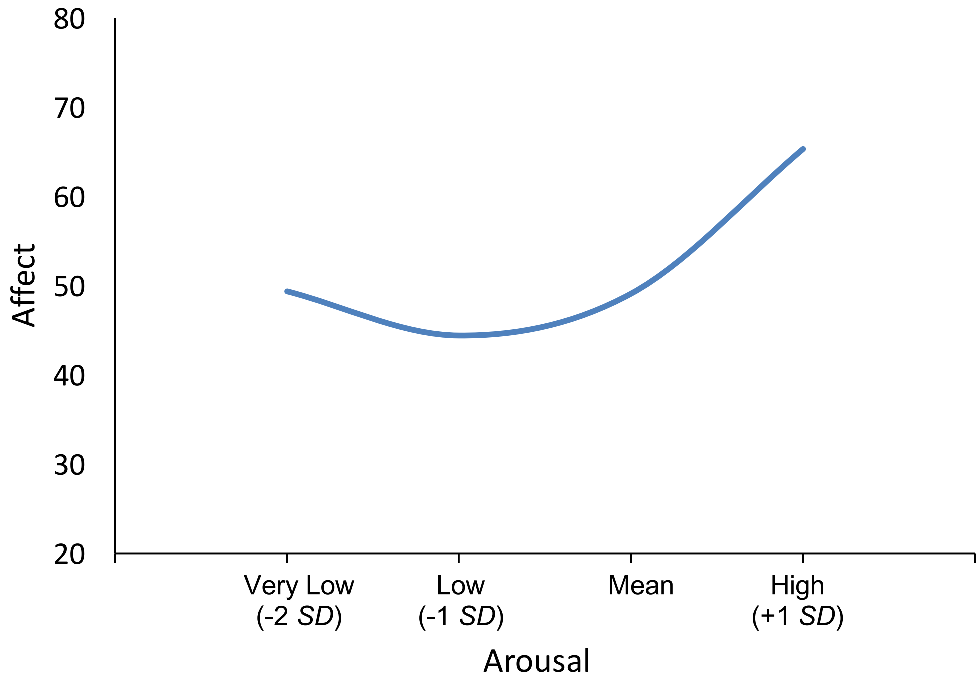

Figure 3-2 Significant Curvilinear Relationship between Post-Intervention Arousal and Affect

Gender differences between boys and girls for parent-reported self-control, affect, arousal, and DCCS scores were tested using independent samples *t*-tests (Table 3-3). The assumption of homogeneity of variance was met for all tests. Parents reported girls as having significantly higher self-control than boys. Girls reported significantly higher affect at both time points as well as higher arousal at time two.

Table 3-3 Gender Differences Among Study Variables

Variable	Boys	Girls				
	M(*SD*)	*M*(*SD*)	*t*	df	*p*	*d*
Parent-reported Child Self-Control	3.34(0.68)	3.62(0.65)	-3.23	234	.001	.42
Affect Time 1	50.03(22.61)	59.24(20.15)	-3.35	241	.001	.43
Affect Time 2	49.57(23.00)	60.03(19.83)	-3.75	235	<.001	.49
Arousal Time 1	5.88(2.29)	6.37(2.17)	-1.68	241	.09	.22
Arousal Time 2	5.20(2.52)	5.88(2.42)	-2.12	235	.04	.28
DCCS Time 1	564.25(201.11)	610.42(198.59)	-1.80	240	.07	.23
DCCS Time 2	555.40(205.44)	605.78(204.61)	-1.89	234	.06	.25

3.4 Hypothesis 1

Hypothesis one stated that there would be a significant effect of experimental condition on DCCS scores. Specifically, it was expected that children engaging in mindfulness meditation would have significantly higher DCCS scores post-intervention than children engaged in either mind-wandering or silent reading. Findings failed to support this hypothesis, with results graphically displayed in Figure 3-3. Results from the mixed ANCOVA revealed that, after controlling for the effects of age, parent-reported child self-control, and gender[2], there was no effect of experimental condition on changes in DCCS scores, $F(2, 221) = 1.28$, $p = .28$, $\eta_p^2 = .01$. Additionally, when collapsed across all conditions, there was no change ($p = .37$) in DCCS scores from pre-intervention (*M* =

[2] Girls (*M* = 611.76, *SE* = 16.83) performed significantly better then boys (*M* = 557.82, *SE* = 16.83) across time and conditions, $F(2, 225) = 4.94$, $p = .03$, $\eta_p^2 = .02$.

589.81, *SE* = 12.61) to post-intervention (*M* = 579.78, *SE* = 13.38). Finally, there were no differences between experimental condition (*ps* > .999) on DCCS scores collapsed across both time points: mindfulness (*M* = 595.38, *SE* = 19.69), mind-wandering (*M* = 589.81, *SE* = 20.01), silent reading (*M* = 576.38, *SE* = 19.65).

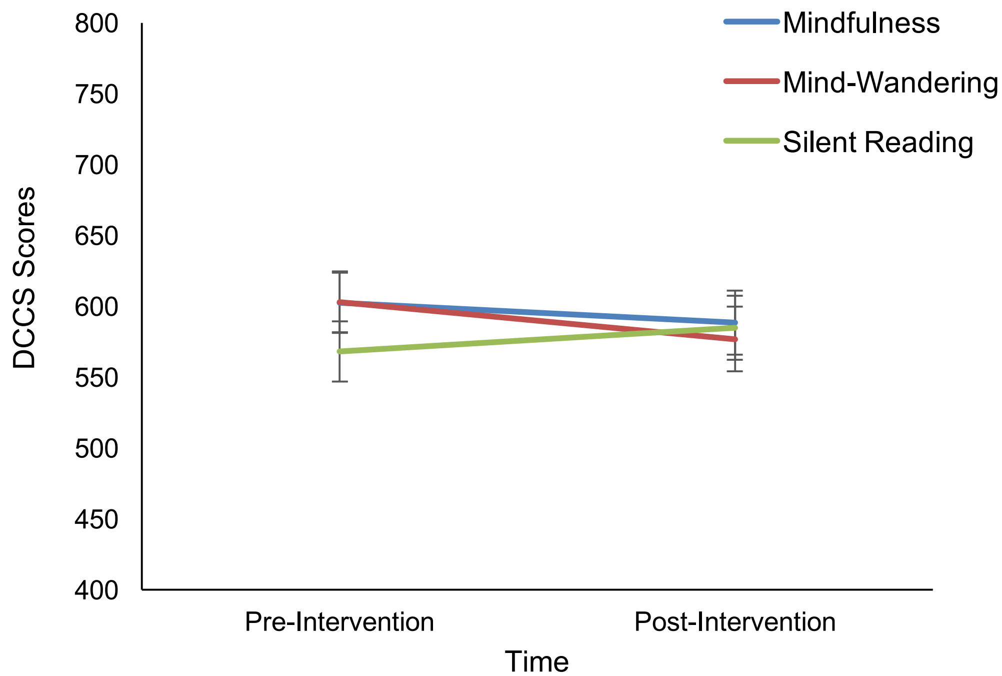

Figure 3-3 Results of Mixed ANCOVA for Hypothesis One

3.5 Hypothesis 2

Hypothesis two stated that there would be a significant effect of experimental condition on affect. Specifically, it was expected that children engaging in mindfulness meditation would report significantly higher positive affect than children engaging in either mind-wandering or silent reading. Findings failed to support this hypothesis, with results graphically displayed in Figure 3-4. The mixed ANCOVA revealed that, after controlling for the effects of age and gender, there was no effect of experimental condition on changes in affect, $F(2, 230) = .024$, $p = .98$, $\eta_p^2 < .001$. Overall, there were no changes ($p = .85$) in affect across all conditions from pre-intervention ($M = 54.58$, $SE = 1.37$) to post-intervention ($M = 54.86$, $SE = 1.39$). Additionally, there was no effect of condition on affect collapsed across both time points. Affect for those in the mindfulness condition ($M = 52.09$, $SE = 2.01$) did not differ from children in the mind-wandering ($M = 52.88$, SE = 2.04; $p = .57$) or silent reading ($M = 56.19$, $SE = 2.01$; $p = .45$) conditions. Affect for mind-wandering and silent reading did not differ ($p > .999$).

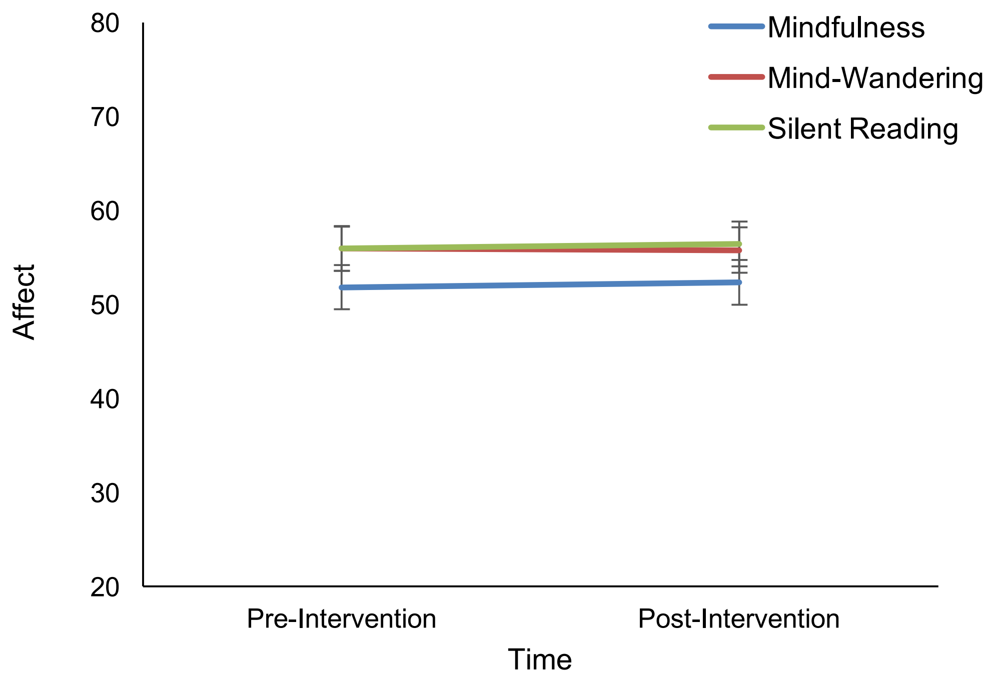

Figure 3-4 Results of Mixed ANCOVA for Hypothesis Two

3.5.1 Ancillary Analysis for Hypothesis 2

Although tests of mean change in affect produced null results, change scores were categorized into groups of “increase”, “decrease”, and “no change” to further explore these relationships. A chi-square test of independence revealed that change in affect was associated with experimental condition, $\chi^2(4, N = 237) = 11.60, p = .02$. Across conditions, 65 children reported an increase in affect, 66 children reported a decrease, and 106 reported no change in affect from prior to the intervention. As shown in Figure 3-6, significantly less children in the mindfulness condition reported no change in affect compared to children in the mind-wandering and silent reading conditions ($p < .05$). There were no other significant differences among frequencies.

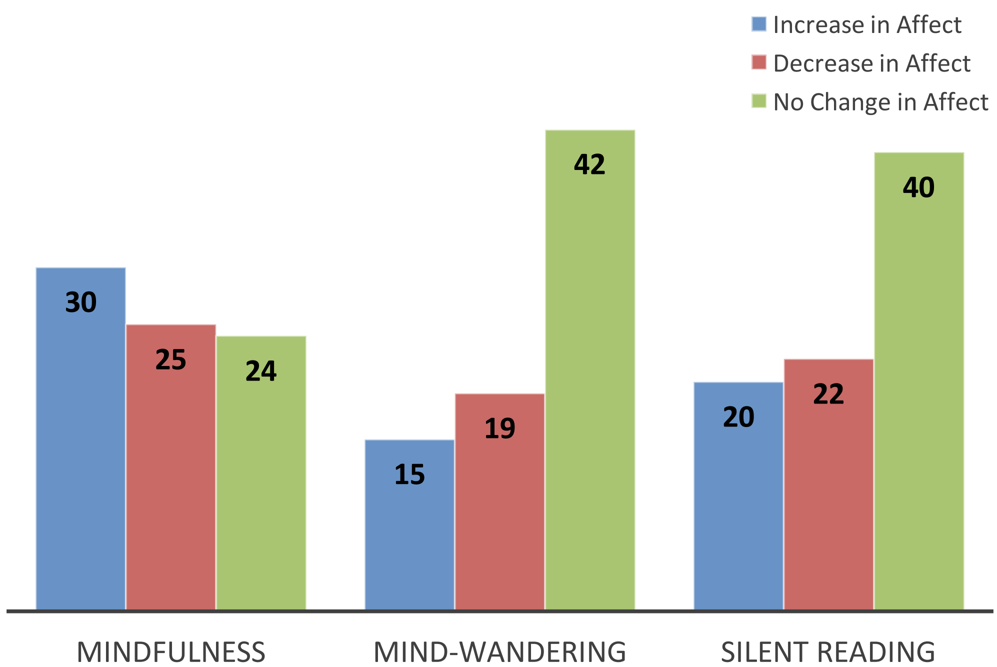

Figure 3-5 Results of Chi-Square Test of Independence Showing an Association Between Changes in Affect and Experimental Condition

3.6 Hypothesis 3

Hypothesis three stated that children participating in mindfulness meditation would report significantly lower arousal than children engaged in the silent reading condition. Children in the mindfulness condition would not differ in self-reported arousal from children in the mind-wandering condition. This hypothesis was partially supported with results graphically displayed in Figure 3-3. After controlling for age and gender, there was a significant interaction between condition and arousal, such that post-intervention arousal was significantly lower among those in the mindfulness condition compared to the mind-wandering and silent reading conditions, $F(2, 230) = 4.11$, $p = .02$, $\eta_p^2 = .04$. Arousal levels did not differ among conditions prior to the intervention. Arousal levels significantly differed between condtions after the intervention, in which children in the mindfulness condition ($M = 4.74$, $SE = .27$) had significantly lower levels of arousal than children in both the mind-wandering ($M = 5.76$, $SE = .28$; $p = .03$) and silent reading conditions ($M = 6.01$, $SE = .27$; $p = .004$). Arousal levels between children in the mind-wandering and silent reading condtions did not differ ($p > .999$). The hypothesis was partially supported, because it was not expected that children in the mindfulness condition would report significantly lower arousal than children in the mind-wandering condition.

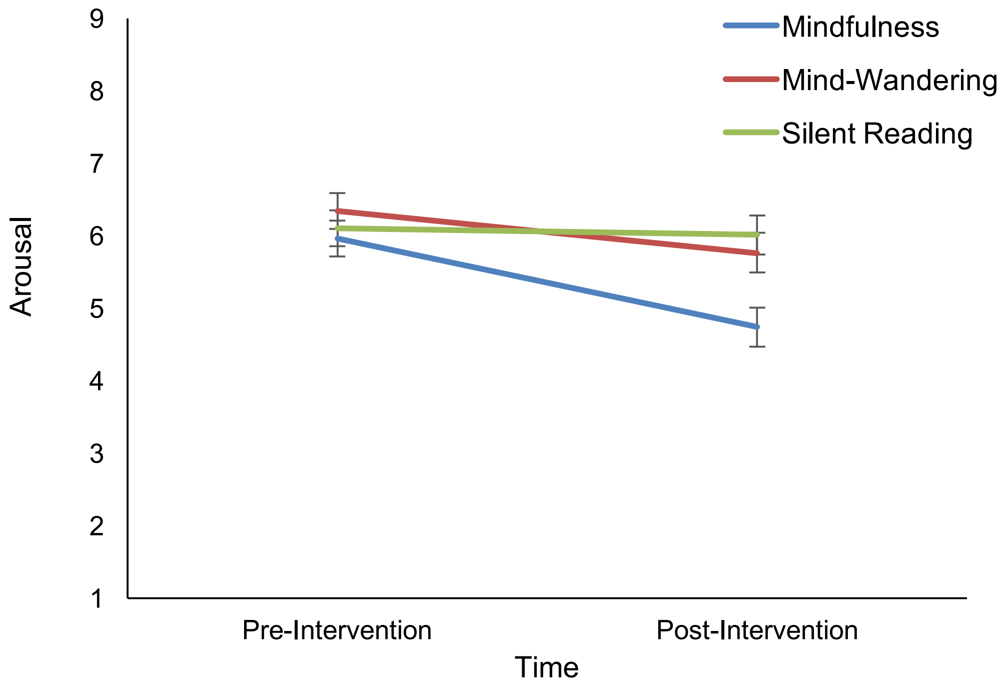

Figure 3-6 Results of Mixed ANCOVA for Hypothesis Three

Examining this interaction another way, those in the mindfulness condition significantly decreased in arousal from pre-intervention to post-intervention ($p < .001$). Children in the mind-wandering condition also significantly decreased from pre-intervention to post-intervention ($p = .04$). Arousal did not change in the silent reading condition over time ($p = .74$).

3.7 Hypothesis 4

It was expected that affect and arousal would act as mediators of the effect of mindfulness meditation on DCCS performance. Specifically, it was expected that increases in positive affect and lower arousal would result from engaging in mindfulness, which would then lead to greater DCCS scores. Because there was no effect of experimental condition on DCCS scores, there was no test of a mediated effect.

However, due to the finding that experimental condition produced changes in arousal levels, as well as the curvilinear relationship found between arousal and DCCS scores, these relationships were probed further. To explore the relationships between condition, arousal, and post-intervention DCCS scores, an interaction between experimental condition and arousal on post-intervention DCCS scores was tested.[3] Using hierarchical polynomial regression analyses, a four step procedure was employed (Table 3-4). All variables were centered prior to analysis. The same interaction did not exist between pre-intervention arousal and condition, $\Delta F(2, 225) = .25$, $p = .78$, $\Delta R^2 = .001$.

[3] The same interaction was tested with affect, but the interaction was not significant, $\Delta F(2, 226) = .98$, $p = .38$, $\Delta R^2 = .005$.

Table 3-4 Hierarchical Multiple Regression Analysis of Arousal Effects on DCCS Scores

Step 1	*b*(*SE*)	*t*	*p*	*df*	ΔF	ΔR^2
Main Effects			<.001	8, 212	22.91	.47
Intercept	580.61(10.29)	0.90	.37			
$Condition_1$	-13.07(14.93)	-0.88	.38			
$Condition_2$	12.44(14.97)	0.83	.41			
Arousal	12.08(4.52)	2.67	.008			
Age	6.51(7.24)	0.90	.37			
Child Self-Control	6.05(16.65)	0.36	.72			
Gender	7.88(11.30)	0.70	.49			
Maternal Education	-0.58(4.73)	-.12	.90			
DCCS Time 1	0.65(0.06)	11.29	<.001			
Step 2	*b*(*SE*)	*t*	*p*	*df*	ΔF	ΔR^2
Main Effects + $Arousal^2$			.04	2, 207	4.14	.01
$Arousal^2$	-3.53(1.73)	-2.03	.04			
Step 3	*b*(*SE*)	*t*	*p*	*df*	ΔF	ΔR^2
Main Effects, $Arousal^2$ + Arousal X Condition			.94	2, 209	0.06	<.001
Arousal X $Condition_1$	0.31(6.37)	0.05	.96			
Arousal X $Condition_2$	1.85(6.38)	0.29	.77			
Step 4	*b*(*SE*)	*t*	*p*	*df*	ΔF	ΔR^2
Main Effects, $Arousal^2$, Arousal X Condition + $Arousal^2$ X Condition			.09	2, 207	2.49	.01
Intercept	601.30(14.35)	41.89	<.001			
$Condition_1$	-8.64(20.21)	-0.43	.67			
$Condition_2$	-14.95(20.49)	-0.43	.47			
Arousal	6.92(4.83)	1.43	.15			
$Arousal^2$	-3.88(1.80)	-2.16	.03			
$Arousal^2$ X $Condition_1$	-0.77(2.53)	-0.31	.76			
$Arousal^2$ X $Condition_2$	5.07(2.45)	2.08	.04			

Note: Condition was coded using unweighted effects codes, where $Condition_1$ represents the comparison of mind-wandering to the unweighted grand mean and $Condition_2$ represents the comparison of silent reading to the unweighted grand mean.

To probe the interaction, three sets of dummy codes were created to reflect the three experimental conditions. Following, twelve interaction terms were computed to examine the arousal X condition and arousal^2 X condition results. The same hierarchical regression analysis reflected in Table 3-4 was conducted three additional times to examine the changing effect of arousal on DCCS scores. A graphical display of those results is shown in Figure 3-7. As stated with Figure 3-1, four points were chosen to display this relationship as these four points cover the full range of valid arousal scores.

As shown in Figure 3-7, there was a significant quadratic relationship between post-intervention arousal and DCCS scores only within the mindfulness condition, b = -8.19, SE = 3.08, t(207) = -2.66, p = .009, sr^2 = 1.74%. The quadratic relationship was not significant in either the mind-wandering, b = -4.66, SE = 3.20, t(207) = -1.46, p = .15, sr^2 = 0.05% or silent reading conditions, b = 1.19, SE = 2.94, t(207) = 0.41, p = .69, sr^2 = 0.04%. Within the silent reading condition, the linear relationship between arousal and DCCS scores was stronger than the quadratic relationship, but it was not significant, b = 10.86, SE = 7.58, t(207) = 1.43, p = .15, sr^2 = 0.50%.

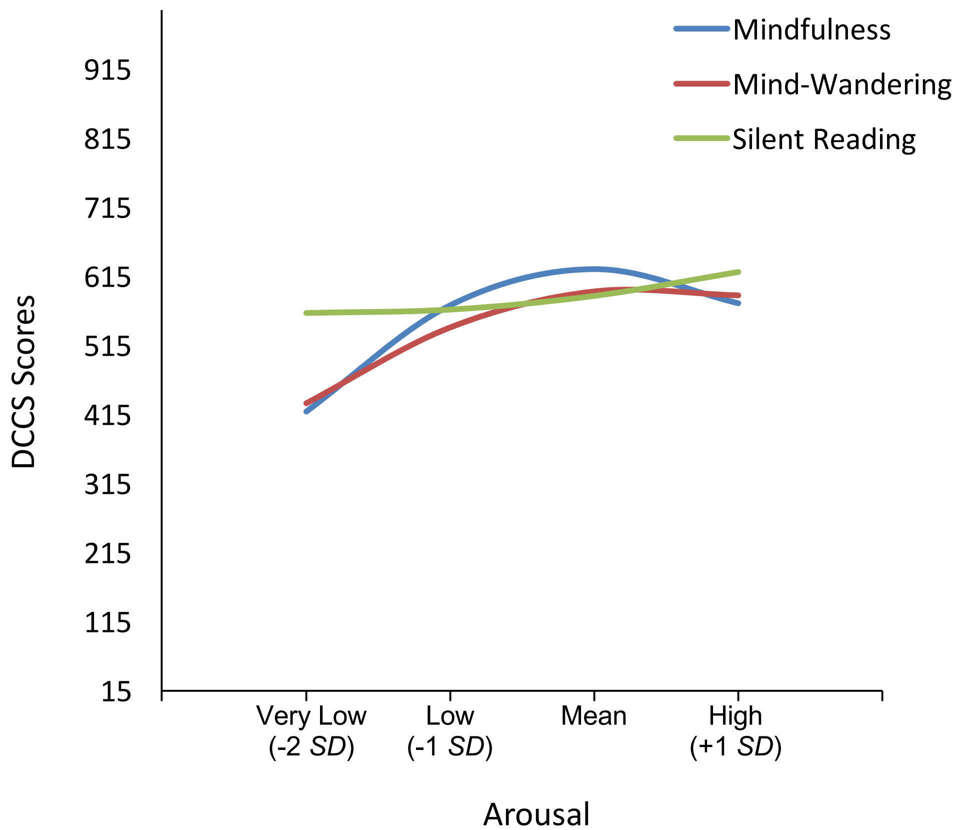

Figure 3-7 The Relationship Between Arousal and DCCS Scores Depended on Experimental Condition

An examination of simple slopes within each of the three conditions revealed significant slopes within the mindfulness condition. Specifically, there were significant slopes for mindfulness at very low, $b = 82.16$, $SE = 26.94$, $t(206) = 3.05$, $p < .01$, and low levels, $b = 41.37$, $SE = 12.93$, $t(206) = 3.20$, $p < .01$, of arousal. This indicates that at lower levels of arousal, there was a positive relationship between arousal and DCCS scores. There were no significant slopes in the mind-wandering or silent reading conditions. Examining this interaction a different way, there were no significant differences between experimental conditions on DCCS performance at any point. The largest differences emerged at very low levels of arousal, but there was no significant difference in DCCS performance (mindfulness vs. silent reading, p = .06; mindfulness vs mind-wandering, p = .30; mind-wandering vs. silent reading, p = .39).

Furthermore, for the significant quadratic relationship between arousal and DCCS scores within the mindfulness condition, it was of interest to explore the point of arousal at which DCCS scores reached their maximum. This maximimum point occurred just above the mean of arousal at a value of 5.60. This indicates that for children within the mindfulness condition, scores on the DCCS began to decrease at an arousal level of 5.60.

Chapter 4

Discussion

The current study examined the effect of brief mindfulness and mind-wandering interventions on subsequent affect, arousal, and self-control among children. There was no support for the first hypothesis, which predicted that briefly introduced states of mindfulness would impact self-control. This was unexpected given findings with adults demonstrating that brief mindfulness practice positively impacts self-control (Friese et al., 2012; Heppner et al., 2008; Mrazek et al. 2012; Yusainy and Lawrence, 2015). One explanation for the current study's null finding is that brief mindfulness practices may not impact children in the same way as they do with adults. To date, this is the first study to examine the impact of brief mindfulness practice on self-control among children. Another explanation, not mutually-exclusive from the first, concerns experimental design. Both Heppner et al. (2008) and Yusainy and Lawrence (2015) compared aggressive impulses of adults who engaged in mindfulness practice to a control group not made mindful. Neither study used active control conditions nor controlled for differences in self-control prior to the manipulation. Friese et al. (2012) found that adults who engaged in mindfulness practice performed equally well on subsequent self-control task as adults who had not exerted self-control previously, which did not allow for a comparison among different short-term interventions. The only study with the same experimental design as the current investigation, completed by Mrazek et al. (2012), did find a significant effect on subsequent self-control. However, there were critical differences in statistical approach. The authors of that study conducted a univariate ANOVA without controlling for performance on the first self-control task and it is unclear whether those in the mindfulness condition were better at self-control regardless of the intervention. Thus, not only was this the first study of its kind with children, but experimental design and statistical approach possibly impacted the results.

The second hypothesis, which predicted higher positive affect among those experiencing mindfulness, was not supported. Importantly, there was little change in affect across all conditions, limiting the potential of a test of mean differences to observe effects. A small number of studies have examined the impact of mindfulness on affect and have done so primarily with adult populations. These previous studies did not assess affect in the same way as the current investigation, with the majority of results demonstrating greater affect in response to pictures (e.g., Arch & Craske, 2006; Erisman & Roemer, 2010) rather than increased positive affect overall. It is possible that mindfulness does not produce a recognizable change in affect when practicing for the first time, but rather takes repeated practice to produce noticeable changes.

Additionally, the control conditions in the current study appeared to impact affect in similar ways. It was evident that children liked reading the educational books, or at least did not decrease in positive affect to a measurable extent. The feedback from the children indicated that the books were interesting and entertaining for many of them. When asked what they were thinking about during the reading period, children said things such as: “how cool the rocks were,” “how the earth was formed,” and “the rainforest and all the cool animals that live there.” Although silent reading has been used as a control condition in long-term mindfulness interventions with children (Flook et al., 2010), the present study did not find that silent reading produced any meaningful differences in affect (or self-control) compared to mindfulness. Again, short-term mindfulness interventions may not lead to demonstrable changes in affect—these effects may simply emerge over time.

Extending the above explanation, a third factor potentially influencing results of the second hypothesis is the context in which this study occurred. Children may have been eager to explore and learn in the museum rather than sit quietly. This is potentially a reason children found the educational books entertaining. Testing the effect of mindfulness on affect in other contexts, such as in school and controlled lab settings, is warranted. In an educational environment, mindfulness may offer a needed and desired break from sitting and performing school work, which may ultimately have positive impacts on affect.

The third hypothesis was partially supported. Results are consistent with previous findings with adults that mindfulness meditation reduces physiological arousal (Krygier et al., 2013; Libby et al., 2012; Takahashi et al., 2005; Wu & Lo, 2008; Zeidan et al., 2010). Critically, this is the first empirical finding with children that has shown that mindfulness meditation reduces arousal. Equally important, children engaged in mindfulness demonstrated significantly lower arousal than a similarly relaxing intervention. This was unexpected, given that daydreaming is often associated with default-mode brain activation—an indication that the brain is resting. Mind-wandering may not reduce arousal to the same extent as mindfulness, but mind-wandering did produce significantly lower arousal from pre- to post-intervention. One benefit of mind-wandering is planning of personally relevant future goals (Baird et al., 2011; Smallwood et al., 2009). The current findings add to this list of benefits for children, demonstrating a significant reduction in arousal ratings after engaging in mind-wandering.

The final hypothesis predicting a mediated effect of affect and arousal on self-control was not supported. There was no effect of condition on self-control, and, thus, no test of a mediated effect. However, there was a moderating effect of experimental condition on arousal and self-control. A critical finding from the current study was the curvilinear relationship between arousal and self-control, which has yet to be reported or explored with children. The Yerkes-Dodson law (Yerkes & Dodson, 1908) predicts that the relationship between arousal and performance will follow an inverted U-shaped function. Interestingly, the curvilinear relationship between arousal and self-control was only observed within the mindfulness condition. That is, arousal did not seem to play a role in self-control for children in the mind-wandering and silent reading conditions. It is unclear why arousal only affected self-control within the mindfulness condition, but this finding provides an important foundation for future research. One explanation is that mindfulness actually produced physiological changes in children, whereas children in the other conditions similarly reported lower arousal ratings, but did not possess lower arousal to the same extent. Objective measurements of physiological arousal are critical for the full understanding of this nuanced relationship. The present results suggest that there is an optimal state of arousal for effective self-control, which, in this sample, fell slightly above average arousal levels. Both very low and very high arousal are not ideal for self-controlled behavior. Thus, mindfulness may be most beneficial for children who not only respond to the practice with lower arousal, but who are also more highly physiologically aroused when beginning the practice. This is particularly relevant for children who are consistently in higher states of arousal, such as those suffering from ADHD. Children with ADHD and related developmental disorders show the largest increases in self-control as a result of long-term mindfulness practice (Spann et al., 2016), which supports previous suggestions that those lowest in self-control may benefit the most from any intervention (Diamond & Lee, 2011). Present findings suggest that, through mindfulness practice, lowering arousal of highly aroused children (i.e. children with ADHD) may positively impact self-control.

Although findings revealed that a low level of arousal was inversely related to self-control, this does not indicate that low arousal is always a negative state. Lower physiological arousal is associated with a host of positive outcomes, including physical health and emotion regulation (Thayer & Lane, 2009). Therefore, the current results should not be interpreted to mean mindfulness has a negative impact on child behavior. Results from this study provide a base for understanding when mindfulness is most beneficial. Additionally, other types of meditations, such as compassion-based meditation, may not decrease arousal to the same extent as mindfulness meditation. In contrast to beliefs that mediation is always relaxing and associated with low arousal, Lumma et al. (2015) found that meditations aimed at improving compassion required effort and were related to greater physiological arousal compared to mindfulness meditation. Further exploration into other types of meditations for children, which may not reduce arousal to the extent that mindfulness meditation does, is needed.

Regardless of the intervention, self-control, tested with the DCCS on an iPad, did not significantly change from pre-intervention to post-intervention. The theory of ego depletion (Baumeister et al., 1998) suggests that exercising self-control exhausts cognitive resources to a certain degree and increases chances of reduced self-control in subsequent tasks requiring regulation. Current results should be interpreted in light of the fact that this study was not an explicit test of ego depletion theory. That is, there was not a true control group for testing the theory in the sense that *all* children completed an initial task that required self-regulation. Studies of ego depletion theory use a dual-task paradigm (Baumeister et al., 1998), in which participants are assigned to either an ego-depletion group or a control group. Participants assigned to an ego-depletion group are required to engage in two consecutive tasks requiring self-control, while control participants engage in two consecutive tasks, but only the second requires self-control.

Although the theory of ego depletion was not explicitly tested in the current study, the theory is still relevant, as children were using self-regulation throughout the study, which influences performance on self-control tasks.

The lack of change in self-control in the present study could have occurred for a number of reasons. First, children did not show a significant decrease in self-control, because all children experienced a brief intervention that, to a certain extent, replenished cognitive resources needed for self-regulation. Second, the findings could indicate that the measure of self-control was not sensitive enough to detect changes in cognitive control. Computer-administered measures of executive functioning relate less well to self-control phenomena (Duckworth & Kern, 2011). Observational measures such as delay of gratification tasks or emotionally impulsive behavioral tasks may be more sensitive than computer-mediated tasks, because computer-mediated tasks are largely dependent upon reaction time data. In laboratory assessments of self-control, regulation has been assessed by the ability to delay gratification—that is, resisting an immediate reward in order to receive a larger reward later (Prencipe & Zelazo, 2005). The ability to delay gratification occurs in an emotionally 'hot' situation where one has choices of delicious snacks and various toys (Beck et al., 2011). In the current study as well as in many assessments of self-control with children, assessing a child's ability to override an automatic response occurs in an emotionally 'cool' situation. Recent research has pointed to the idea that these two forms of self-control may have distinct relationships to concurrent and later functioning. Preschoolers who performed better on a 'cool' measure of self-control demonstrated higher academic achievement and higher verbal mental age, but no such relationships were found with 'hot' self-control tasks (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009). Moreover, Beck et al. (2011) found 'hot' delay tasks showed little change across age, but much more variability within each age, which suggests that delay of gratification could be a more informative individual-differences measure of self-control at any age.

A critical consideration when choosing self-control tasks, however, is the time, resources, and error introduced by other behavioral tasks. No single measure is ideal for assessing self-control. Even when administered under optimally controlled conditions, self-control tasks generate random error—error produced by unexplained influences on behavior—which is particularly cumbersome for self-control tasks yielding a single score. Using multiple measures to assess self-control exploits the principle of aggregation, which states that uncorrelated errors across measures cancel out, thus reducing noise and increasing reliability (Clark & Watson, 1995; Rushton, Brainerd, & Pressley, 1983). Evidence for this is found in studies using six executive functioning tasks, which correlated higher with informant-reported measures of self-control compared to using just three executive functioning tasks (Beck, Carlson, and Rothbart, 2011 as cited in Duckworth et al., 2011). Again, time, resources, validity, and reliability of self-control tasks should be considered. In the present study, the DCCS, which is the most widely used measure of executive control among children, was the best option considering the context as well as time restrictions.

A final explanation concerns the time and complexity of the DCCS. Specifically, the DCCS may not have been long or complex enough to produce ego depletion in children. In their meta-analysis of ego-depletion studies, Hagger et al. (2010) found that the greatest effects of ego depletion were observed when the initial depleting task was longer and highly complex. That is, the longer and more complex the task, the greater the ego-depletion effect. Although the DCCS is five minutes in length and initially complex when learning multiple rules, it was clear that children became comfortable with the task and were able to complete the second assessment without an extensive amount effort.

Relatedly, it is possible that children simply became familiar with task procedures, which helped buffer against any ego-depletion effects. Experience with a task may lead to increased fluency with task procedures irrelevant to self-controlled behavior (Duckworth & Yeager, 2015). Ideally, a study such as this would have two separate assessments, one with initially complex procedures, and a parallel assessment that is similar, but not identical to the first task. Currently, almost nothing is known about the potential of developing parallel forms of self-control tasks for repeated administration.

4.5 Limitations

Results from the current study should be interpreted in light of a few limitations. First, the quality of each child's mindfulness practice could not be determined. This is an issue affecting much of contemplative science, but is particularly relevant here considering that the physiological and cognitive effects of meditation may vary depending on degree of mental effort (Lumma et al., 2015). For example, two children reporting that they paid attention to their breath during the mindfulness practice may have differed substantially in the quality of that experience. The amount of effort put into attenting to the breath could be an important factor affecting self-control performance. Similarly, the current study did not assess the amount of previous experience with mindfulness or other types of meditation. Prior training in mindfulness potentially impacted the experience of children in the current study. Information on previous meditation experience is a difficult assessment to obtain from parents and children, considering that children may be practicing mindfulness in school. Moreover, any quantitative measure reported would likely suffer from floor effects (i.e., many would report no previous experience), and treating it as a categorical variable would undermine the substantial variability in the amount of previous training.

Context is another important consideration. Sitting and relaxing was likely not a perferred activity for children wanting to have fun and explore the museum. The context, however, was ideal for accessing many children and parents as well as testing these hypotheses outside of the laboratory. Relatedly, the practice of mindfulness was conducted by each child sitting alone. Perhaps sitting in a group and meditating would produce greater effects than meditation by oneself. Many long-term mindfulness interventions use a combination of activities that promote mindfulness, including group discussion, group meditation, mindful eating and walking, and other group-related practices. The potential benefits of group mindfulness practices on children compared to meditating on one’s own warrants further investigation.

The last limitation concerns children’s self-report of affect and arousal. While children are by far the best source for reporting their own emotions and energy levels, self-report scales are always subject to concerns of social desirability. Many parents were sitting at the table with their children and it is unknown whether their presence had any effect on responses. In addition, it may be that children with certain characteristics respond differently when their parents are present. Including objective affective and physiological measurements is needed to fully understand the complex relationships between affect, arousal, and self-control.

4.6 Implications

Findings from the current study have important implications for researchers, parents, and educators. Present findings support the hypothesis that mindfulness in the short-term is beneficial for reducing arousal. This is an important finding for parents and educators who may be seeking methods and tools to help individual children calm their bodies and minds. In particular, negative impacts of heightened states of arousal, such as during high stakes test-taking, could be minimized through short mindfulness practices. Lower physiological arousal is associated with a number of other positive outcomes, including physical health and emotion regulation. Additionally, current results suggest that there is a preferred state of arousal that may produce the greatest benefits for child self-control. Future research should investigate this relationship further with objective measures of arousal. This finding is relevant for educators and parents who should consider the current level of arousal a child is displaying before implementing formal mindfulness practice.

Although results of this experiment produced multiple null findings, this study provides a more in-depth and nuanced understanding of the relationships between mindfulness, affect, arousal, and self-control. Short-term mindfulness practice with children may not be as beneficial for self-control as is repeated practice over time. That is, the benefits of mindfulness to self-controlled behavior may, in fact, emerge after a period of time in which children have learned the ability to attend to their breath and bodies. Particularly, findings suggest that mindfulness meditation is related to substantial variability in child affect, arousal, and self-control, which is counter to the current trend in the field suggesting that mindfulness is beneficial in almost all contexts and at all times. The universal approach to mindfulness practice deserves a critical lens. The present results suggest that the effects of mindfulness are dependent on individual qualities and attributes. The field of contemplative science needs to do a better job of making more specific recommendations about which types of interventions are most effective for a given context and population.

Furthermore, the current study points to the necessity of including active control conditions in mindfulness studies. Present findings confirm assertions that the field of contemplative science is in need of active control conditions. Other researchers have argued that using non-active control groups may limit the quality of the evidence demonstrating benefits of mindfulness practice (Greenberg & Harris, 2012; Zelazo & Lyons, 2012). Specifically, non-active, or waitlist control groups, may inflate the magnitude of the mindfulness effect on self-control. To date, results on the topic of mindfulness with children have tended towards an upward bias of positive findings. Contemplative studies require more rigorous research with randomized controlled trials using active control conditions and careful selection of validated objective measures of self-control.

4.7 Future Directions

Results from this experiment point to a number of new research questions and hypotheses in need of exploration. The first concerns the specific moderating factors at play in the relationship between mindfulness and self-control. Considerations such as previous meditation experience, age, gender, quality of mindfulness practice, and others not yet explored likely play a role in the effectiveness of mindfulness interventions. The impact of mindfulness and mind-wandering varies across individuals. Contrary to a one-size-fits-all approach, research with personalized mindfulness interventions are needed. Investigations into how benefits of contemplative practice emerge depending on individual differences is of critical importance.

In addition, beliefs about one's ability to self-regulate could impact self-controlled behavior. Parents and teachers have their own beliefs as to how certain children will regulate their behavior. Findings from Job, Dweck, and Walton (2010) suggested that depletion effects are better predicted by individual's perception of depletion than by an actual depletion experience. Implicit theories of self-regulatory ability changed how people responded given their level of felt exhaustion on an initial depleting task. Individuals led to adopt a limited-resource theory performed worse the more exhausted they felt, but for people led to adopt a nonlimited-resource theory, there was no relationship between perceived exhaustion and subsequent performance. Thus, in some cases, self-control failure may result not from a true lack of resources after an exhausting task, but from an individual's beliefs about their ability. This is especially important for parents and educators who may have predetermined beliefs regarding a child's ability to self-regulate. An investigation into how these mindsets impact a child's self-regulation is warranted.

Considerations of the differences and similarities between mindfulness and mind-wandering are required. The current narrative surrounding mindfulness suggests that mind-wandering provides little to no benefit. It is clear, however, that a child's ability to plan for the future and reflect on the past is critical for behavior change and executive planning. One benefit to mind-wandering is planning of personally relevant future goals, termed autobiographical planning. Thinking self-related, prospective thoughts during mind-wandering has been demonstrated in recent findings (Baird et al., 2011; Smallwood et al., 2009), suggesting mind-wandering allows for goal-directed, personally relevant planning for the future. In addition, mind-wandering is also linked to creativity. Individuals with ADHD, who typically display high amounts of mind-wandering during tasks, tend to score higher on creativity measures in the laboratory (White & Shah, 2006) and on questionnaire items reflecting achievement in the creative arts (White & Shah, 2011). Future research on mindfulness and mind-wandering is needed to provide a more balanced and thorough understanding of these two seemingly opposing, but related constructs. Practicing mindfulness may strengthen a child's capacity for effective cognitive regulation, which may ultimately give children better awareness and control over their mind-wandering thoughts.

Finally, objective physiological assessments are critical to our understanding of how arousal influences self-control. Physiological arousal varies on the level of seconds, meaning arousal is changing before, during, and after any behavioral task. Considering that arousal is relevant to both mindfulness practice and self-controlled behavior, better assessments of this construct should be considered. Objective measures such as galvanic skin response, facial recognition software, heart rate and heart-rate variability monitoring, would provide valuable insights into how child arousal, as well as affect, changes over time. These physiological assessments will also provide more advanced information regarding the quality of a child's mindfulness practice. Additionally, use of physiological data will support the development of personalized mindfulness interventions, which will allow researchers and practitioners the ability to target specific individuals with specific interventions.

4.8 Conclusion

All children have the capacity to practice mindfulness and become aware of the present moment. Results from the current investigation demonstrate that short-term mindfulness practice is related to self-control. To participate in formal schooling, children need the ability to self-regulate their behavior. Children are faced with situations throughout the day where they are required to sit quietly and pay attention and if children are expected to sit and perform a task for an extended period of time, they need the skills to do so. The ability to self-regulate is imperative for problem-solving success in both school and in daily life (Shapiro et al., 2015; Zelazo & Lyons, 2012). Further investigation of mindfulness practice as an intervention for improving self-control addresses social and emotional aspects of children, which may produce numerous benefits whereby children become happier, less disruptive, more connected to their peers, and better able to learn.

Appendix A

Temperament in Middle Childhood and Early Adolescent Temperament Questionnaires

Today's Date ____________ Participant Number ____________

Child Behavior

Please read each statement and decide whether it is a "true" or "untrue" description of your child's reaction within the past six months.

Please **circle** a number for every item.

The child:	Almost always **untrue**	Usually **untrue**	Sometimes **true**, sometimes **untrue**	Usually **true**	Almost always **true**	Does not apply
1. Can stop him/herself when s/he is told to stop.	1	2	3	4	5	NA
2. Can stop him/herself from doing things too quickly.	1	2	3	4	5	NA
3. Has an easy time waiting to open a present.	1	2	3	4	5	NA
4. Has a hard time waiting his/her turn to talk when excited	1	2	3	4	5	NA
5. Is very careful and cautious when crossing the street.	1	2	3	4	5	NA
6. Likes to plan carefully before doing something.	1	2	3	4	5	NA
7. Is able to keep secrets.	1	2	3	4	5	NA
8. Has a hard time slowing down when rules say to walk.	1	2	3	4	5	NA

Ages 7-9

Note: Items 4 and 8 were reverse scored, so that higher scores reflected better self-control.

Today's Date ______________ Participant Number ______________

Child Behavior

Please read each statement and decide whether it is a "true" or "untrue" description of your child's reaction within the past six months.

Please **circle** a number for every item.

The child:	Almost always **untrue**	Usually **untrue**	Sometimes **true**, sometimes **untrue**	Usually **true**	Almost always **true**
1. Has a hard time waiting his/her turn to speak when excited.	1	2	3	4	5
2. Opens presents before s/he is supposed to.	1	2	3	4	5
3. Is more likely to do something s/he shouldn't do the more s/he tries to stop her/himself.	1	2	3	4	5
4. Is able to stop him/herself from laughing at inappropriate times.	1	2	3	4	5
5. Is usually able to stick with his/her plans and goals.	1	2	3	4	5

Ages 10-12

Note: Items 1, 2, and 3 were reverse scored, so that higher scores reflected better self-control.

Appendix B

Mindfulness and Mind-Wandering Scripts

Mindfulness Script

Find a relaxed, comfortable position. Make sure to sit up straight, but not stiff. Close your eyes and let your hands rest on your knees. Relax your shoulders. Relax the muscles in your face. Relax your stomach muscles. Relax any areas in your body that are tight.

Let go of anything you might be holding. Now take a deep breath through your nose, and let the breath come out through your mouth so that you can hear it like a soft sigh. Try to make the out-breath slow and long. Do this two or three more times to help you relax. Keep your attention on your breath.

As you breathe, you will notice that your mind may start to wander. You might start thinking about other things. That's perfectly normal. Just notice that your mind has wandered, but don't think about what your mind is wandering about. Don't label your thoughts as good or bad; gently bring your attention back to your breath. Instead of thinking, just be here in the present moment, and rest your attention on your breath.

Now let your breath move into and out of your nostrils soundlessly, and just pay attention to the in-breath and the out-breath. And begin to tune into your breath in your body. And notice where you feel your breath in your body. It might be in your stomach, it may be in your chest or throat, or in your nose. See if you can feel the sensation of breath, one breath at a time.

There's only one thing to do right now: feel the breath move; notice the sensations of breathing. Again, you might notice that your mind wants to wander. It's ok if this happens. Just notice that your mind has wandered and then gently bring your attention right back to the breathing.

We will stay here with your breath for just a short time. See if you can be really kind to yourself in this process.

And once again, you can notice your body, your whole body seated here. Let yourself relax even more deeply. And then offer yourself some appreciation for doing this today. Find a sense of ease and kindness for yourself and this day.

When you are ready, open your eyes and remove your headphones.

Mind-wandering Script

Find a relaxed, comfortable position. Make sure to sit up straight, but not stiff. Close your eyes and let your hands rest on your knees. Relax your shoulders. Relax the muscles in your face. Relax your stomach muscles. Relax any areas in your body that are tight.

Now let yourself daydream. Think about whatever you want to think about and just rest here for a period of time. Feel free to daydream about anything that crosses your mind.

We will stay here for some time in silence. Just relax and rest in this position. Simply sit here and let your mind wander.

When you are ready, open your eyes and remove your headphones.

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Biographical Information

Catherine Spann received her Master of Science in Experimental Psychology at The University of Texas at Arlington in 2014. She received her Bachelor of Science in Psychology from The University of Georgia in 2010. Prior to research in child development, she has worked as a research assistant examining alcoholism and nicotine dependence, memory impairments in an aging population, and the formation and retrieval of long-term memories.

Catherine currently works as a researcher in the Learning Innovation and Networked Knowledge Research Laboratory at The University of Texas at Arlington where she investigates the role of contemplative practice in cognitive and affective regulation, including topics such as mindfulness, gratitude, and compassion. Catherine would like to explore new methods for understanding and supporting contemplative practice as well as investigate the role it plays in how people connect with one another. She cares deeply about understanding and promoting positive development in children through adulthood and is passionate about conducting research that helps people live their best lives.