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The Effect of Yoga Lessons on Young Children's Executive Functioning

Heidi L. Beattie
University of Nebraska-Lincoln, heidi.fleharty@huskers.unl.edu

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by

Heidi L. Beattie

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Heidi L. Beattie, Ph.D.

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Advisor: Anne Schutte

Individual differences in preschool and school-aged children's attention, inhibition and spatial working memory were examined after exposure to a yoga intervention. Previous research has found that exposure to yoga has improved attention in both adults and children. Previous research, however, is limited in regards to examining this relationship in a preschool-aged population. The purpose of the current study is to examine and compare the relationship between preschool-aged as well as school-aged children's attention, inhibition, and spatial working memory abilities for children who participated in a yoga intervention and children who do not participate in a yoga intervention. Twenty-six 4 to 8-year-olds who participated in a six-week yoga intervention and 26 4 to 8-year-olds who did not participate in a yoga intervention, but instead read an extra 30 minutes a week with their parents, were asked to complete a Continuous Performance Task (attention measurement), a Flanker Task (inhibition measurement) and a Spatial Memory Task in a pre and posttest format. Parents were asked to fill out questionnaires regarding their child's social behavior, and effortful control. Follow-up questionnaires were administered along with follow-up questions regarding the parents and children's perception of the yoga and reading intervention to the preschool-aged children's parents. The findings suggest that yoga can be used as an

intervention for both preschool and school-aged children as noted by video observations of the yoga course. Our current study provided weak evidence that yoga may have impacted the inhibition abilities of preschool-aged children as measured by our flanker task. However, future research should further examine the relationship between yoga and the improvement of inhibition abilities in young children. This current research added to the research in the area of behavioral interventions for young children's executive functioning by examining if yoga helps improve the executive functioning in school-aged and preschool-aged children. This study is a good first step to understanding if yoga could be used a possible intervention strategy with children in order to help strengthen his or her executive functioning.

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CHAPTER 1

A Review of Previous Research

Attention is important for people's well being, in regards to educational attainment as well as to the quality of social relationships (Posner, 2012). Therefore, it is important to better understand the cognitive process of attention in order to further comprehend the influence of attention on the everyday life of a person. Sheridan (2007) defines attention as the "focusing of sensory, motor and/or mental resources on aspects of the environment that requires knowledge" (p. 16). Attention allocation is the process used to decide what areas to focus these resources on, based on things such as the needs of the current task as well as the costs and benefits of the given task (Sheridan, 2007). In a review of literature examining the developmental trajectories for attention skills in children, McKay and colleagues (2010) found that attention in individuals involves a network of interrelated processes, which includes both basic selective and sustained skills as well as higher-order and controlled components (Klimkeit, Mattingley, Sheppard, Farrow, & Bradshaw, 2004; Posner & Dehaene, 1994). These attention networks help carry out certain functions such as achieving and maintaining alert states, orienting to certain sensory events, and controlling thoughts and feelings (Posner, 2012). The current study will examine the improvement of these interrelated processes. These additional cognitive processes will be examined in detail next.

Deficits in attention are often connected to deficits in other cognitive processes that can influence children's development (Karatekin & Asarnow, 1998; Wodka et al., 2007). Therefore, it is important to examine these other cognitive processes in order to

further understand how they are influenced by one another. In the area of cognitive psychology attention is just one cognitive process that falls under the overall term of executive functioning. Executive functioning often refers to processes that are connected with the prefrontal cortex (Pribram, 1973) and involves a collection of interrelated elements that are responsible for goal-directed behavior (Giolia, Isquith, & Guy, 2001). Zhou and colleagues (2011) provides a similar definition for the term through their examination of previous research: "Executive function is a multidimensional concept that is created by a number of elements that help control an individual's attention, cognition, and their behavior" (p. 2). However, researchers have defined the term executive function in a number of different ways, and there is therefore no commonly accepted definition that is openly followed (for a review of definitions, see Barkley, 2012).

Due to the lack of a commonly accepted definition or concept of executive functioning, as well as a clear plan for how to measure executive functioning and executive dysfunction, many different approaches have been taken in order to investigate the effectiveness of executive functioning. For example, many researchers tend to disagree about what processes contribute to executive functioning. Barkley (2012) found a number of different processes that researchers have identified to encompass the term executive functioning, including intellect, thought, self-control, and social interaction (Lezak, 1995); anticipation, goal selection, planning, initiation of activity, self-regulation, mental flexibility, deployment of attention, and utilization of feedback (Anderson, 2002); and inhibition, working memory, shifting, and planning (Best, Miller, & Jones, 2009). Miyake and colleagues (2012) also noted the following processes as having an influence

on executive functioning: mental set shifting, information updating and monitoring, and inhibition of prepotent responses (for an overview of several definitions and processes associated with the term executive functioning see Barkley, 2012).

Not only is there not a clear list of processes that are defined to make up the term executive functioning, but there is also not a clear idea of what methods should be utilized in order to measure executive functioning. Many believe that neuropsychological tests should be used to examine executive functioning, whereas some believe that such tests do not fully assess what is occurring during the everyday life of an individual and his or her executive functioning (Barkley, 2012). Consequently, until there is a clearer definition of executive functioning and commonly accepted methods to measure executive functioning processes, individual researchers must choose the definition and approach they believe encompasses their own understanding of the term.

For the purpose of the current study, the following cognitive processes that are involved in executive functioning will be examined: spatial working memory, inhibition, and attention. First, spatial working memory was chosen because working memory is an executive function that relies on both attention and inhibitory control (Roderer, Krebs, Schmid, & Roebers, 2012; Sowerby, Seal, & Tripp, 2011). It has also been found that children who suffer from attention deficits like ADHD also tend to have lower levels of spatial working memory (Karatekin & Asarnow, 1998). Next, inhibition is viewed as a primary deficit in children who suffer from attention disorders (ADHD) (Wodka et al., 2007). Therefore, in examining the impacts of yoga on attention, it is important to also investigate its effect on inhibition. Improvement in both of these areas could help

children who have low levels of executive function improve their self-regulation. Lastly, in regards to attention, there has been recent research on the effects of different activities on restoration of attention (e.g. spending time in nature). There is also a great amount of research examining interventions that are used to help train individuals' attention (for a review see Diamond and Lee, 2012). A more detailed explanation regarding these areas of executive functioning that will be examined in the current study will be discussed later.

A large majority of the research examining intervention approaches to the improvement of attention has been conducted with people who suffer from Attention Deficit Hyperactivity Disorder (ADHD). ADHD is one of the most common neurobehavioral disorders of children in the United States, with 1 in 10 children between the ages of 4 and 17 being diagnosed with the disorder (Center of Disease Control and Prevention (CDC), 2013). These children have trouble focusing their directed attention (top-down processing), which involves more effortful forms of attention; yet, children with ADHD do not show the same struggle when utilizing involuntary attention (bottom-up processing), which involves more effortless forms of attention. For example, children with ADHD may have trouble focusing on items that they do not find interesting such as doing homework, which requires directed attention, but are able to maintain their attention on tasks that they find interesting, like watching television or building structures with blocks, which requires involuntary attention (Faber Taylor & Kuo, 2009).

Children who are diagnosed with ADHD are often put on stimulants, which 70 to 80 percent of children respond positively to (Center of Disease Control and Prevention

(CDC), 2013). Other children, however, may experience a number of different side effects from using these ADHD treatment medications. A five-year review of the side-effects of ADHD medication on ADHD diagnosed children found that some children experienced psychotic effects (e.g. bizarre behavior, paranoia, visual hallucinations, auditory hallucinations, depression, decreased sleep, and suicidal behavior) (Cherland & Fitzpatrick, 1999). An additional examination of ADHD medication side-effects on 325 ADHD diagnosed individuals found that forty-eight percent of the sample reported at least one side effect from their medication. The most reported side effects included: loss of appetite; sleep problems (mostly difficulty falling asleep); and mood disturbances or mood swings (Cascade, Kalali, & Wigal, 2010). Whereas, most of these side effects involve the loss of sleep or appetite, which may be helped through the use of non-stimulant medication (Center of Disease Control and Prevention (CDC), 2013), for some children the use of ADHD medications may be a poor option for the treatment of their ADHD symptoms. Consequently, behavioral interventions may be a better option to help improve attention for those children who are diagnosed with attention deficits.

Behavioral interventions could also be used to help children who are not diagnosed with ADHD, but who may have trouble self-regulating either in the classroom or in the home. The use of fun and interactive behavioral interventions will provide children with useful skills to help themselves be better able to self-regulate their everyday behaviors. Lastly, behavioral interventions would also be helpful for preschool-aged children whose executive functioning is already developing at a very fast rate. If we can provide these young children with helpful interventions to help improve their executive

functioning we can help strengthen these skills when they are developing instead of simply after these children display lower levels of executive functioning. A review of the restoration of attention and other types of executive function interventions will be discussed next.

One theory that examines the role of environments in restoration of attention is Attention Restoration Theory (ART) (James, 1962). ART explains why attention in individuals tends to become fatigued and how attention can be restored. First, attention draws on two different mechanisms: one for deliberately, directed effortful forms of attention; and another for involuntary and effortless forms of attention (James, 1962; Kaplan, 1995). James (1962) and Kaplan & Kaplan (1989) proposed that environmental stimuli that capture an individual's involuntary attention have a "direct exciting quality" causing interest for the individual, which can be things such as: "strange or novel items, things that move, and bright or pretty things. Directed attention on the other hand is not tied to particular stimuli or patterns of stimuli. Directed attention is generic or content-free; therefore, a person's ability to pay attention to generic and content-free stimuli may involve a great deal of effort" (Kaplan & Kaplan, 1989, p. 179).

The mechanisms underlying deliberately directed attention is susceptible to fatigue and restoration (Kaplan, 1995). ART is most concerned with the recovery of mental fatigue or directed attention fatigue (Kaplan, 2001). Mental fatigue occurs when an individual experiences a prolonged and severe use of his or her directed attention. After this intense use of directed attention, an individual's ability to direct his or her attention as well as ward off distractions is reduced (Cohen & Spacapan, 1978). When an

individual then rests, like during sleep or activities that draw primarily on involuntary attention, his or her directed attention recovers (Faber Taylor & Kuo, 2009).

Many interventions have been created in order to help children who suffer from lower-levels of attention and executive functioning. A few intervention methods that have been examined to help children improve their attention and executive functions include things such as spending time in nature, which draws on involuntary attention and allows directed attention to recover (Faber Taylor and Kuo, 2009); Tae-Kwon-Do, which focuses on training directed attention (Lakes, 2004); computer and non-computer games, which focus on training directed attention (Mackey, Hill, Stone, & Bunge, 2011); and mindfulness practices, which focus on both resting and training directed attention (Trulson, 1986; for an overview of several interventions see Diamond and Lee, 2012). These intervention options provide parents who have children who suffer from lower levels of attention a way to help improve their children's attention and executive functioning abilities without the harmful side effects that come from the use of medications.

While all of these interventions have shown some success, the current study will focus on mindfulness practices, in particular yoga. I chose to examine the practice of yoga in the current study due to the fact that this practice includes aspects that help rest as well as train directed attention. By including both approaches this type of intervention may have a larger impact on executive functioning in young children than other interventions. I chose to examine the practice of yoga as an intervention for attention and other executive functions, because it is both easy and inexpensive to implement and can

be practiced throughout the lifespan. Therefore, yoga can be practiced across a person's lifespan without using a great number of resources.

The effectiveness of yoga as an intervention for young children will be examined. The current study will investigate yoga as an intervention with typically developing preschool and school-aged children in order to further understand the effects of yoga on children's executive functioning. First, I will review the literature on mindfulness, which is a practice in which individuals bring their attention to the present moment. Next, I will discuss how mindfulness is related to meditative practices and review research examining the effect of meditation on attention. I will then describe the practice of yoga and explain the connection between yoga and mindfulness, the eight limbs of the yoga practice, the impact of yoga on attention and other executive functions, and research examining the different elements of yoga (breathing techniques, physical poses and meditation practices) and how these elements affect different forms of executive functioning, including attention. Lastly, I will introduce a quasi-experimental research study that will examine how yoga practices affect three different dimensions of executive functions (inhibition, attention, and spatial working memory) and discuss the importance of further intervention research examining the improvement of executive functions.

Mindfulness

Few researchers in Western cultures have studied the Buddhist approach to psychology, which has both religious and philosophical elements; however, according to De Silva (2005), Buddhism offers many insights into the nature of human behavior and consciousness (De Silva, 2005). Western psychology is becoming interested in the

Buddhist practice of mindfulness. Mindfulness practice is described as bringing awareness and attentiveness to the here and now, or, in other words, a person being able to direct awareness to the event he or she is currently experiencing. In Buddhist psychology the concept of mindfulness is not just based in cognition, but also includes emotional, social, and spiritual elements (Grossman, 2010).

The practice of mindfulness is characterized as a dispassionate, non-evaluative, and constant moment-to-moment awareness of a person's mental states and processes. Most mindfulness practices begin with breathing techniques (Grossman, 2010). Concentration on one's breathing is the starting point for how mindfulness is developed. There are many reasons why concentrating on breath is a good starting point for mindfulness. First, breathing is similar to attention processes as both can be involuntary and voluntary (Grossman, 2010). For example, a person has the ability to adjust his or her breathing through concentration (voluntary), and he or she is also able to breathe without thinking about the process of breathing (involuntary). According to the concept of mindfulness, a person gains insight into how his or her mind and body interact through moment-to moment awareness of breathing (Grossman, 2010). By bringing awareness to his or her breath and through controlling one's breath, a person is able to gain insight into how the mind and the body interact with each other. This awareness is usually accomplished by a person first bringing his or her focus to his or her breathing, which for some individuals may include concentrating on the breath that comes through their nostrils, or for others it may include concentrating on the breath that comes from the base of their belly. During this concentration exercise, individuals are told to not consciously

alter their breathing in any way. Through this concentration, people are able to focus their attention on the flow of their physical breath. Next, as a person develops their concentration, he or she becomes aware of other physical sensations that may or may not be related to their breathing. This awareness of other physical sensations develops into an awareness of mental elements, including things such as emotions, memories, and thoughts. Once people fully develop a sense of mindfulness, they experience a continuous state of moment-to-moment awareness of both their physical and mental experiences (Grossman, 2010).

According to the concept of mindfulness, the insight caused by breathing techniques and this continuous state of moment-to-moment awareness allows a person to use very little attention on the mental events and processes that are occurring (Epstein, 1995). Using less attention allows a person to shift from one sensation to the next without spending time concentrating on a single mental or physical event (e.g. thoughts or breath) (Grossman, 2010). Through the practice of mindfulness techniques; such as meditation, a person uses less attention, and therefore is able to let his or her directed or voluntary attention rest. Achieving mindfulness allows a person to then restore this form of attention, which helps a person recover from mental fatigue and be better able to focus his or her attention.

Mindfulness is practiced most often in meditation and yoga practices. Research in both areas will be reviewed below. Mindfulness is a key aspect in many, but not all, meditation practices. Meditation that does not utilize mindfulness practices centers on a person concentrating on a specific idea or object. On the other hand, meditation that

involves mindfulness practices does not require people to focus their attention on a single object or thought, but rather to be fully alert and conscious to all things in the here and now through moment-to-moment awareness ("Enlightenment through yoga and meditation", 2010). Yoga practices, on the other hand, bring mindfulness practice into movement. In yoga practices the emphasis is on moving with mindfulness through the use of postures (Kozak, 2010). Kozak (2010) argues that if a person is able to bring mindfulness into movement through practices like yoga or meditation then it will be easier to bring it into everyday life, where movement is occurring all the time. Next, research examining mindfulness and meditation will be reviewed with consideration to the associations between these practices and attention and other executive functions.

Mindfulness and Meditation

One of the main practices where mindfulness is utilized is through meditation. Therefore, many researchers have chosen to investigate the influence of meditation on executive functioning. Flook and colleagues (2010) examined the connection between mindfulness practices and executive functions in school-aged children. Children were placed in either a mindfulness awareness program or in a control group. The mindfulness awareness program consisted of exercises and games that promoted "(a) awareness of self through sensory awareness, attentional regulation, and awareness of thoughts and feelings; (b) awareness of others; and (c) awareness of the environment" (Flook et al., 2010, p. 74). Parents and teachers of the children completed a questionnaire on his or her children's executive functioning before and after the intervention (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). Results indicated that children in the mindfulness group, who

had lower executive functioning before the intervention as indicated by the parents' and teachers' reports, showed greater improvement in their executive functioning (e.g. behavioral inhibition, metacognition, and overall global executive functioning) than those in the comparison group. Therefore, those with lower executive functions benefited from the mindfulness intervention both at home and at school. Those who were already higher in executive functioning at the beginning of the intervention, however, did not improve significantly more than the control group (Flook et al., 2010).

Meditation is the mindfulness practice that has been most frequently examined in research. Until recently, most of the research examining the effects of meditation on attention examined long-term meditation practices, which can take months or years of training (e.g. Slagter et al., 2007). Some recent research has examined shorter-term meditative interventions. Tang and colleagues (2007) explored effects of short-term meditation on young adults' attention and self-regulation. The short-term meditation training program took place over 5 days and consisted of one 20-minute training session per day. Young adults who participated in the meditation training sessions showed greater improvement than the control group on the executive attention component of the Attention Network Tests (Fan, Sommer, Raz, & Posner, 2002). This study showed that even short-term training in meditation had a positive effect on adults' attention.

Leite and colleagues (2010) also examined meditative practices in an adult population with anxiety problems in order to determine if it improved their attention. Forty-two adult participants were placed in either a Progressive Self-Focused Meditation group, who had 1-hour meditation training once a week for 5 weeks, or a control group.

In an examination of the Mindful Attention Awareness Scale, which is a self-report measure of attention in routine situations, the meditation group increased more than the control group in their perceived attention. Specifically, after the meditation training, individuals in the experimental group perceived themselves as being more attentive and aware in comparison to those in the control group (Leite et al., 2010). Lastly, members of both the meditation group and the control group completed a digit-symbol task, which is a measurement of attention and agility. The focused meditation group and the control group improved equally on the digit-symbol task (Leitte et al., 2010). Therefore, when taken together, these findings showed that the meditation practices had an influence on how alert individuals felt in different situations; however, because there was no difference between groups on the objective measure of attention (digit-symbol task), the meditation practice may have made the participants feel more alert without actually making them more alert. It is also important to note that the focused meditation participants may have reported feeling more alert because of demand characteristics; that is, they may have thought they should feel more alert after a meditation practice.

The research described above suggests that even short-term meditative practices may have some influence on attentional processes; however, this research does not examine whether there are any long-lasting effects of meditation on adults' attention. Chan and Woollacott (2007) explored how long-term meditative practices impact certain attentional networks by examining two groups: meditators who were recruited from meditation centers and a control group of non-meditators. Chan and Woollacott examined executive processing and orientational processing. Executive processing includes

inhibition of incorrect responses. Orientational processing involves how adults orient to specific objects in the attentional field. Chan and Woollacott found that meditators had higher inhibition scores than the control group, but were not different from the comparison group in their orientational processes. The results of this study suggested that meditation was related to long-term increases in inhibition, but was not related to how people orient their attention (Chan & Woollacott, 2007). Therefore, meditation may have different impacts on different aspects of attention. It is important to note that this study was also a correlational study and therefore, it is not possible to determine the cause of the correlation between meditation and inhibition.

In a similar study examining both expert adult mindfulness meditators and a control group that was matched on age and gender, Van de Hurk and colleagues (2010) explored whether meditation had an impact on attentional processes. Like Chan and Woollacott (2007), Van de Hurk and colleagues found that the skilled meditators showed greater executive attention than those in the control group; however, unlike Chan and Woolacott, Van de Hurk and colleagues also found meditation was related to attentional orienting. Therefore, this study suggested that in addition to increasing executive attention, meditation might also influence orienting processes in those who are highly trained in meditation. Van de Hurk and colleagues explained that the difference between their study and the study by Chan and Woollacott might be due to the fact that their study included more experienced meditators. Another thing to note is that Chan and Woollacott did try to control for education level in their study, however, Chan and Woollacott as well as Van de Hurk did not control for other aspects of cognitive functioning, which may have

also affected their individual findings. Van de Hurk and colleagues suggested that through mental training, such as meditation, individuals may increase their overall attentional processing, which could be an easy solution for individuals who have trouble focusing and sustaining their attention in their day-to-day life.

Although several studies have examined mindfulness meditation practices, which are practices that concentrate on cognitive processes (Leite et al. 2010, Tang et al., 2007), less research has examined emotional-focused meditation practices. Emotional-focused meditation allows a person to strengthen his or her feelings of love and kindness and lets the person direct those feelings toward other people (May et al. 2011). Loving-Kindness meditation is one example of emotional-focused meditation. May and colleagues (2011) examined Loving-Kindness meditation utilizing an attentional blink task. Attentional blink is a phenomenon that is observed in rapid serial visual perception and occurs when a person fails to detect a second salient target in a sequence of visual stimuli when the target appears too quickly (between 100-500ms). The attentional blink task measures the failure to detect this second target after a previous target. Positive affect theory states that positive affect helps distribute an individual's attention, which would result in a person who displays a positive affect to make a lower attentional investment on the sequence of stimuli and as a result have a reduced attentional blink. Because the Loving-Kindness Meditation training is designed to increase positive affect, it was hypothesized that participating in the meditation training would result in a reduced attentional blink. May and colleagues (2011), however, found no differences between an experimental group

who completed the meditation training and a control group, on pre and posttest of the attentional blink task.

In a second experiment May et al. (2011) examined the short-term effect of participating in Loving-Kindness yoga by investigating whether participating in a practice emotional-focused meditation session prior to the meditation training might play a part in the effect of meditation on an individual's attentional blink. Therefore, members of both the experimental and the control groups completed a single Loving-Kindness Meditation session directly prior to their training. May et al. (2011) found those in the experimental group showed a significant reduction in the attention blink task in comparison to those in the control group in a follow-up test that was conducted 1-2 weeks after the completion of their posttest in experiment 1. This study suggests that a person's attentional blink is only improved immediately following a meditation session, and, therefore, training in meditation by itself may not be enough to improve overall attention (May et al., 2011).

Yoga

Yoga is another technique that involves elements of meditation and mindfulness. In Western cultures the practice of yoga is often used for fitness training, in which different physical poses are practiced in order to build strength and stretch the muscles of the body. However, there is more to yoga than the physical poses that are associated with the practice (Feurstein, 2003). As mentioned previously, yoga also includes elements of meditation where individuals focus on bringing awareness to their mental and physical state as well as concentrating on their breath. Yoga expands on meditative practices to

not only bring moment-to-moment awareness to a person's mental state, but to create connections between the mind, body and spirit through concentration on physical poses, meditative states, and spiritual inquiry. There are eight main limbs to yoga, which illustrate the connection between mindfulness and this practice. To better understand their significance, these eight limbs will be described in detail next.

The Eight Limbs of Yoga. The core elements of yoga were compiled centuries ago, in Patanjali's Yoga Sutra (Iyengar, 1966). These eight limbs are a non-hierarchical system that people can experience in their yoga journey. A person does not necessarily move from the first limb to the second and so on, but instead in the practice of yoga he or she is simultaneously completing the limbs together. Gates and Kenison (2002) explains that it is impossible, for example, to complete one of the limbs without the support of the others and therefore instead of thinking about yoga as a step by step process that needs to be done in a certain order, a person can think about the yoga limbs as more of a map where a person is simultaneously jumping from one location (or limb) to another. The non-hierarchical framework allows for flexibility in an individual's yoga practice (Iyengar, 1966). Each limb concentrates on different elements of the yoga practice, with common themes being illustrated across some of the limbs. First, I will discuss these common themes and then I will describe each of the eight limbs.

The first two limbs, the Yamas and Niyamas, deal with the control of an individual's emotions and enable people to stay in unity with those around them. The next two limbs, Pranayama and Pratyahara, both concentrate on breathing techniques that allows the person to fully concentrate and have control over his or her mind. The final

three limbs, Dharana, Dhyana, and Samadhi, help the individual search his or her soul. They allow a person to look inwardly into his or her soul and find inner peace through the use of deep concentration, meditation, and becoming one with his or her yoga practice (Iyengar, 1966).

The first limb of yoga, Yamas, consists of five specified duties or rejections of actions that should be followed. Individuals practicing yoga should try to avoid the following five actions: violence, falsehood, stealing, indulgence, and possessiveness (Sarkar, 1902). Practitioners of yoga believe that these rejections need to be completed in order for a person to lead a moral life. Practitioners of yoga also believe that if these rejections are not completed, then chaos and pain will come to the individual. Iyengar (1966) states that the roots of these evils are the emotions of greed, desire, and attachment, which can be experienced to differing degrees by individuals who do not rid themselves of these restrictions.

Whereas Yamas is the rejection of actions that should not be followed, Niyamas are practices that should be followed. Niyamas, or the second limb of yoga, consists of the observances of purity (both body and mind), contentment, strictness, study of scriptures, and preserving devotion to God (Sakar, 1902). These practices are thought to help foster individual well-being through the gain of courage and wisdom, and to bring bliss to the lives of those who follow them (Iyengar, 1966).

The third limb of yoga is Asana or posture. Asana brings a sense of steadiness, health, and lightness to a person. Completing a steady or pleasant posture helps create mental equilibrium in a person and prevents uncertainty in the mind. Through practicing

the postures that make up the yoga practice a person is able to develop agility, balance, stamina and great vitality (Iyengar, 1966).

Pranayama is the forth limb of yoga, and it is through Pranayama that a person is able to understand the process of breathing and the steps that he or she needs to take in order to increase his or her body's ability to breathe. Yogic breathing is a type of breathing that trains a person's mind to concentrate on a single point. This practice then helps people to be able to control and utilize the energy that he or she receives from the air they breathe (Gates & Kenison, 2002).

Pratyahara is the fifth limb of yoga and is the moment in the yoga practice when a person is able to push away the distractions around him or her and direct his or her attention inward. Through this process a person is then able to accomplish the sixth and seventh limbs of yoga, Dharana and Dhyana (Gates & Kenision, 2002).

The sixth limb of yoga is Dharana or concentration. In this limb a person brings his or her attention to a single point. This point of reference can be external (an object located in the room) or internal (a single thought). During yoga a person can experience Dharana quite often. This takes place most often when a person is concentrating so deeply on a yoga pose that he or she begins to forget about his or her everyday problems or concerns and time passes by unnoticed (Gates & Kenison, 2002).

The seventh limb of yoga is Dhyana or meditation. Once a person is able to focus his or her attention on a single object, he or she is able to become conscious of the mind and the object on which he or she is concentrating. In Dhyana, attention becomes effortless and a person's body, breath, senses, mind, reason, and ego become immersed in

the object of concentration (Iyengar, 1966). For example, when a runner is completing a race his or her concentration is so attuned to the run that he or she is not concentrating on his or her stride, the other runners around him or her or how many more laps he or she has to complete. In other words, everything else disappears and the runner is simply running.

The final limb of yoga is Samadhi, the experience of blissful oneness. Samadhi can be described as a satisfying realization that things are all right. In order to achieve this realization a person has to go through self-forgetting, or, in other words, a person needs to put faith in the fact that even though he or she may have problems and struggles, in the end things will turn out well (Gates & Kenison, 2002). Through this experience, the person will achieve a sense of faith in the practice.

Yoga and Attention

Yoga has many elements that can affect attention. First, in regards to psychological practices, yoga focuses on relaxation techniques such as meditation, which has been found to have many positive impacts on attention (Leite et al., 2010; May et al., 2011; Tang et al., 2007; and Van Hurk, Giommi, Gielen, Speckens, & Barenregt, 2010). Yoga also has the physical component of the postures that are completed during the practice. Coordinated exercise, like that of yoga, has a positive impact on increasing adolescents' selective attention (Budde, Voelcker-Rehage, Pietrabyk-Kendziorra, Pedro, and Tidow, 2008). Lastly, yoga focuses on breathing techniques, which is a central concept to mindfulness theory. Mindfulness practices and meditation practices that utilize aspects of mindfulness can have positive impacts on attention (Flook et al., 2010; Leite et

al., 2010; Tang et al., 2007; and Van Hurk, Giommi, Gielen, Speckens, & Barenregt, 2010). Diamond (2012) examined how a number of different intervention techniques, including mindfulness and yoga, can improve executive functioning. In regards to mindfulness techniques, Diamond reviewed previous research that examined the impact of physical activity on forms of executive function and found that exercise practices alone may not be as effective at improving executive functioning as the combination of exercise and mindfulness practices like that found in yoga exercises (Diamond, 2012). Therefore, because yoga includes both the element of exercise and, also the element of mindfulness, the practice has potential to have a positive impact on helping people be better able to focus their direct attention, which will increase their attention capabilities.

Next, I will examine research that has examined specific elements of yoga practices. First, I will survey studies that examined breathing techniques that are completed in yoga practices. I will then review research that concentrates on the postures that are used in yoga as well as examine research that looks at meditative practices that are used in yoga. Lastly, I will review research that concentrates on all of the elements of yoga practices.

Yoga Practices: Breathing Techniques. Breathing techniques are a main focus of yoga. Naveen and colleagues (1997) completed a study examining the impact of yoga on adolescents, where they concentrated simply on the breathing techniques used in yoga. Naveen and colleagues (1997) split the children (10-17 year olds) into four separate groups where each group practiced a different yoga breathing technique including: right nostril breathing, left nostril breathing, alternate nasal breathing, and breath awareness

(no manipulation of the nostrils). A comparison group, who were matched by age to the experimental group, was also assessed. Children in the breathing group practiced their specified breathing techniques over a 10-day stay at a yoga camp, where they also participated in other yoga exercises. Naveen and colleagues (1997) examined verbal memory by using a standard nonsense syllables task where a grouping of three letters was selected from a prepared list and shown on a screen for 10 seconds. Ten slides of three letter nonsense syllables were shown. After a delay the child recalled the letters they saw on the slides and wrote them down on a piece of paper. Spatial memory was assessed using a similar format as the verbal memory task; however, instead of the use of nonsense syllables, ten simple line drawings were projected on the screen. Children then had to draw the line drawings. Children completed the verbal memory and spatial memory tasks prior to the intervention and then again after their 10-day participation in the yoga camp (Naveen, Nagarathan, Nagendra, & Telles, 1997).

Naveen and colleagues (1997) found that participants in all four of the breathing groups showed significant improvement in spatial memory scores across the ten-day span, and those in the comparison group showed no change. There was, however, no significant effect of breathing techniques on verbal memory scores. These results suggest that breathing techniques may improve spatial memory scores, but may not have the same impact on verbal memory. This study also showed that all of the breathing techniques that were examined helped improve spatial memory scores (Naveen, Nagarathna, Nagendra, & Telles, 1997). There were some noted limitations to this study, however. First, this study covered a large age range of children, and, therefore, due to

developmental differences, there may have been great variability between what the children in this study were able to do in both their yoga practice and the spatial and verbal memory tasks. This variability, therefore, may have masked any significant effects of breathing techniques on the verbal memory task. Second, the verbal memory task in this study also used sequences of nonsense letter combinations instead of sequences of words. Remembering a combination of nonsense letter combinations may be significantly more difficult than remembering a sequence of words that a child may be already familiar with. Thus, the difficulty level of this task could be the reason no significant effects were found. Lastly, the children in the breathing groups also participated in other yoga exercises throughout their participation at the yoga camp. Therefore, one of these additional exercises may have also influenced the spatial memory capabilities of these children in comparison to those in the control group. Next, I will examine previous research that has examined yoga postures, the physical component of the practice of yoga, and their impact on attention.

Yoga Practices: Postures. Research examining the posture element of yoga practices has examined whether this physical aspect of the practice helps benefit cognitive functioning. One aspect of cognition that has been closely examined by Kimbrough and colleagues (2007) is short-term memory. Kimbrough and colleagues (2007) examined the impact of inverted yoga poses (a pose where a person's head is lower then their heart) on adults' short-term memory. Inverted postures were chosen due to previous research finding that these poses help increase both short-term memory and attention due to an increased blood flow to the brain (Schaeffer, 2002). Participants were

split into four different experimental groups: a yoga posttest only group, a yoga pretest and posttest group, a control posttest only group, and a control pretest and posttest group. This experimental design was chosen to help control for effects of repeated testing. Participants completing the yoga intervention were taught by a group fitness instructor and were guided in a series of three inverted yoga poses where they held each pose for five slow breaths. None of the participants had participated in a yoga practice prior to this study. The pre and posttests consisted of a verbal memory span test.

Kimbrough, Balkin, and Rancich (2007) found that there was no significant difference between the two control groups (control posttest only, and control pretest and posttest) and the two different experimental groups (yoga posttest only, yoga pretest and posttest group). This study, however, only examined one aspect of yoga (inverted postures) and did not include other aspects of yoga practices, such as breathing techniques, other postures, and meditation. Therefore, it may be limited in scope when it comes to examining the benefits of yoga on short-term memory (Kimbrough, Balkin, & Rancich, 2007). Next, I will review research that has examined the meditative aspect of yoga, which is the cognitive and spiritual component of the practice, and how it affects attention.

Yoga Practices: Meditation. Research has examined the impact of yoga practices that focus on meditative and awareness techniques in typically developing children. In a study examining pre-adolescent girls, Manjunath and Telles (2001) examined whether yoga had a positive effect on children's executive functions. Manjunath and Telles (2001) examined twenty girls between the ages of 10 and 13 who

attended the same residential school. The girls were split into two separate groups. The first group participated in yoga practices for an hour and fifteen minutes a day, seven days a week, for 30 days. The yoga practice included physical activity, instructions to relax, and awareness of physical and other sensations. The second group was a comparison group who participated in other physical training for the same amount of time as the yoga group; however, this group did not receive instruction about relaxation or awareness. Participants in both groups were given the Tower of London test, which is an executive function measure of planning ability. Participants were asked to move an assortment of colored beads that were placed on three vertical rods to correspond to a given arrangement. The number of moves required to complete the task varied between the tasks, where the first task required two moves, the second task required four moves, and the third task requiring five moves. Performance was measured by the amount of time it took to plan and execute moves and the number of moves to complete the task (Manjunath and Telles, 2001).

Manjunath & Telles (2001) found that the girls who participated in the yoga practice showed a significant decrease in planning time for both the two move and the four move tasks. The yoga group also showed a significant decrease in execution time for both the four move and five move task and a significant decrease in the number of moves in the four move task. The physical training group showed no significant change in the Tower of London Test across the thirty days. This finding provides evidence that practicing yoga had a significant impact on children's executive functioning, in particular their planning ability. However, Manjunath and Telles found that those in the physical

training group had better planning time in comparison to the yoga group at pretest; therefore, because the yoga group displayed a lower level of performance in the beginning, their performance could potentially improve more than the control group. Thus, the improvement of the yoga group may be due to this group having lower initial scores to begin with and therefore they made greater gains overall. The validity of this finding therefore may be limited. (Manjunath and Telles, 2001).

Pradhan and Nagendra (2009) also examined different forms of meditative yoga practices and their effect on short-term memory and selective attention in 13- to 16-year-olds. These adolescents participated in a 10-day yoga-training course, where the yoga practice concentrated on two separate relaxation techniques. The first technique examined was Cyclic Meditation, which combines stimulating and calming practices and consists of yoga postures combined with periods of relaxation. The second technique was Supine Rest, which is often known as the sleep posture. This rest posture is usually done at the end of a yoga practice where participants lay on their backs, close their eyes, and let their bodies fully relax (Pradhan & Nagendra, 2009). The group of participants was split into two groups: one group conducted the Cyclic Meditation practice on day 9 of the camp and the Supine Rest practice on day 10 and the other group reversed these practices. In the days prior to being placed into the two meditation groups the members of the camp were trained to complete both meditative practices (cyclic and supine). Participants completed a Digit-Letter Substitution Task (DLST), which is a measurement of memory and selective attention, both before and after each of the two yoga practices. The DLST consisted of an 8-row by 12-column group of random digits from 1 to 9.

Subjects were given a coding sheet that listed which letter to substitute for each number. Participants were then asked to substitute as many digits as they could in a matter of 90 seconds.

Pradhan and Nagendra (2009) found that there was a significant improvement in the DLST after both forms of relaxation techniques (Cyclic Meditation and Supine Rest); however, there was greater improvement after the Supine Rest technique as measured by net mean scores. Net mean scores were computed by taking the number of wrong substitutions away from the total number of substitutions made. An additional finding also showed that wrong substitutions on the DLST increased after both of these interventions. Therefore, it was found that both Cyclic Meditation and Supine Rest yoga relaxation techniques lead to improved performance on the DLST, but also led to an increase in the percentage of wrong cancellation errors. The increase in wrong cancellations may be due to the fact that these participants were asked to deeply relax during these interventions and, therefore, may have been a little drowsy when asked to perform the task. It is also possible that because this study used a within-subject, pretest/posttest design with no control group that a practice effect may be responsible for the significant improvement in the DLST (Pradhan & Nagendra, 2009).

Subramanya and Telles (2009) examined the effect of Cyclic Meditation and Supine Rest on attention in adult males who were staying at a yoga center. Participants took part in both relaxation techniques with one group doing Cyclic Meditation on the first day and Supine Rest techniques the second day and a second group doing the opposite schedule. All participants were assessed on the digit span forwards, digit span

backwards, and verbal paired associate learning task, which all measure verbal working memory, both before and after the two yoga techniques.

Subramanya and Telles (2009) found a significant increase in all three measures of verbal working memory (digit span forward, digit span backwards, and verbal paired associate learning task) following both the Cyclic Meditation and Supine Rest techniques; however, performance increased more following the Cyclic Meditation technique. These findings support previous research examining these relaxation techniques and their positive effects on executive functioning (Subramanya & Telles, 2009).

Yoga with meditation practices has also been examined as an alternative approach to treating the symptoms of ADHD in young children. In a pretest to posttest experimental design Harrison and colleagues (2004) examined a six-week family treatment method for children with ADHD, which included two weekly 90-minute clinical sessions using Sahaja Yoga Meditation techniques. Following the treatment, parents reported that their children showed improvements in ADHD behavior, self-esteem, and relationship quality. Children expressed that they experienced better sleep and less anxiety in the home, and were also better able to concentrate and experienced less conflict while in school. Parents also reported that they were less stressed, felt happier and were better able to handle their child's behavior (Harrison, Manocha, & Rubia 2004). However, this study only found significant improvements based on self-report measurements. Performance on a measure of cognition (Peabody Picture Vocabulary Test, 3rd edition) and a measure of self-esteem (Burnett self-scale) did not

change from pre to posttest. Therefore, it is difficult to determine the exact effect of meditation. For instance, participants may report based on what they believe the finding of the study should include (e.g. that they should feel more alert after a meditation practice). Therefore, the measurements used in this study are probably not the best outcome measure that could have been utilized in this study and behavioral measurements may have been a better option. Next, research that includes all components of yoga that have been previously discussed (breathing, poses, and meditation) will be examined in relation to their impact on executive functions.

Yoga Practices: All Elements Included. Research examining yoga and all of the elements that make up the practice (breathing techniques, postures, and meditation) has shed light of the effect of yoga on many forms of executive functions and has provided evidence for the importance of participating in a complete yoga practice. A study conducted by Prakash and colleagues (2010) examined the impact of yoga practices on a number of different executive function tasks. Fifteen males who had practiced Vihangam Yoga for more than 10 years and a comparison group who were matched based on age, sex, and years of education participated in the study. Participants completed a variety of executive function tasks including: (a) the verbal intelligence subtest of the Post Graduate Institute Battery of Brain Dysfunction (Pershad & Verma, 1990), which was used to remove any intelligence-related bias between participants; (b) a digit forward and digit backward task as a measure of attention span, concentration, and mental control (Weschler, 1981); (c) the Symbol Digit Modalities Test from the Weschler Adult Intelligence Scale (Weschler, 1939); (d) the Stroop interference test (Stroop, 1935),

which is used to measure the ability to inhibit distracters; and (e) the Trail Making Test (Reitan, 1958), which is a measure of response alternation ability and visual scanning and attention (Prakash et al., 2010).

Prakash and colleagues (2010) found that, after controlling for intelligence, the Vihangam Yoga practitioners performed significantly better on all of the above mentioned tasks of executive functions. Therefore, it can be argued that long-term Vihangam yoga practices can improve a number of executive function abilities including attention span, processing speed, attention alternation ability, and inference (Prakash et al., 2010).

Manjunath and Telles (2004) examined the effect of yoga practices on verbal and spatial memory in children. Manjunath and Telles (2004) examined two groups composed of thirty children ages 11 to 16 years. One group was composed of children who attended a yoga camp and the other group was made up of children who went to a fine arts camp. An additional comparison group was made up of children who were on vacation, but were not part of the camps and did not receive the intervention.

Children completed spatial working and verbal working memory tasks prior to attending their specified camps and after 10 days of camp. Manjunath and Telles (2004) assessed verbal memory and spatial memory by using the same tasks that Naveen and colleagues (1997) used in their study of breathing techniques (discussed above). Manjunath and Telles (2004) found that children who participated in the yoga camp showed a significant 43% increase in their spatial memory scores from the first day to the tenth day. The fine arts group and the comparison group showed no significant change.

No significant changes were found for any of the verbal memory scores. These results support those found by Naveen and colleagues (1997) by suggesting that yoga practice may improve the delayed recall of spatial information, but may not have the same effect on the delayed recall of verbal information (Manjunath and Telles, 2004).

In addition to studies with typically developing children, researchers have also studied the influence of yoga on the executive functioning of children with ADHD. Abadi and colleagues (2008) examined the effects of yoga treatments in ADHD diagnosed children between the ages of 9 and 12. Abadi and colleagues compared the ADHD symptoms of an experimental group, who participated in 16 sessions of yoga over a two-month period, and a control group. Abadi and colleagues found that the ADHD symptoms of the children in the yoga treatment group improved, whereas the control group's symptoms did not improve (Abadi, Madgaonkar, & Venkatesan, 2008). Children with ADHD often face many stressful situations that non-ADHD children do not, and these situations can worsen their ADHD symptoms. Based on the results of this study, yoga treatments may be a good option for children who suffer from ADHD as an approach to restore both their attention as well as decrease their stress (Abadi, Madgaonkar, & Venkatesan, 2008).

Yoga practices, however, may also be beneficial for non-diagnosed children who may have trouble paying attention in a school setting. Peck and colleagues (2005) examined 10 elementary school children who were not diagnosed with ADHD, but were recommended by their teachers for the study due to attention problems in the classroom. These children completed a 30-minute yoga video twice a week for three weeks and were

later observed in their classroom setting. Children's behaviors were measured using the Behavioral Observation Form (BOF; Rhode, Jenson, & Reavis, 1993). This measurement was used to examine a number of different behaviors displayed by the child, including the amount of time the child stayed on task, the amount of time a child made eye contact with the teacher, and if he or she was able to complete the assigned classroom assignment (Peck, Kahle, Bray, & Theodore, 2005).

Peck and colleagues (2005) found that participating in the yoga video treatments had a significant effect on children's later attention. In an examination of classmates who did not participate in the yoga videos, Peck and colleagues found that the amount of time these children stayed on task did not change over the course of the study; however, classmates who participated in at least one yoga video showed increases from their baseline score on the amount of time they stayed on task. This study demonstrated that yoga can have positive effects on the attention of children who are not diagnosed with ADHD, but who display attentional problems. This study also showed that a simple 30-minute yoga video can have an impact on children's ability to focus their attention in a classroom setting (Peck, Kahle, Bray, & Theodore, 2005). Therefore, yoga treatment could be implemented without requiring significant resources.

Most studies of yoga in children have examined the effects of yoga on school-aged children and adolescents (Abadi, Madgaonkar, & Venkatesan, 2008; Flook et al., 2010; Manjunath and Telles, 2001; Manjunath and Telles, 2004; Nagarathan, Nagendra, & Telles, 1997; Peck, Kahle, Bray, & Theodore, 2005; & Pradhan & Nagendra, 2009). One exception was a study by Rich (2011), who examined yoga in preschoolers. In

general, preschoolers have a hard time paying attention and can often be impulsive. Rich examined 49 children between the ages of 3 and 6. Children participated in 20-minute yoga sessions that were led by a certified yoga instructor twice a week for 4-weeks. Rich examined gender differences and the overall effect of the yoga session using Connor's Teaching Rating Scale that was completed by the children's classroom teachers (Connors, 2001). Rich did not find strong evidence that yoga practices had a significant impact on preschool children's attention, but found that yoga practices may impact boys and girls differently, with girls showing more improved attention by the end of the 4-week session.

It is possible that yoga practices do not have the same impact on preschoolers as on children who are school-aged. Wiebe and colleagues (2010) showed that executive functions for children in the preschool age group is best described as a unitary concept, through showing that different measurements of executive function loaded better on to a single factor in comparison to three separate dual factor models that were examined: a. working memory and inhibition; b. spatial demands and nonspatial demands; and c. no performance feedback and performance feedback. For children who are school-aged, executive functions factor into part of three separate components (working memory, shifting, and inhibition) (Huizinga, Dolan, & van der Molen, 2006). Therefore, it may be more difficult to pinpoint the exact effect that yoga had on the preschool children examined by Rich (2011) due to the fact that the measurements used in this study were designed to examine a specific executive function (e.g. attention), which may not be fully developed in this age group (Wiebe, Espy & Charak, 2008).

Summary and Critique

Overall, previous research on the impact of yoga practices on executive functions has shown many positive aspects of the practice and has shed light on what specific elements of yoga may be more beneficial to people's executive functions. First, research that examines mindfulness practices (i.e. meditation), which utilizes breathing techniques (Chan and Woollacott, 2007; Flook et al., 2010; Leite et al., 2010; Tang and colleagues, 2007; and Van de Hurk and colleagues, 2010) and research examining simply the breathing techniques associated with yoga (Naveen, Nagendra, & Telles, 1997) have shown positive impacts on children's executive functions. However, research that examines breathing as a central focus in yoga is lacking and therefore future research is needed to further examine the impact of this technique. Next, the examination of the practice of yoga postures and their effect on individuals' executive functions found that this element alone might not be enough to improve executive functions (Kimbrough, Balkin, & Rancich, 2007). The meditative element of yoga, on the other hand, was related to improved executive functioning; however, most of the previous research focused primarily on just two forms of meditative practices (Cyclic Meditation and Supine Rest) and, therefore, further research examining other meditative practices is needed. Lastly, the research examining all aspects of yoga practices has been very promising with many studies finding that yoga practices positively influenced executive functions (Abadi, Madgaonkar, & Venkatesan, 2008; Manjunath and Telles, 2004; Peck, Kahle, Bray, & Theodore, 2005; & Prakash et al., 2010). This review shows that the influence of yoga on executive functions may depend a great deal on all elements of the

practice. When elements of the full practice are examined individually or in isolation, it may not fully illustrate the benefit of the yoga practice on executive functions, and, therefore, future research should examine all elements of yoga practices.

Research provides evidence of the benefits of yoga in many different populations. Research examining ADHD populations show that alternative treatments such as yoga and meditation practices, may help improve some of the symptoms of ADHD in children, as well as help parents cope with taking care of a child with ADHD (Harrison, Manocha, & Rubia 2004). Research in typically developing children and adult populations also shows many benefits of yoga practices on executive functions (Manjunath and Telles, 2001; Manjunath and Telles, 2004; Naveen, Nagarathan, Nagendra, & Telles, 1997; Pradhan & Nagendra, 2009; & Sabramanya & Telles, 2009) therefore, future research examining this form of intervention may be beneficial to many populations, including individuals who have a wide range of attentional skills, members of both sexes, and different age groups.

Even though the studies previously discussed provide us with promising findings supporting the idea that yoga practice may have a positive influence on young children's executive functions, there is still a great need for further research. In particular many studies that examined yoga practices did so in adolescent or adult populations (Kimbrough, Balkin & Rancich, 2007; Naveen, Nagendra, & Telles, 1997; Pradhan & Nagendra, 2009; Prakash et al., 2010; & Subramanya & Telles, 2009). There is very limited research examining the effect of a yoga practice on young children, in particular preschool-aged children. It is important to examine intervention options that are available

to help improve executive functioning in this age range due to the fact that executive functions are developing at a fast rate and because symptoms of attention disorders such as ADHD can be detected as early as preschool.

Another limitation of the studies examined in this review is that many of these studies are not experimental in nature. Some studies discussed in this review utilized correlational data (Chan & Woollacott, 2007; Harrison, Monacha, & Rubia, 2004; & Peck, Kehl, Bray, & Theodore, 2005), which is suggestive, however, does not make a case for causality. Therefore, it is difficult to determine from these studies what impact yoga actually has on executive functioning. Many studies also utilized comparison groups instead of control groups. Not having a matched control group may further hinder the validity of a study by creating unwanted group differences. Further experimental research is needed to better explore the impact that yoga has on executive functions, and whether yoga could be a possible intervention method for children to help them improve their attention.

Unique Contributions of the Proposed Study

The proposed study will add to the current literature in many ways. First, the current study will examine a younger age group than what is usually examined in this type of research. Preschool is an important period for the development of executive functions. Therefore, by examining a preschool-aged sample I will be able to closely examine the effect of yoga during this rapid development of executive functions and will be able to explore if a yoga intervention may help enhance the executive functioning abilities of these children. The proposed study will examine whether a yoga intervention

could have a positive impact on both preschool and school-aged children's attention and other executive functions in a typically developing population.

Next, the current study will use a quasi-experimental design to examine the impact of child centered yoga classes on three areas of executive function (attention, inhibition, and spatial working memory). These three areas of executive function were chosen due to their widespread prevalence in previous research measuring executive functions in the preschool age group (Thorell, Lindqvist, Bergman, Bohlin, & Klingberg, 2008; Wiebe, Espy, & Charak, 2008; & Wiebe et al., 2010). The impact of yoga on attention has been examined at length in this review. The importance of choosing age appropriate measurements of executive function was important for the current study in order to add to previous research, which shows positive impacts of the practice on attention and other executive functions. Therefore, we took steps to choose appropriate measurements that could be utilized by both preschool and school-aged children and that measured a number of important elements of executive functioning.

The Utilization of Inhibition, Spatial Working Memory and Attention as Dependent Variables

There are a number of reasons for choosing to study inhibition when conducting research that examines attention in young children. First, research that examines the development of executive function has found that basic forms of executive functions including inhibition and working memory develop earlier then more complex processes like systematic problem solving and planning (Espy et al., 2001). Next, Wiebe and colleagues (2010) proposed that executive functions in a preschool age group are best

described as a unitary concept. Therefore, when examining a preschool age group it is important to explore components of executive functioning that are developmentally present. It is also important to utilize a variety of different executive function measurements because it is more difficult to pinpoint a specific dimension of executive function that yoga is having an effect on in a preschool population. On the other hand, Huizinga and colleagues (2006) proposed that executive functioning in a school-aged children tends to not be a unitary construct, but instead is made up of three separate components (working memory, attention shifting, and inhibition). Therefore, when examining a school-aged population it is important to make sure that you are utilizing measurements that measure these areas of executive functions. Lastly, certain executive functions tend to affect other executive function processes. For example, inhibition is also viewed as a primary deficit in children who suffer from attention disorders (ADHD) (Wodka et al., 2007). Inhibition is also connected with both orienting and executive functioning of attention and is important for attentional selection and effortful control (Fuentes, 2004). Inhibition has also been found that the inhibition of attention has also been found to be necessary in order to be able to shift attention (Willoughby, Wirth, & Blair, 2012). Therefore, the connection between attention and inhibition is apparent and when examining the impacts of yoga on attention, it is important to also investigate its effect on inhibition. Improvement in both of these areas could help children who have low levels of executive functioning improve their self-regulation.

Spatial working memory (SWM) is short-term memory for keeping a location in mind in order to complete a task. Several researchers have proposed that attention has a

strong influence on spatial memory. First, researchers believe that spatial selective attention acts as a rehearsal mechanism in SWM (Awh et al., 1999; Awh & Jonides, 2001). Researchers have found that children who are diagnosed with ADHD also show deficits in SWM (Karatekin & Asarnow, 1998). Schutte and colleagues (2014) have also shown that distractors, when presented during a delay in a SWM task, influence children's memory responses. This finding suggests that the children's attentional control influences performance on the SWM task. SWM has also been found in previous research to be influenced by yoga practices (Naveen, Nagarathna, Nagendra, & Telles, 1997; & Manjunath and Telles, 2004) as well as in intervention research examining the impact of nature walks on preschool-aged children's attention (Schutte, Torquati, & Fleharty, 2014). Therefore, for the current proposed study a SWM task will be utilized to further examine the connection between yoga and improved spatial memory skills.

A SWM task was chosen instead of a verbal working memory task due to the fact that the current study would be examining the executive functioning of a very young population (preschool-aged children). Verbal memory tasks may be difficult for preschool-aged children to complete due to the development of their own verbal skills. The SWM task used in the current study is simple enough for a preschool-aged child to complete and with the large touch screen that is utilized in the implementation of the task it will be possible to measure children's continuous performance. Therefore, we will be better able to measure the working memory capabilities of our preschool-aged sample on the SWM task in comparison to a verbal memory task, which may be too difficult for this sample of children to complete. Given the connection between attention and spatial

memory, and the success of implementing a SWM task in a young population, it will be hypothesized that participating in a yoga intervention should improve spatial memory.

Lastly, a great amount of research that has examined the impact of yoga on children's attention has utilized parental or teacher report measurements. Therefore, in the proposed study I will be utilizing a parental measurement of children's social and emotional behaviors (Devereux Early Childhood Assessment (DECA), Devereux Student Strengths Assessment (DESSA) (Lebuffe & Naglieri, 1999, Lebuffe, Shapiro, Naglieri, 2009) as well as a parental measurement of children's effortful control (Childhood Behavior Questionnaire) (Goldsmith and Rothbart, 1991). Although these types of reports or questionnaires are valid and important measurements of perceived behaviors, they still may not directly assess the actual behaviors that the child is able to accomplish. Through the use of behavioral measures in the current study, I will be able to expand upon research that utilized parental or teacher reports to examine the observed executive function abilities of these children.

I hypothesize that the children in the study who participate in the yoga intervention will show larger increases from pre to posttests in three levels of executive functions (attention, inhibition, and spatial working memory) than the children in the comparison group. My second hypothesis is that parents of the yoga intervention group will report more positive changes in their child's social-emotional development, as well as their effortful control behaviors, from pre to posttest relative to the comparison group.

Because the current study will examine a typically developing population of preschool and school-aged children, we will be able to determine if yoga helps improve

attention and executive functioning in these children. This line of research could lead to future research that would examine the practice of yoga as a possible intervention method for children in order to help them improve their executive functioning. This future research topic could help improve the way we think about the treatment of attention disorders, where intervention methods like the practice of yoga may be viewed as another option instead of relying a great deal on the use of medications.

CHAPTER 2

Methods

Design

Children in our study were placed into two intervention groups. Our experimental group participated in a yoga course that met for 30 minutes once a week for a 6-week period. Our comparison group participated in a reading intervention where the children read with their parents an extra 30 minutes a week (relative to their usual amount of reading) for a 6-week period. Children in both groups were measured on their executive functioning skills (attention, inhibition and spatial working memory), their social-emotional development (initiative, self-control, attachment, goal directed behavior, self-management, social awareness and relationship skills) and effortful control skills (attention focusing, attention shifting, and inhibitory control) one week prior to their interventions starting and one week after the interventions ended. Follow-up phone calls were completed four weeks after the end of the intervention to once again measure the children's social emotional development, and effortful control as well as to ask the children's parents additional questions regarding his or her child's experience in each of the interventions.

Participants

Six 4-year olds and 6 5-year-olds made up our preschool-age experimental group, while 6 6-year olds, 3 7-year olds and 5 8-year olds made up our school-age experimental group. Seven four-year olds and 5 five-year olds made up our preschool comparison group, while 2 6-year olds, 7 7-year olds and 5 8-year olds made up our school-age

comparison group (see Table 1). One 4-year old male child from the preschool experimental group dropped out of the study due to no longer being interested in participating in the yoga course. This participant's data were not included in the current study. Participants in this study were recruited through advertisements issued through the Lincoln Yoga Center, the University of Nebraska-Lincoln, and through numerous preschools and elementary schools throughout the city of Lincoln. The majority of the sample were Caucasian (81%), 7% were bi-racial, 6% were African American, 4% were Asian, and 2% did not report race/ethnicity. No parent reported that their child was experiencing any serious medical conditions.

Table 1

Sample Descriptives.

Sample	Intervention	Age Group Total	Mean Age	Sex
Preschool	Yoga	Age 4: 6 Children	*M*= 4.33 years, *SD*= .31 years	1 Male 5 Females
Preschool	Yoga	Age 5: 6 Children	*M*= 5.57 years, *SD*= .33 years	4 Males 2 Females
Preschool	Reading	Age 4: 7 Children	*M*= 4.52 years, *SD*= .37 years	5 Males 2 Females
Preschool	Reading	Age 5: 5 Children	*M*= 5.33 years, *SD*= .25 years	2 Males 3 Females
School-Aged	Yoga	Age 6: 6 Children	*M*= 6.58 years, *SD*= .37 years	2 Male 4 Females
School-Aged	Yoga	Age 7: 3 Children	*M*= 7.28 years, *SD*= .34 years	2 Males 1 Female
School-Aged	Yoga	Age 8: 5 Children	*M*= 8.38 years, *SD*= .13 years	3 Males 2 Females
School-Aged	Reading	Age 6: 2 Children	*M*= 6.72 years, *SD*= .34 years	1 Male 1 Female
School-Aged	Reading	Age 7: 7 Children	*M*= 7.49 years, *SD*= .32 years	4 Males 3 Females
School-Aged	Reading	Age 8: 5 Children	*M*= 8.48 years, *SD*= .21 years	3 Males 2 Females

Apparatus

All three of the computerized tasks utilized in this study (Continuous Performance, Spatial Memory Task, and Flanker Task) used a large 29in x 42in (74cm x 107cm) liquid crystal display (LCD) computer monitor (Sharp, Inc). The monitor was tilted 15 degrees from horizontal. The LCD monitor has a resolution of 1024 x 760 pixels. The LCD monitor also has a touchscreen overlay (Smartboard) that reacts to the touch of a stylus. Children used a stylus during the Spatial Working Memory Task, the letter d and the letter l on a standard computer keyboard for the Flanker Task, and the spacebar during the Continuous Performance Task.

A video camera was used to record three out of the six yoga classes (the first class, the third class and the sixth class). The video was examined to better understand the elements that make up the yoga instruction and the children's reaction to the practice.

Participants practiced the spatial memory computerized task by using flashcards. Two flashcards were used, where one was a distracter target (yellow dot) and the other flashcard was a target (spaceship).

Procedure

Children in the experimental group participated in a yoga course called the "Take-5 Yoga Program," which was designed by a certified yoga instructor in Lincoln, Nebraska. The program's mission is to help address and manage childhood obesity, stress, self abuse, bullying, and violent behavior through helping children learn to self-regulate their behaviors and emotions and navigate their environment (Palmquist, 2013).

The Take-5 yoga curriculum incorporates the three main areas of the practice of yoga including breathing techniques, meditative techniques, and the use of physical postures. The course was designed to be age appropriate. For example, child friendly terms were used to explain the yoga poses (e.g. the use of animal names to describe the posture of certain poses). Children were asked to complete a number of different tasks within five-minute increments that make up these core areas. First, children spent 5-minutes practicing breathing techniques, followed by five minutes of exercise and movement (physical postures), next meditative techniques were practiced through five minutes of drawing or journaling, five minutes of concentration and quiet time, and five minutes of contact (talking and touch). The course took place over a six-week period. The class met once a week at the yoga studio of the instructor who designed the course. Therefore, the children in the experimental group participated in six 30-minute classes throughout a six-week period. The preschool-aged children took the course during the fall, while the school-aged children participated in the course during the spring.

Children in the experimental group were tested at the university laboratory one week prior to the yoga intervention and one week after the completion of the 6-week intervention. Members of the comparison group were also tested twice with a seven-week gap between testing occasions; however, these children did not participate in any form of yoga intervention. Instead the children's parents were given books to take home and were asked to read with their child an additional 30 minutes a week over and above the time they usually spend reading with their child.

An experimenter met with each child and their guardian when they arrived at the university laboratory for their first visit. After consent forms and a demographic information form (including questions related to the families background, and any developmental delays or disorders the child may experience) were completed (see Appendix A), the experimenter told the child about the three tasks. Children then participated in the three computerized tasks: a Continuous Performance Task, a Spatial Working Memory Task, and a Flanker Task. While the child was completing the computerized tasks, the parents of the preschool-aged children filled out the protective factors subscale of the Devereaux Early Childhood Assessment (DECA), and the parents of the school-aged children filled out the Devereaux Student Strengths Assessment (DESSA). Both parents of the preschool-aged children and the school aged children also filled out the Attention Shifting, Attention Focusing and Inhibitory Control subscales of the Child Behavior Questionnaire (CBQ). The child was then scheduled to come back to the laboratory in approximately seven weeks to participate in a second session (after the experimental group completed their yoga intervention). The procedures for the second session were the same, except the consent form and demographic information form did not need to be filled out again.

A follow-up phone call was made to the parents of preschool-aged children who participated in the study four-weeks after the intervention when parents were asked questions from the DECA and the CBQ as well as additional demographic information (information regarding the socio-economic status of the family). Open-ended questions for parents of the preschool-aged children who participated in the intervention regarding

the child's experience with the yoga class (e.g. if the child talked about the yoga class or practiced yoga at home, and if their child seemed to enjoy the yoga course) were also asked (See Appendix B). Parents of preschool-aged children in the comparison group were also asked questions regarding the additional reading time they participated in with their child (e.g. did the child seem to enjoy the extra reading time they participated in each week).

Measurements

Continuous Performance Task. Children in this study participated in a Continuous Performance Task (CPT) designed by Wiebe and colleagues (2010). A Continuous Performance Task assesses components of attention in both adults and children. A Continuous Performance Task also measures an individual's ability to detect and respond to specific stimulus changes occurring infrequently at either fixed or random intervals over a prolonged period of time, while simultaneously inhibiting responses to extraneous stimuli (Corkum & Siegel, 1993). In each trial of the CPT, children saw either a fish or a shark on the monitor. Children were asked to press a spacebar to "catch a fish" when they saw a fish on the screen, and if they were too slow the fish would "get away." The researcher also instructed the child not to press a spacebar (i.e., "let the shark swim away") when a shark came on the screen. The task consisted of a maximum of 60 trials where 14 required a go response (fish) and 46 required a no go response (sharks).

Flanker Task. Children also completed a Flanker task (an adaption of Rueda et al., 2004) as a measure of inhibition. The target of a horizontal row of five pigs appeared across the screen. The children needed to "help the pigs find their way home." In order to

help the pigs, the child needed to know who the "leader" of the pig group was in order to know which direction they should tell the pigs to go to get home. If the pigs were pink in color, they would need to tell the pigs to go in the direction that the outside pigs were facing. If the pigs were green in color they would need to tell the pigs to go in the direction that the middle pig was facing. Children were asked to name what color the pigs were during the explanation of the game to make sure that they were able to recognize both of the colors. Children pressed either the letter d or the letter l on the keyboard in order to express which direction the leader pig was facing. Children pressed the letter d if the leader pig/pigs was facing towards the left and the letter l if the leader pig/pigs faced toward the right. The task consisted of (a) congruent trials, where all of the pigs faced the same direction , or (b) incongruent trials where the leader pigs pointed in the opposite direction of the other pig/pigs. Children completed 48 trials, where each trial consisted of one of 8 conditions (congruent left facing pink pigs, congruent left facing green pigs, congruent right facing pink pig, congruent right facing green pig, incongruent left facing pink pig, incongruent left facing green pig, incongruent right facing pink pig, and incongruent right facing green pig) in equal proportions. The differences between this measurement and that of Rueda and colleagues' (2004) includes that our measurement did not include a neutral trial (a picture of just one animal that would show up on the screen), we also did not use a cue screens prior to the picture of the target or measure reaction times based on different cue trials, lastly we also used different colors of animals in order to create another inhibition element to our task by making the children remember

which animal leader needed to be followed based on the color of the animals while inhibiting their response to follow the non-leader animal/animals.

Spatial Memory Task. The Spatial Memory Task (Schutte, Keiser, Fleharty, & Espy, 2014; Schutte & Spencer, 2002) was used to measure the children's ability to remember the location of a target (i.e. spaceship), while ignoring a distractor (i.e., yellow dot) that periodically appeared on the computer screen. The children played a game that involved "finding a lost spaceship." The child used a stylus to point to the location of the target. Prior to the game the experimenter went through a flashcard warm up game to familiarize the child with the task. One card had a picture of the target (spaceship); the second card had a yellow dot on it, which represented the distracter. The experimenter told the child to ignore the yellow dot and to remember which card displayed the picture of the target. The experimenter then placed the flashcards face down on the floor and the child needed to wait for the experimenter to say "Go, Go, Go" before they pointed to the target location with the stylus. The child then completed two warm-up trials before moving on to the actual game.

The game started with a demonstration trial that was performed by the experimenter. The demonstration trials helped familiarize the children with the game so they would know what to expect. The demonstration trial was exactly the same as the test trials. After the demonstration, the child completed two practice trials followed by the test trials. Each trial began with the phrase, "Let's look for a spaceship"; the target then appeared for 2000 ms and disappeared. When the computer said "Go, Go, Go," the child

pointed to the target location with the stylus. The computer then gave feedback indicating how close they were to the target.

Following the demonstration trial, the child completed two practice trials and 24 test trials. In these trials, children responded to one of two target locations. One target appeared 40° to the right of the midline symmetry axis of the monitor (40° from midline) and the other target appeared 20° to the left of midline (-20° from midline). The children responded to the desired target location after delays of 100ms, 5s and 10s. During half of the 5 and 10s delays a distracter target appeared at a location 20° from the target location. For the -20° target, the distracter appeared at either -40° or 0°. For the 40° target the distracter appeared either at 60° or 20°.

Devereux Early Childhood Assessment (DECA) Protective Factors Scale. Parents of the preschool-aged children filled out the protective factors scale of the Devereux Early Childhood Assessment (DECA) (Lebuffe & Naglieri, 1999). The protective factors scale of the DECA is designed to assess the ability of a preschool child (ages 2 years through 5 years) to think and act independently (initiative), experience a range of emotions and to express these emotions in appropriate ways (self-control), and to examine whether there is a strong positive social bond between the child and adult (attachment). Parents filled out the questionnaire based on the frequency of their child's behavior during the past 4 weeks at both the pre and posttest, and during a follow-up phone call. Therefore, they were asked to think back to the four weeks prior to the intervention, the four weeks of the intervention, and the four weeks after the intervention in order to fill out the questionnaire. The questionnaire is based on a five-point scale

ranging from "Never" to "Very Frequently". The internal reliability was determined by using Cronbach's alpha. The internal reliability of the protective factors parent scale, which was utilized in this study was .91. The range for individual subscales that were utilized in this study is as follows: .84 for the initiative subscale; .86 for the self-control subscale; and .76 for the attachment subscale. The average T-score for the measurement is 50 with a standard deviation of 10 (Lebuffe & Naglieri, 1999).

Devereux Student Strengths Assessment. Parents of the school-aged children completed the Devereux Student Strengths Assessment (DESSA) (Lebuffe, Shapiro, Naglieri, 2009). The DESSA is a 72-item, standardized, non-referenced behavior rating scale that assesses the socio-emotional competencies for children who are in Kindergarten through Eighth Grade. The DESSA includes eight scales; self-awareness, social awareness, self-management, goal-directed behavior, relationship skills, personal responsibility, decision-making, and optimistic thinking. For the purpose of the current study only the following subscales were examined: goal-directed behavior, self-management, social awareness and relationship skills. Parents filled out the questionnaire based on the frequency of their child's behavior during the past 4 weeks at both the pre and posttest (the four weeks prior to the intervention, and the four weeks of the intervention). The questionnaire is based on a five-point scale ranging from "Never" to "Very Frequently". The internal reliability was determined by using Cronbach's alpha. The internal reliability of the DESSA ranged from .79 to .90. The Cronbach's alphas for each of scales that were examined in this study are as follows: .88 for goal directed

behavior, .86 for self-management, .84 for social awareness, and .89 for relationship skills. The average T-score for this measure is 50 with a standard deviation of 10.

Child Behavior Questionnaire. Parents of both the preschool-aged and school-aged children filled out the Child Behavior Quesitonnaire's Attention-Focusing, Attention Shifting, and Inhibitory-Control subscales as a way to evaluate their effortful control (Goldsmith and Rothbart, 1991). The Attention-Focusing subscale assesses a child's ability to concentrate on a given task. The Attention-Shifting subscale measures the child's ability to shift attention from one item to another. Lastly, the Inhibitory-Control subscale is used as a way to measure the ability of a child to control his or her behavior. Parents were asked to fill out the questionnaires over their children by rating each item on a 7-point scale (1-never; 7-always) at both the pre and posttest, and for the parents of the preschool-aged group during a follow-up phone call (four weeks after the intervention). Reliability estimates for this measurement were determined using Cronbach's alphas. The Cronbach's alphas for this measurement range from .67 to .94.

CHAPTER 3

Design, Data Analysis, and Results

Design and Data Analysis

In order to examine the impact of a yoga intervention on young children's executive functioning, we first wanted to better understand how our intervention was perceived. Therefore, a short video analysis was conducted as a way to examine the behaviors of the children as they participated in the yoga intervention and determine whether or not the children seemed to enjoy the exercises that were taught to them during the yoga course. Additional follow-up questions were also conducted in a phone interview format with the parents of both the preschool-aged yoga intervention group and the preschool-aged reading intervention group. The follow-up interview was done in order to gather parents' opinions about whether or not their child/children enjoyed the interventions and if they felt that the interventions impacted their child/children's everyday behaviors. To examine the question of whether exposure to a yoga intervention had an impact on young children's executive functions, I conducted a linear mixed model analysis with repeated measures for each of the scores of the three different cognitive measures (continuous performance task, spatial working memory, and flanker task). Intervention was a between-participants variable and time was a within-participants variable. For these analyses I utilized the Proc Mixed procedure in SAS. The Proc Mixed procedure is used to analyze mixed models and repeated measures by structured covariance models. This procedure allows you to model the means of your data, and the variances and covariances as well (SAS Institute Inc., 2011).

Signal detection theory was used to analyze children's accuracy in the CPT (Wiebe et al., 2011). Signal detection theory models the decision making process for someone deciding between two different classes of items. A "hit" occurs when a signal is present and the individual correctly identifies the signal (i.e. in the CPT task when a fish appears and the child correctly presses down the spacebar in order to "catch" the fish). A "false alarm" occurs when a signal is absent and the person identifies the signal as being present (i.e. when a shark appears and the child incorrectly presses the spacebar) (Wiebe et al., 2011). Measures are derived from the relationship between the signal present and the signal absent distributions.

D prime is the standardized difference between the means of the signal present and the signal absent distributions. Thus, d prime is a measure of the distribution of the sensitivity between a signal present and a signal absent response. Specifically, if a person is more sensitive to a signal, meaning they are more accurate, the difference between the two distributions is larger in comparison to a person who is less sensitive to a signal. The d prime of an individual takes into consideration both a person's hit and false alarm rates in one score. Those who have very high hit rates (e.g., .90) and low false alarm rates (e.g., .10) would receive a higher d prime score than those who have both a high hit rate (e.g., .90) and a high false alarm rate (e.g., .90). Likewise, an individual who has both a low hit rate (e.g., .10) and a low false alarm rate (e.g., .10) will have a low d prime score.

In this study, d prime will be calculated for the CPT using the z scores of the right tail p-values of the child's hit and false alarm rates. The following formula will be used to calculate each child's d prime score: $d' = z(\text{FA}) - z(\text{H})$ (Wiebe et al., 2011). For example,

if a person has a hit rate of .80 (H) and a false alarm rate of .30 (FA), his or her d prime score would be 1.37.

I also analyzed children's reaction time on their correct "go" trials. I used a linear mixed model for the analysis of the CPT with children's reaction time as the dependent variable. I analyzed the main effects of intervention, age group, time, and any possible interactions.

For the Flanker Task (adaption of Rueda et al., 2004) I completed a linear mixed model with mean reaction time on correct trials as the dependent variable for each subject. The children's reaction time was computed in milliseconds for the analysis. I analyzed the main effects of intervention, age group, time, and any possible interactions for each flanker type (congruent and incongruent). I analyzed the main effects of intervention, age group, time, and any possible interactions for each flanker type (congruent and incongruent).

In the data analysis of the Spatial Memory Task (Schutte, Keiser, & Fleharty, 2014; Schutte & Spencer, 2002) I utilized linear mixed models where mean direction error and mean distance error were treated as the dependent variables. I analyzed the main effects of intervention, target, distractor, age group, time, and all possible interactions.

T-scores were used to examine the Devereux Early Childhood Assessment (DECA) protective factors scale (Lebuffe & Naglieri, 1999) with a mean of 50 and a standard deviation of 10. T-scores between 41 and 59 are considered average for the three subscales (initiative, self-control, and attachment). A linear mixed model was used to

examine the differences in these three subscales from pre to post to follow-up test. Main effects of intervention and time as well as all possible interactions were examined.

T-scores were used to examine the Devereux Student Strengths Assessment DESSA (Lebuffe, Shapiro, Naglieri, 2009) with a mean of 50 and a standard deviation of 10. T-scores between 41 and 59 are considered average for the examined subscales (goal directed behavior, self-management, self-awareness, and relationship skills). A linear mixed model was used to examine the differences in these four subscales from pre to posttest. Main effects of intervention and time as well as all possible interactions were examined.

A linear mixed model was used to examine the difference in the three subscales (attention-focusing, attention-shifting, and inhibitory control) of the Child Behavior Questionnaire (CBQ) (Goldsmith and Rothbart, 1991) from pre to posttest. Main effects of intervention, age group, time as well as all possible interactions were examined.

Research Hypotheses. Because the yoga intervention covered all aspects of yoga (postures, breathing techniques, and meditation), which in past research have been shown to have positive impacts on cognitive functions (Abadi, Madgaonkar, & Venkatesan, 2008; Manjunath and Telles, 2004; and Prakash et al., 2010), it is hypothesized that the children who participate in the yoga intervention will show larger increases from pre to posttest in all three areas of executive functions. The following hypotheses will be tested:

H1a: Children participating in the yoga intervention will demonstrate improved performance on the continuous performance task (measurement of attention) as measured by d prime scores.

H1b: Children participating in the yoga intervention will demonstrate improved performance on the continuous performance task (measurement of attention) as measured by reaction time.

H1c Children participating in the yoga intervention will demonstrate improved performance on the flanker task (measurement of inhibition) as measured by reaction time.

H1d: Children participating in the yoga intervention will demonstrate improved performance on their spatial working memory task (measurement of spatial working memory) as measured by error direction.

H1e: Children participating in the yoga intervention will demonstrate improved performance on their spatial working memory task (measurement of spatial working memory) as measured by error distance.

The second hypothesis is that parents of the yoga intervention group will report more positive changes in their child's social-emotional development relative to the comparison group from pre to post to follow-up test as measured in the four and five-year-olds by the Devereux Early Childhood Assessment protective factors scale (Lebuffe & Naglieri, 1999) and from pre to posttest as measured in the six to eight-year-old children by the Devereux Student Strengths Assessment (DESSA) (Lebuffe, Shapiro, Naglieri, 2009). The following hypotheses will be tested:

H2a: Preschool-aged children parents of those participating in the yoga intervention will report higher levels of social/emotional development after

participating in the intervention as measured by the Devereux Early Childhood Assessment (DECA).

H2b: Parents of school-aged children participating in the yoga intervention will report higher levels of social/emotional development after participating in the intervention as measured by the Devereux Student Strengths Assessment (DESSA).

The third and final hypothesis is that parents of the yoga intervention group will report more positive changes in their child's effortful control behaviors (attention focusing, attention shifting, and inhibitory control) from pre to posttest relative to the comparison group as measured by the Child Behavior Questionnaire (CBQ) (Goldsmith and Rothbart, 1991). The following hypothesis will be tested:

H3: Parents of children who are participating in the yoga intervention will report higher levels of effortful control displayed by children after completion of the intervention as measured by the Child Behavior Questionnaire (CBQ).

Results

Yoga Course Video Observation: Preschool Course. Three of the six classes from the preschool-aged yoga course were video recorded as a way to review the course and to gain a better understanding of the curriculum, the children's reactions to the practices being taught, and the children's behaviors throughout the course. The three classes that were video-taped included the first, third, and sixth yoga classes.

For the first class the yoga instructor utilized an introductory lesson in order to get the children comfortable with the concepts that would be examined in upcoming classes.

The class started out with the children being asked to share their name as well as an animal with a name that matched the first letter of their own name (e.g., Cassie, Cat). This was done in order to help the other children in the course learn each other's names. The children also went around and shared how they were feeling on that day. The instructor demonstrated two types of breaths that could be utilized by the children (breathing in and breathing out) to display the emotion that they were feeling. When a child shared a positive emotion (feeling happy) the children practiced "breathing in the emotion." When a negative emotion was expressed (feeling sad) the children practiced "breathing out the emotion." When a child was unsure how he or she felt, the children put one hand on their chest and one hand on their stomach and practiced breathing in and out. This was done to display that if a person is feeling unsure of his or her emotion the children could check in with themselves and what they are feeling on the inside to better understand their emotions.

In the next part of the class children participated in a number of different yoga poses (cat and cow, cobra, and volcano). The instructor first demonstrated each pose for the child and then the children completed the poses on their own. Next, the children practiced breathing exercises along with the poses (breathing in and out). The instructor then taught a few more breathing exercises to the children including breathing while making a buzzing noise with their throat (the buzzing bee) and breathing out for a long extended period of time (lion's breath). As a way to better understand the way breathing works the instructor also had the children lay their head on another child's stomach as that child breathed in and out. The child could then feel his or her head move up and

down as his or her friend breathed in and out. As a last breathing exercise the instructor handed out Kleenexes to the children and had them hold it out in front of their nose. The children were then asked to breath out quickly and as they did so they could see that the tissue moved as a result of their breath. This exercise displayed how breathing works and how it influences other things.

Lastly, the instructor dimmed the lights and had the children lay on their backs with their hands on their stomach and their eyes closed. The children were then asked to take five breaths in and out. This was done as a relaxation exercise and was a reflection of the meditative aspect of yoga.

The children during this class were very attentive. They paid close attention to the instructor as she was describing each exercise and mimicked the poses and breathing exercises that she demonstrated. There was only one child who was not actively participating in the exercises (he was later removed from the study due to him not wanting to participate further in the course). Children seemed to really enjoy all of the practices that were completed during this first class especially some of the breathing exercises (laying their head on a friend's stomach) as well as the postures. The children's enjoyment was noticeable due to their big smiles and consistent laughter throughout the exercises.

During the third yoga class the main yoga instructor was out of town and another certified yoga instructor conducted the class. During the start of the class the instructor asked the children what were some things they had completed in the previous two courses. She then had them sit up tall and practice their breathing (breathing in and out).

Next, the children stretched and participated in a number of different poses that they had learned during the first two yoga courses. The instructor led the children in the poses and reminded the children how to complete the poses if they forgot. The majority of this course included the children practicing their poses along with reminding them to use their breathing during the poses. The teacher instructed the children when to breath in and when to breath out during each pose.

Next, the instructor moved on to the meditative aspect of the course. She dimmed the lights and had the children lie on their back and close their eyes and "imagine that they were riding on a cloud." The instructor then suggested things that they might see as they were "flying on their cloud." For example the instructor said things such as "you have come to a beach, what do you see?" About seventy-five percent of the children would shout out things that they might see on a beach or things that they were imagining during this exercise, while the other 25 percent simply laid quietly during the exercise. After this imagery exercise the instructor then handed out a paper with a big cloud drawn on it. The children were asked to journal through drawing what they saw during the cloud exercise. Children drew things such as sand on the beach, water, and sea animals/creatures. Therefore, all of the pictures that were made by the children were of positive things that could be seen on a beach. After the children were finished drawing they shared what they drew with the others in their class. The children and the instructor then reflected together about how drawing made them feel (happy) and the instructor reminded the children that if coloring makes them happy this is something they could then do if they were feeling sad.

Children during this course were also very attentive. At times they were also very talkative, but this did not seem to disrupt the class in any way and in fact talking was encouraged during many parts of this class. This was particularly true during the meditative cloud exercise. The children were more comfortable in completing the poses and exercises in comparison to the first recorded class, as displayed by the children being better able to get into the poses and imitate the poses that were displayed by the instructor.

During the sixth class and final class of this course, the children participated in a number of different stations that represented the main components of a yoga practice (breathing, physical postures, and meditation). During the breathing station the children practiced breathing exercises using a number of different tools/toys (e.g. noise makers, balloons). When they were using these tools the instructor talked with the children about how their breath impacted the tools (e.g. when you breath out hard the balloon blows up).

Next, the children moved to the posture station where they practiced the yoga poses that they learned throughout the course. During this practice the children also worked on breathing in and out as they completed the poses. Lastly, the children completed the meditation station. During this station the children examined a jar that was filled with water and glitter. The instructor shook the jar up and shared that the spiraling and floating glitter is like the feelings that we have sometimes in ourselves and in order to settle ourselves down we need to find ways to express our energy in a positive way (through movement, breathing, or concentration). The children then were asked to lie down and close their eyes and again pretend that they were "floating on a cloud." At the

end of the course the instructor reminded the children of things that they could do when they became frustrated, angry, or antsy which included things such as: moving around, breathing, talking about it, or using coloring as a way to reflect their thoughts.

The children during this class were very rambunctious. There were many times when the instructor had to pause during the lessons in order to allow the children time to regain attention. There were also a number of behavioral issues that were displayed during this class including children not following instructions, running around when they were not supposed to, and getting into others' personal space. At one point two young boys were asked to sit out of the class for a while until they were able to follow instructions and behave properly. These issues made it challenging for the instructor to cover all of the material that was part of this class and the children seemed to not participate fully in all aspects of the lesson. The children's behaviors may be due to the fact that this was their final class and the activities that were planned for that day were particularly exciting for them (e.g. playing with the toys during the breathing exercises) and therefore they had a harder time handling their excitement.

Yoga Course Video Observation: School-Age Course. Three of the six classes of the yoga course taught to the school-aged children were also video recorded as a way to review the course and to gain a better understanding of the curriculum, the children's reactions to the practices being taught, and the children's behavior throughout the course. The three classes that were video-taped once again included the first, third, and sixth yoga classes. The first yoga class concentrated a great deal on the physical postures of the yoga practice. The class started with the children practicing a number of different poses

(e.g. tree, cat and cow, frog, star). As the children were participating in the poses the instructor discussed what part of their body they were using during the pose for example in the tree pose the children stand on one foot while lifting the other foot and resting it on the side of their upper leg.

Next, the children participated in a number of breathing exercises. One exercise included having the children placing one hand on their heart and another on their belly and feel their breath go in and out while they also felt their heart beat. The instructor also had the children sit on their bottoms on their mats where they made sure their posture was straight up and down and then had them complete five breaths in and out. When they breathed in they were supposed to pay attention to the way that their belly filled up with air and as they breathed out they were supposed to notice how their belly was sucked in.

The children moved on to do a number of different yoga poses where they were supposed to also concentrate on their breath as they were conducting the poses (e.g. warrior, triangle, tree, sun salutations). The children also completed a meditation exercise where the instructor had them touch their fingers together one at a time and count to five. During this meditation exercise she also had the children concentrate on their breath by breathing in and out five times. Following this, the instructor had the children complete a few additional meditative poses including "dead bug" where the children laid on their back and lifted both their arms and legs into the air. She also had them complete another breathing exercise called buzzing bee (mentioned above). Lastly, the class ended by having the children complete a relaxation practice where the children laid on their back and pretended that they were part of the earth. The instructor had the children close their

eyes and imagine floating on a cloud flying over the city and asking them to imagine what it would look like to fly over different parts of the city (e.g. their school, their home, the yoga studio). This exercise was the same cloud exercise that was used in the preschool course.

The children during this class were very attentive and actively participated in all of the poses, breathing, and meditative exercises that were introduced by the instructor. The children appeared to be eager to learn, which may be in large part due to the fact that for many of these children this was the first yoga class that they ever participated in. Only one 6-year-old boy was a little fidgety during the class and at times was not following along or was not participating in what he was supposed to be doing. However, he did not seem to hinder the other children in the class from completing their yoga practice.

During the third yoga class the original instructor was out of town and another trained yoga instructor taught the class. The class started out with a breathing exercise where children pretended that they were holding a flower and smelling the fragrance of the flower. This got the children to practice breathing in and out through their nose. The instructor then had the children work on their postures including a large number of poses that the children had practiced in the last two classes and a few new poses (e.g. cat and cow, frog, down dog, star pose, sun salutations, happy elephant, warrior pose). During each of these poses the instructor had them practice breathing in and out.

Next, the children completed breathing exercises including the buzzing bee and also simply having the children run in place. After the children completed these exercises the instructor had them place one hand on their heart and the other on their belly and feel

how their breath was moving. She also had them breath in and out on their own and feel the way that their belly moved. The instructor then had the children participate in a combined meditative and physical posture exercise where she had the children pretend they were on a surfboard. The children started by lying on their stomachs and then jumped up into a sideways squat when it was time to "catch a wave." During this exercise the instructor had the children imagine what they might see as they were surfing (e.g. seals, sharks, crabs) and then had them complete a pose that resembled that animal. For example, if the children saw a seal they laid flat on their stomachs with their arms to their side and lifted their head slowly to bark like a seal.

Lastly, the children completed a few relaxation poses while on their back. For example the children stretched out their legs and backs by doing the rock and roll pose, where they rolled on their spine from their head to their feet. The instructor then had them go completely into a relaxation pose where they silently laid on their back and closed their eyes for a few minutes of total silence.

During this class the children were once again very attentive and actively participated in the poses, breathing, and meditative exercises. The children seemed to really enjoy the substitute instructor and often felt that her descriptions of the poses were humorous. For example, the children laughed and smiled a great deal when this instructor taught them the seal pose where she not only showed the pose, but also barked like a seal herself. Through their laughter and smiles you could tell that they felt the instructor was "silly" and that they themselves were having a fun time doing the exercises. Once again the 6-year-old boy who was mentioned in the first class was still a little fidgety and

towards the end of the class the children got a little silly and stopped paying attention to the relaxation exercise. For example, one child began to giggle and make loud noises and after awhile other children began to mimic this laughter, which resulted in a lack of participation in the relaxation exercise. This lack of attentiveness could be due to the fact that this class went a little long and surpassed the usual thirty minutes of allotted time.

During the sixth and the final class of this course the instructor had the children start the class with a breathing exercise where they breathed in and out five times. She then had the children complete a number of physical postures for a total of five seconds each (e.g. cobra pose, cat and cow, down dog, happy elephant, child pose, rock, rock and roll, butterfly). After the series of physical poses the children alternated between breathing exercises including placing one of their hands on their heart and the other on their belly in order to feel their breath, the buzzing bee, and lions breath (breathing in, opening your mouth wide and breathing out) and physical postures (e.g. star, frog, happy baby, sun salutations, chair pose, rocking chair).

Next, the instructor opened up a discussion with the group about the techniques that they learned during the yoga course and had the children shout out what their favorite thing they learned was. Many children mentioned physical poses including: star, happy elephant, rock and roll, warrior, tree pose and volcano. Other children mentioned some of the breathing techniques, including breathing in and out five times, and a couple of children mentioned the act of meditating as something that they liked. Therefore, the children mentioned all three of the main elements of a yoga practice as being something that they enjoyed.

Lastly, the children participated in a meditative exercise where they were each given an LED candle whose "flame" changed to different colors. The children were asked to pick one of the colors (e.g. blue, red, green) and count how many times the flame changed to that color. This allowed the children to bring their focus to a single object. At the end the children shared how many times they counted their specific color. Next, the children were led through a guided imagery exercise where they laid on their backs and imagined laying in a shallow river with water rushing over their legs and arms. The children were then asked to imagine that the sun came up and washed the water away. This was representative of washing away the troubles of the day and starting new. At the very end of the class the children were given a special toy to take home, which was a Chinese finger trap. This toy was used to represent how at times when we are frustrated that staying frustrated can make our situation harder (if you put your fingers in the trap and panic it is harder to get your fingers out of the trap); however, if you can think of ways to remain calm it is easier to handle the situation that you are in (if you calm down and take your time it is much easier to get your fingers out of the trap).

The children in this class were a little more energetic, and talkative, which was probably due to the fact that this was the last class that they would be participating in and due to the fun activities that the instructor had planned for the day (e.g. the meditative candle exercise, and the Chinese finger traps). However, the children were still actively following along to the practices and there did not seem to be any trouble with children not participating or with certain children distracting others from their practice.

Follow-up Questions. Follow-up questions were asked to the parents of our preschool sample four weeks after the completion of the yoga and reading interventions. The questions for the yoga group included: "Did your child seem to like the yoga course they participated in?"; "Did they talk at all about aspects of the course with you at home?"; "Did they practice any of the yoga techniques while at home?"; "How often do you usually read with your child?"; and "Did you notice any changes in your child's everyday behaviors since participating in the yoga class?". In regards to the first question, "Did your child seem to like the yoga course they participated in?" 100 percent of the parents responded that their child did enjoy the course. One parent expressed that their child seemed to really enjoy all of the movement that the course provided and the fact that the course was very active.

When asked "Did your child talk at all about aspects of the course with you at home?" 67 percent stated that their child did talk about some aspects of the practice, while 33 percent of parents stated that their child did not mention aspects of the class with them at home. One parent shared that her child talked mostly about the breathing exercises, while another parent said that her child talked about the different exercises (poses) that they did in the class. Another parent stated that her child did not talk about the course or what she learned from the course at home.

When parents were asked, "Did your child practice any of the yoga techniques while at home?" 50 percent of parents shared that their child did practice some of the techniques at home, while the other 50 percent said that their children did not practice the techniques. One parent shared that her child mostly showed them the postures that were

done in class, while another parent expressed that her child did not really show her any techniques, but mostly just talked about the course.

One question that was asked as a way to compare the children in the yoga group to those in the reading group was "How often do you read with your child?". The large majority of parents (75%) reported that they read to their child daily, while the rest of the parents (25%) said that they tried to read to their child at least four days a week.

Lastly, the parents of the children in the yoga group were asked, "Did you notice any changes in your child's everyday behaviors since participating in the yoga class?" The large majority of parents reported that they did not notice any changes in their child's everyday behaviors since attending the class (83%), while the rest of the parents (17%) expressed that they did notice a change in their child's behaviors. For the parents who didn't notice a change, they expressed that the children seemed to be behaving normally and that there was no obvious change in their behaviors. One of the parents who did express that their child displayed a change in their behavior since taking the yoga course expressed that their child "didn't get as frustrated", and another parent shared that their child "has been a little calmer and had less tantrums."

A group of follow-up questions was also given to members of the reading intervention. The questions asked to the parents of the reading group included: "Has your child ever participated in a yoga class?"; "Did your child enjoy reading with you every week?"; "How often do you usually read with your child?"; "Were their any weeks across the 6 week period when you did not read to your child the extra 30 minutes that we requested?"; and "Did you notice any changes in your child's everyday behaviors since

you began to read with them more?" The first question was asked as a way to compare the reading intervention group to that of the yoga group and was: "Has your child ever participated in a yoga class?" The majority of parents (67%) expressed that their child has never participated in a yoga class, whereas (33%) of parents expressed that their child has participated in a yoga class before and in all instances this participation took place at the child's school.

When asked "Did your child enjoy reading with you every week?" 100 percent of parents expressed that yes, their child did enjoy reading the extra time with them each week. The parents were then asked "How often do you usually read with your child?" and 83 percent of parents expressed that they read with their child daily, whereas 17 percent shared that they read with their child a few times each week. When asked "Were there any weeks across the 6 week period when you did not read to your child the extra 30 minutes that we requested?" 83 percent of parents expressed that they were able to complete the extra 30 minutes of reading each week, however, one parent expressed "The extra 30 minutes was hard sometimes, but we were able to do it." Seventeen percent of parents did express that at times they were unable to meet the extra 30 minutes a week of reading.

Lastly, parents were asked "Did you notice any changes in your child's everyday behaviors since you began to read with them more?" Fifty percent of parents expressed that they did notice changes in their child's behaviors whereas 50 percent of parents also expressed that they did not notice any changes in their child's behaviors. For the parents who did notice a change in their child, one parent expressed that they felt that their child

was “more confident when trying to read by himself,” and another parent shared that their child was “better behaved and calmer.” The parents who did not notice a change expressed that no changes in their child’s behavior were “distinctly noticeable.”

Overall, the follow-up questions provided a great amount of insight into how both the yoga and the reading intervention were perceived by both parents and their children. For example, many parents of both the yoga group and the reading group were able to share with us that their child enjoyed completing both the yoga course as well as the extra reading each week. Parents were also able to share with us if their child discussed or displayed any of the techniques that they had learned from the yoga course. A great amount of knowledge was also gained about the everyday activities that these children usually participate in including the amount of reading time completed by the child each week and whether or not they have actively participated in a yoga course before. It also provided information about the impact that each intervention had on the child’s everyday behaviors as perceived by their parent.

Continuous Performance Task. To test Hypothesis 1a that children would perform better on an attention task (continuous performance task) following participation in the yoga course as measured by d prime scores, a linear mixed model with d prime scores as the dependent variable and intervention type (yoga, reading), age group (preschool, school-aged) and time (pre-, post-test) as independent variables was conducted. There were no significant main effect of intervention $F(1,48)=.51$, $p=.48$. There were also no significant interactions with intervention. There was, however, a significant main effect of time $F(1,48)=5.99$, $p=.02$, where children had higher d prime

scores at posttest (*M*=6.44, *SE*=.31) in comparison to the pretest (*M*=5.36, *SE*=.31) (See Figure 1). There was also a main effect of age group $F(1,48)=41.10$, $p<.0001$, where school-aged children had higher d prime scores (*M*=7.30, *SE*=.30) in comparison to the preschool-aged children (*M*=4.49, *SE*=.32).

To test Hypothesis 1b that children would perform better on an attention task (continuous performance task) following participation in the yoga course as measured by reaction times a second analysis was conducted where the same procedure was used except mean reaction time on correct trials was treated as the dependent variable and intervention type (yoga, reading) age group (preschool, school-aged) and time (pre-, post-test) as independent variables. There was no significant main effect of intervention $F(1,76)=.04$ $p=.85$. There were also no significant interactions with intervention. There was, however, a significant main effect of time $F(1,76)=8.03$, $p=.01$, where children had faster reaction times at posttest (*M*=645.55, *SE*=8.86) in comparison to the pretest (*M*=681.75, *SE*=10.66) (See Figure 2). There was also a main effect of age group $F(1,76)=89.93$, $p<.001$, where school-aged children had faster reaction times (*M*=593.00, *SE*=9.42) in comparison to the preschool-aged children (*M*=734.23, *SE*=11.53). Therefore, Hypothesis 1a was not supported because there were no significant effects of intervention.

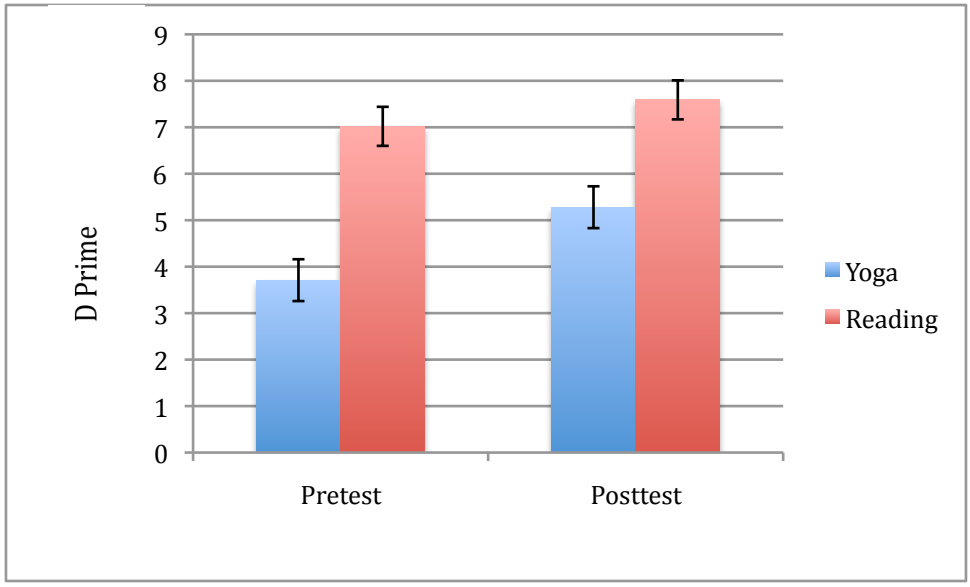

Figure 1. D Prime scores for the continuous performance task at both pre and posttest for members of both the yoga and reading intervention groups. Error bars represent standard error.

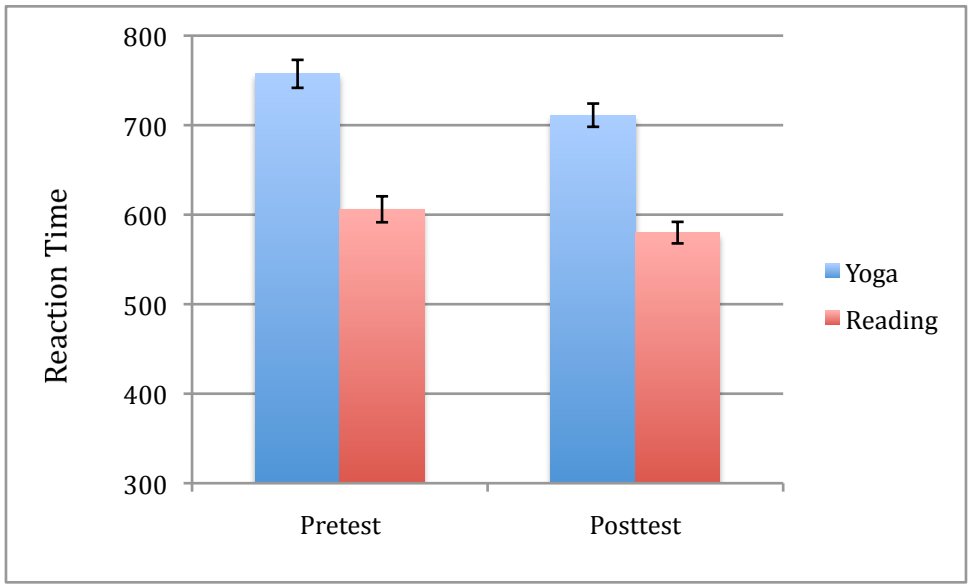

Figure 2. Mean reaction time (ms) for the continuous performance task at both pre and posttest for members of both the yoga and reading intervention groups. Error bars represent standard error.

Flanker Task. To test Hypothesis 1c, that children would perform better on an inhibition task (flanker task) following participation in the yoga course, a linear mixed model was completed with mean reaction time on correct trials acting as the dependent variable and with intervention type (yoga, reading), age group (preschool, school-aged), and time (pre-, post-test) as independent variables for each flanker type (congruent, incongruent). There was a marginal main effect of intervention for congruent trials $F(1,76)=3.60$, $p=.06$ and a significant main effect of intervention for incongruent trials $F(1,76)=5.07$, $p=.03$, where the children in the yoga intervention had faster reaction times ($M=3225.74$, $SE=192.11$) in comparison to the reading group ($M=3741.25$, $SE=192.11$) for the congruent trials. For the incongruent trials members of the yoga intervention also had significantly faster reaction times ($M=3887.12$, $SE=304.06$) in comparison to the reading group ($M=4855.77$, $SE=304.06$). There was also a significant main effect of age group for both congruent $F(1,76)=42.65$, $p<.0001$ and incongruent trials $F(1,76)=44.12$, $p<.0001$. For congruent trials school-aged children had faster reaction times ($M=2596$, $SE=168.92$) in comparison to the preschool-aged children ($M=4370$, $SE=212.78$). For incongruent trials school-aged children also had faster reaction times ($M=2942$, $SE=270.01$) in comparison to the preschool-aged children ($M=5799.48$, $SE=334.66$).

There was also a significant age group by intervention interaction for both the congruent trials $F(1,76)=5.08$, $p=.03$ and incongruent trials $F(1,76)=5.93$, $p=.02$. For the congruent trials the preschool yoga group had faster reaction times ($M=3806.72$, $SE=300.91$) in comparison to the preschool reading group ($M=4934.57$, $SE=300.91$). For the school-aged children the yoga group had slightly slower reaction times ($M=2644.76$,

SE=238.90), in comparison to the reading group (*M*=2547.93, *SE*=238.90). However, in an examination of the simple effects of this interaction, the school-aged effect was not significant $F(1,76)=.08$, $p=.78$. The preschool effect, however was significant $F(1,76)=7.02$, $p=.01$. Therefore, the preschool age yoga group was significantly faster in comparison to the preschool reading group on the congruent trials (see Figure 3). In regards to the age group by intervention interaction for the incongruent trials the preschool yoga group had faster reaction times (*M*=4791.66, *SE*=473.28) in comparison to the preschool reading group (*M*=6807.30, *SE*=473.28). The school-aged yoga group had slightly slower reaction times (*M*=2982.57, *SE*=381.85) in comparison to the school-aged reading group (*M*=2904.25, *SE*=381.85). However, in an examination of the simple effects of this interaction, the school-aged effect was not significant $F(1,76)=.02$, $p=.89$, whereas the preschool age effect was significant $F(1,76)=9.07$, $p=.004$. Therefore, the preschool age yoga group was significantly faster in comparison to the preschool reading group on incongruent trials (see Figure 4). Therefore, Hypothesis 1c was partially supported due to the fact that we were able to see an effect of intervention; however, this effect did not interact with time (pre and posttest), and therefore, this effect may be due to group differences in our two intervention groups.

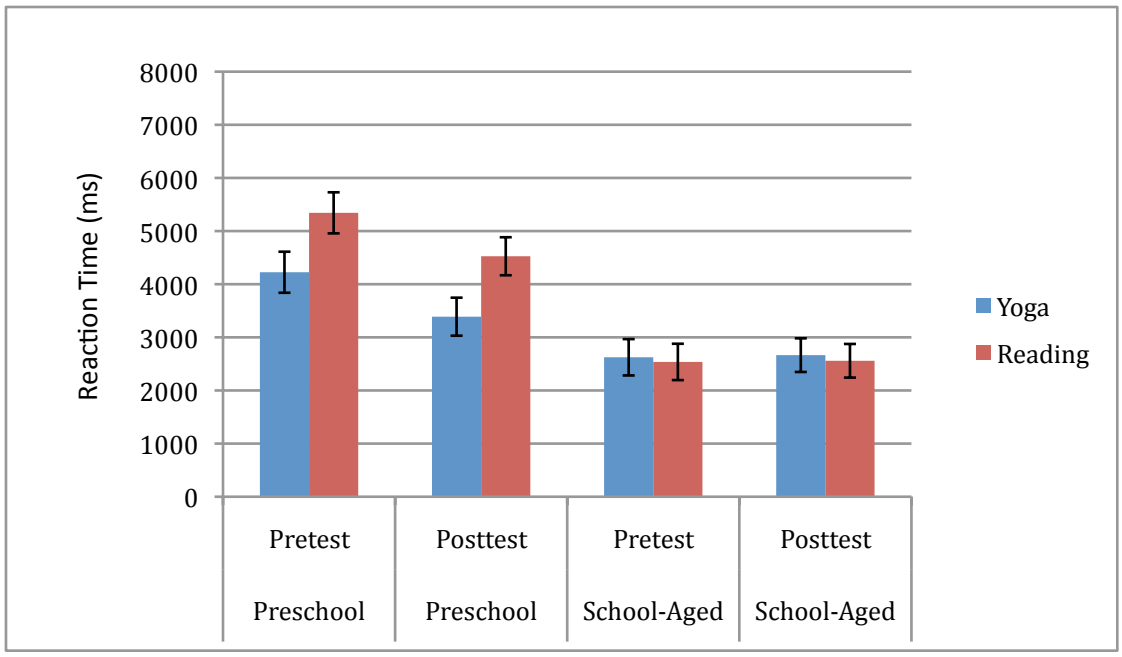

Figure 3. Mean reaction time (ms) for correct congruent trials on the flanker task at both pre and posttest for members of the preschool and school-aged yoga and reading intervention groups. Error bars represent standard error.

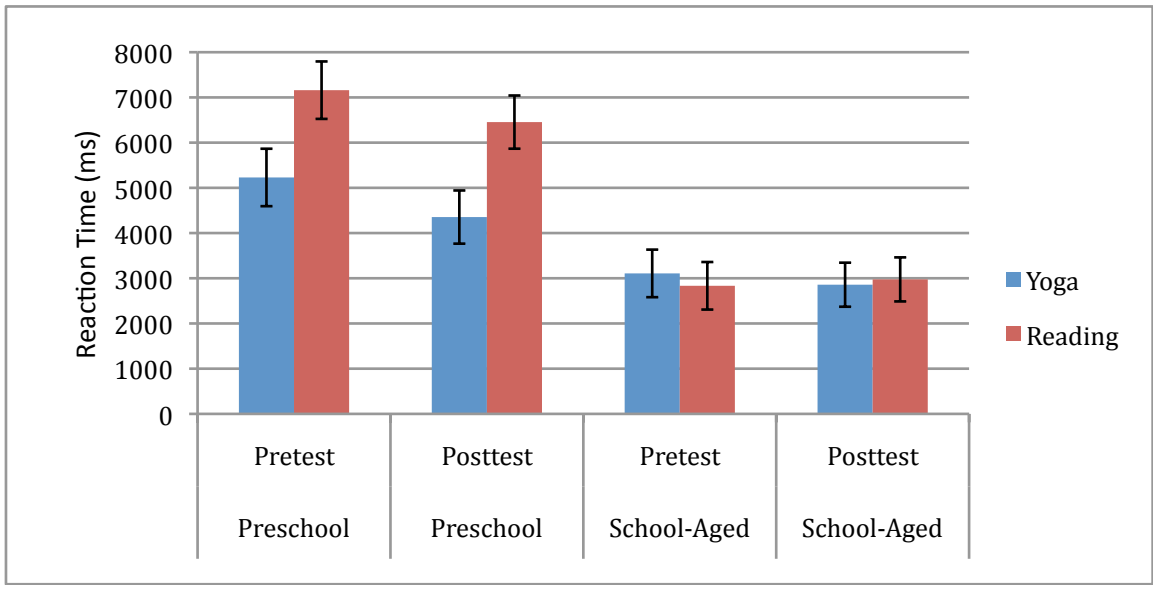

Figure 4. Mean reaction time (ms) for correct incongruent trials on the flanker task at both pre and posttest for members of the preschool and school-aged yoga and reading intervention groups. Error bars represent standard error.

Previous research studies that have utilized flanker tasks showed that children tend to have faster reaction times on congruent trials in comparison to incongruent trials (Rueda et al., 2004). Therefore, a second analysis was completed in order to determine if this was also true for the children in our study. A linear mixed model was completed with mean reaction time on correct trials as the dependent variable and with intervention type (yoga, reading), age group (preschool, school-aged), time (pre-, post-test) and trial type (congruent, incongruent) as independent variables. Only significant effects of trial type will be reported for this analysis. There was a significant main effect of trial type $F(1,52)=12.41$, $p<.001$, where children had faster reaction times on congruent trials ($M=3483.49$, $SE=178.23$) in comparison to incongruent trials ($M=4371.45$, $SE=178.23$). There was also a significant trial type by age interaction, where preschool aged children had faster reaction times on congruent trials ($M=4370.64$, $SE=277.96$) in comparison to incongruent trials ($M=5799.48$, $SE=277.96$). School-aged children also had faster reaction times on congruent trials ($M=2596.34$, $SE=223.17$) in comparison to incongruent trials ($M=2943.41$, $SE=223.17$). In an examination of the simple effects of this interaction it was found that the preschool-age effect was significant $F(1,152)=13.21$, $p<.001$, whereas the school-age effect was non-significant $F(1,152)= 1.21$, $p=.27$. Therefore, our preschool-age sample displayed faster reaction times on congruent trials in comparison to incongruent trials, while our school-age sample showed no significant difference between the two trial types.

Spatial Working Memory Task. To test Hypothesis 1d that children would perform better on the spatial working memory task after participation in the yoga course

as measured by error direction I analyzed spatial working memory errors using a linear mixed model with repeated measures utilizing SAS PROC MIXED. Restricted Maximum likelihood (REML) was used in reporting model parameters and to assess the significance of random effects; degrees of freedom were estimated using the Between Within method. In the first analysis directional error was the dependent variable and age group (preschool, school-aged), time (pre-, post-test), intervention type (yoga, reading), target location (-20°, 40°), and distractor (no distractor, inner distractor, outer distractor) were independent variables. Negative errors indicate errors toward midline; positive errors indicate errors away from midline. There was no significant main effect of intervention $F(1,48)=.32$, $p=.58$. There was also no significant interaction with intervention. However, there was a significant main effect of age group $F(1,48)=6.80$, $p=.01$. School-aged children made larger errors away from midline ($M=3.62°$, $SE=.66°$) than the preschool-aged children ($M=1.07°$, $SE=.72°$). There was also a marginal age group by time interaction $F(1,48)=3.52$, $p=.07$. School-aged children made more errors away from midline at pretest ($M=3.95°$, $SE=.76°$) in comparison to the preschool-aged children ($M=.34°$, $SE=.84°$) (See Figure 5). The school-aged children also made more errors away from midline at posttest ($M=3.31°$, $SE=.76°$) in comparison to the preschool-aged children ($M=1.81°$, $SE=.83°$). Lastly, there was a significant age group by target interaction $F(1,48)=8.89$, $p<.01$, where preschool children made errors away from midline at both the -20° ($M=.08°$, $SE=.83°$) and the 40° target ($M=.2.07°$, $SE=.82°$), but were more accurate at the -20° target. School-aged children also made positive errors away from midline at both the -20° target ($M=4.23°$, $SE=.75°$) and the 40° target

(*M*=3.03°, *SE*=.75°), but were slightly more accurate at the 40° target. Hypothesis 1d was not supported.

To test Hypothesis 1e that children would perform better on the spatial working memory task after participation in the yoga course as measured by error distance a second analysis was conducted using the same procedure except in this analysis degrees of freedom was calculated using the Containment method and error distance was the dependent variable. In the examination of error distance, positive errors indicate that children overshot the target, and negative errors indicate that children undershot the target. There was no significant main effect of intervention $F(1,48)=2.40$ $p=.13$. However, there was a main effect of time $F(1,48)=33.60$, $p<.0001$. At pretest children tended to undershoot the target (*M*=-4.09 mm, *SE*=1.33 mm) and at posttest children tended to overshoot the target (*M*=2.91 mm, *SE*=1.31 mm). There was also a marginal main effect of age group $F(1,48)= 3.76$, $p=.06$, where the preschool-aged children overshot the target (*M*=1.68 mm, *SE*=1.73 mm) and the school-aged children undershot the target (*M*=-2.87 mm, *SE*=1.59 mm). There was a main effect of target as well $F(1,48)=9.03$, $p<.01$. Children tended to undershoot the target at the -20° target (*M*=-2.31 mm, *SE*=1.31 mm) and overshot the target at the 40° target (*M*=.1.13 mm, *SE*=1.30 mm). There was also a significant time by age group interaction $F(1,48)= 25.69$, $p<.001$. The preschool-aged children at pretest (*M*=-4.88 mm, *SE*=1.96 mm) and posttest (*M*=-3.30 mm, *SE*=1.78 mm) undershot the target. In contrast, the school-aged children overshot the target at pretest (*M*=8.24 mm, *SE*=1.93 mm) and undershot the target at posttest (*M*=-2.43 mm, *SE*=1.77 mm) (See Figure 6).

There was also a distractor by intervention interaction $F(2,96)=5.64$, $p<.01$; when there was no distractor present both the yoga group (M=-2.30 mm, SE=1.84) and the reading group (M=-.81 mm, SE=1.83 mm) undershot the target, however the reading group was more accurate. When there was an outer distractor the yoga group overshot the target (M=4.41 mm, SE=2.17 mm) and the reading group undershot the target (M=-1.72 mm, SE=2.13 mm); however, the reading group was more accurate. Lastly, when there was an inner distractor the yoga group tended to overshoot the target (M=1.57 mm, SE=2.15 mm) and the reading group undershot the target (M=-4.69 mm, SE=2.15 mm), however the yoga group was more accurate. In an examination of the simple effects of this interaction it was found that the effect when there was no distractor was non-significant $F(1,96)=.33$, $p=.57$. The effect for the inner distractor was, however, significant $F(1,96)=4.23$, $p=.04$ with the yoga group being more accurate. The effect for the outer distractor was also significant $F(1,96)=4.05$, $p=.05$, with the reading group being more accurate. The cause of this finding, however, is unknown. It has been found that children with higher levels of attention have more stable memories and therefore, make smaller errors on spatial working memory tasks. However, previous research has not found an influence of distractors on distance errors in children in spatial working memory tasks (Schutte, Kaiser & Fleharty, 2014).

There was also a significant age group by intervention interaction $F(1,48)=4.05$, $p=.05$, where the preschool yoga group overshot the target (M=5.85 mm, SE=2.45 mm) and the preschool reading group undershot the target (M=-2.49 mm, SE=2.44 mm). Both the school-aged yoga group (M=-3.41 mm, SE=2.25 mm) and school-aged reading group

(*M*=-2.33 mm, *SE*=2.24 mm) undershot the target. For both age groups the reading group tended to be slightly more accurate. However, when looking at the simple effect of this interaction the school-aged group effect was non-significant $F(1,96)=.12$, $p=.73$ and the preschool-aged group effect was significant $F(1,96)=5.82$, $p=.02$. Therefore, for the preschool-aged group the reading group was more accurate.

Lastly, there was a significant time by age by intervention three-way interaction $F(1,48)=5.70$, $p=.02$. At pretest, both the preschool-aged children yoga group (*M*=-2.59, *SE*=2.77), the preschool-aged reading group (*M*=-7.16 mm, *SE*=2.75 mm), the school-aged yoga group (*M*=-2.99, *SE*=2.51) and school-aged reading group (*M*=-3.61 mm, *SE*=2.51 mm) undershot the target, with the preschool and school-aged yoga groups being the most accurate. At posttest both the preschool yoga group (*M*=14.30 mm, *SE*=2.74 mm) and the preschool reading group (*M*=2.17 mm, *SE*=2.72 mm) overshot the target, with the reading group being more accurate. The school-aged yoga group (*M*=-3.81 mm, *SE*=2.52 mm) and school-aged reading group (*M*=-1.04 mm, *SE*=2.50 mm) undershot the target, with the reading group being more accurate. When examining the simple effect of this interaction it was found that this effect was significant for the preschool-aged group $F(3,96)=21.00$, $p<.0001$ and non-significant for the school-aged group $F(3,96)=.53$, $p=.66$. The effect was non-significant for pretest $F(3,96)=.59$, $p=.63$, whereas the effect of posttest was significant $F(3,96)=8.96$, $p<.0001$. Therefore, the yoga group tended to make more errors in comparison to the reading group at posttest and Hypothesis 1e was not supported. For a review of behavioral data findings please refer to Table 2.

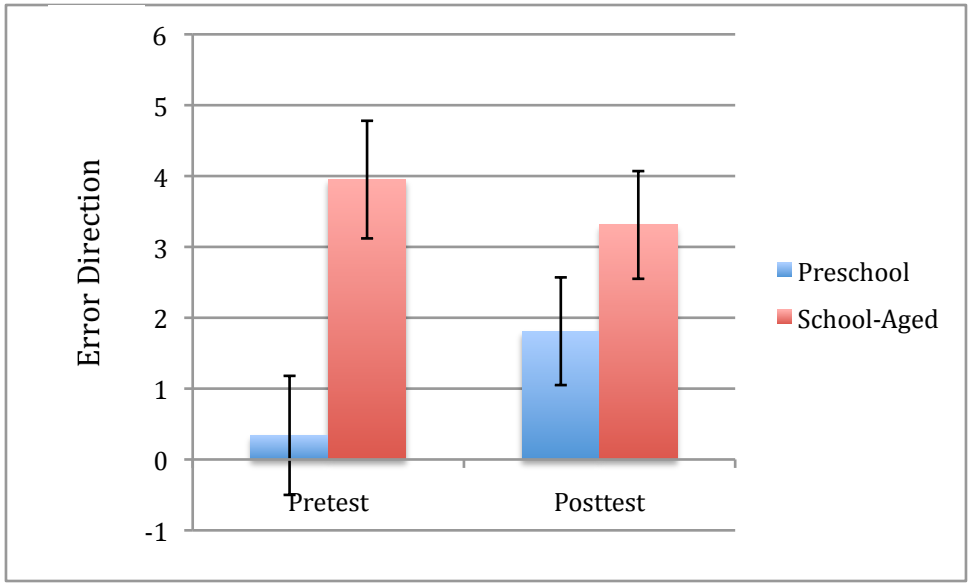

Figure 5. Error Direction for the Spatial Working Memory Task at both pre and posttest for members of the preschool and school-aged groups. Error bars represent standard error.

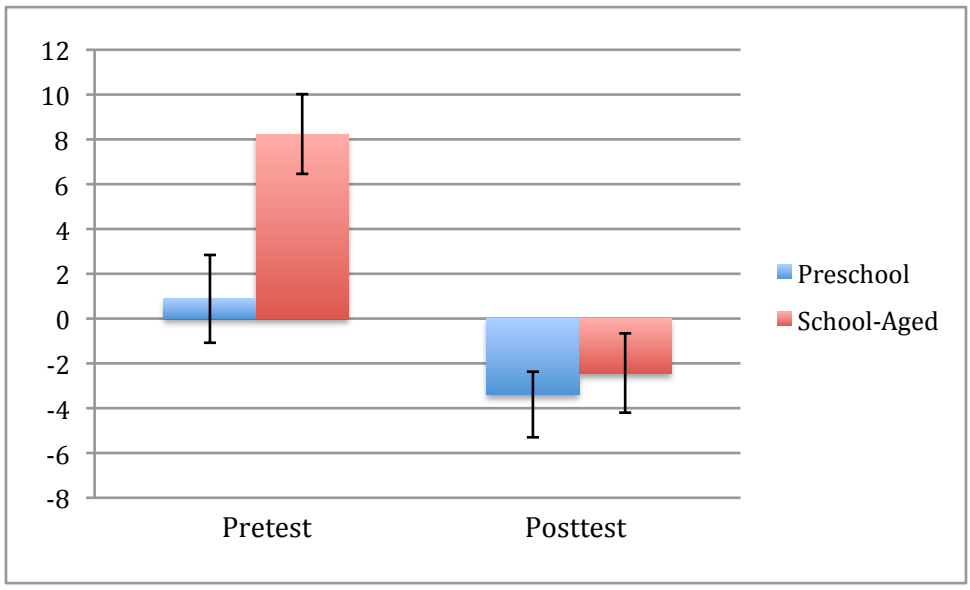

Figure 6. Error Distance for the Spatial Working Memory Task at both pre and posttest for members of the preschool and school-aged groups. Error bars represent standard error.

Table 2

Executive Functioning Behavioral Measurement Findings.

Task	Intervention	Time	Age	Intervention *Time	Intervention *Age	Time *Age	Intervention *Time*Age
CPT (RT)	F(1,76)= .04, p=.85	F(1,76)= 8.03, p=.01	F(1,76)= 89.93, p<.001	F(1,76)= .12, p=.74	F(1,76)= .41, p=.52	F(1,76)= .62, p=.43	F(1,76)= .06, p=.80
CPT (D Prime)	F(1,48)= .51, p=.48	F(1,48)= 5.99, p=.02	F(1,48)= 41.10, p<.0001	F(1,48)= 1.75, p=.19	F(1,48)= .31, p=.58	F(1,48)= 1.31, p=.26	F(1,48)= 1.12, p=.30
Flanker (RT-Congruent)	F(1,76)= 3.60, p=.06	F(1,76)= 3.18, p=.08	F (1,76)= 42.65, p<.0001	F(1,76)= .00, p=.99	F(1,76)= 5.08, p=.03	F(1,76)= 3.69, p=.06	F(1,76)= .00, p=.97
Flanker (RT-Incongruent)	F(1,76)= 5.07, p=.03	F(1,76)= 1.36, p=.25	F(1,76)= 44.12, p<.0001	F(1,76)= .15, p=.70	F(1,76)= 5.93, p=.02	F(1,76)= 1.04, p=.31	F(1,76)= .02, p=.88
SWM (Direction Error)	F(1,48)= .32, p=.58	F(1,48)= .51, p=.47	F(1,48)= 6.80, p=.01	F(1,48)= .44, p=.51	F(1,48)= .01, p=.94	F(1,48)= 3.52 p=.07	F(1,48)= .71, p=.40
SWM (Distance Error)	F(1,48)= 2.40, p=.13	F(1,48)= 33.60, p=<.0001	F1,48)= 3.76, p=.06	F(1,48)= .75, p=.39	F(1,48)= 4.03, p=.05	F(1,48)= 25.69, p=<.0001	F (1,48)= 5.70, p=.02

Devereux Early Childhood Assessment (DECA) Protective Factors Scale.

Hypothesis 2a predicted that parents of the preschool-aged group would report higher levels of social/emotional development after participating in the yoga course. Specifically, Hypothesis 2a predicts that the children will be better able to think and act independently (initiative), experience a range of emotions and to express these emotions in appropriate ways (self-control), and to have a strong positive social bond between themselves and an adult (attachment). I examined T-scores in order to test this hypothesis with a mean of 50 and a standard deviation of 10. A t-score between 41 and 59 was considered average for the three subscales (initiative, self-control, and attachment). Linear mixed models with t-scores of each of the three scales (initiative, self-control, and attachment) as the dependent variables and with intervention (yoga, reading) and time (pre-, post-, follow-up test) as independent variables were conducted. For the initiative subscale there was not a significant main effect of intervention $F(1,23)=.05$, $p=.82$, however, there was a significant main effect of time $F(2,23)=6.69$, $p=.01$. Children's scores significantly increased from pre ($M=53.74$, $SE=1.82$) to post ($M=54.25$, $SE=1.96$) to follow-up test ($M=58.19$, $SE=1.82$). There was also a significant time by intervention interaction $F(2,23)=3.48$, $p=.05$, where t-scores increased for the yoga group from pre ($M=55.15$, $SE=2.53$), to post ($M=55.76$, $SE=2.73$), to follow-up ($M=56.46$, $SE=2.54$). T-scores also increased from pre ($M=52.33$, $SE=2.63$), to post ($M=52.75$, $SE=2.81$), to follow-up ($M=59.92$, $SE=2.61$) in the reading group (See Figure 7). In an examination of the simple effects of this interaction it was found, however that the yoga effect was not

significant $F(2,23)=.33$, $p=.72$, whereas the reading effect was significant $F(2,23)=9.79$, $p=.001$.

In an examination of the self-control subscale there was no effect of intervention $F(1,23)=.11$, $p=.75$ and no other significant effects found. For the attachment subscale there was no effect of intervention $F(1,23)=.00$, $p=.98$ and no interactions with intervention. There was a marginal time main effect $F(2,23)=3.25$, $p=.06$. Follow-up test t-scores were higher ($M=59.20$, $SE=2.45$) in comparison to pretest ($M=56.66$, $SE=2.76$) and posttest ($M=53.93$, $SE=2.82$). Therefore, hypothesis 2a was not supported due to their being no significant time by intervention effect found for the self-control or attachment subscales. There was a significant interaction between intervention and time for the initiative subscale; however, the yoga effect in this interaction was found to be non-significant after closely examining the simple effects of this interaction.

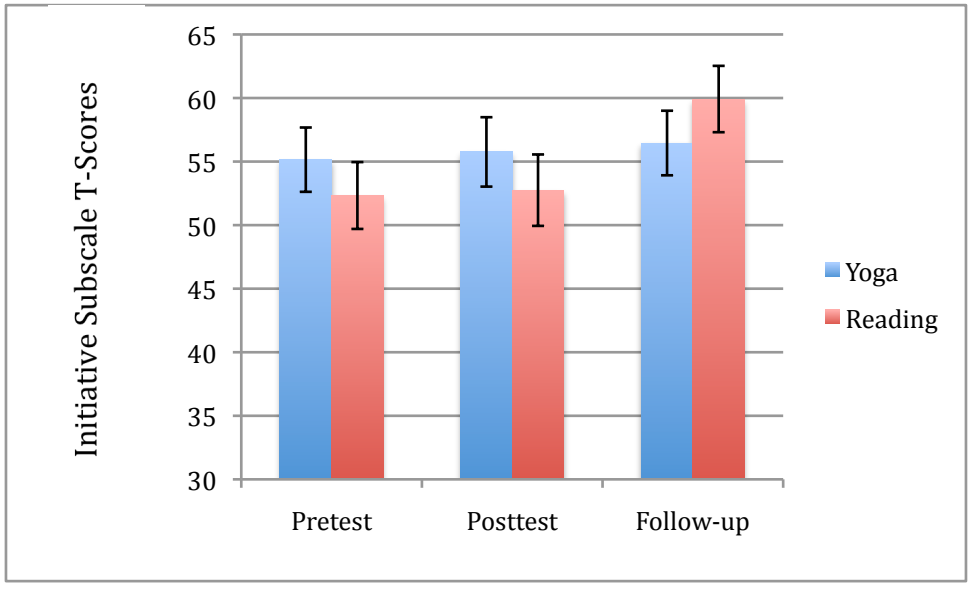

Figure 7. Initiative Subscale T-Scores for the DECA parental questionnaire at both pre, posttest, and follow-up for members of the preschool-aged yoga and reading groups. Error bars represent standard error.

Devereux Student Strengths Assessment (DESSA). Hypothesis 2b, states that parents of the school-aged group will report higher levels of goal-directed behavior, self-management, self-awareness, and relationship skills after participation in a yoga course, in comparison to the parents of the children who did not participate in the yoga intervention. T-scores were examined in order to test this hypothesis with a mean of 50 and a standard deviation of 10. A t-score between 41 and 59 were considered average of these four subscales (goal-directed behavior, self-management, social awareness, and relationship skills) under this scale. Linear mixed models were conducted with t-scores of each of the four scales (goal-directed behavior, self-management, social awareness, and relationship skills) as the dependent variables and with intervention (yoga, reading) and time (pre-, post-test) as independent variables. For the goal-directed subscale there was not a significant main effect of intervention $F(1,26)=.20$, $p=.66$; however, there was a significant time by intervention interaction, $F(1,26)=5.00$, $p=.03$. T-scores for the yoga group increased from pre ($M=49.14$, $SE=2.78$) to posttest ($M=51.50$, $SE=3.00$) and the reading group t-scores decreased from pre ($M=53.71$, $SE=2.78$) to posttest ($M=50.42$, $SE=3.00$). Examination of the simple effects of this interaction revealed that the yoga effect was non-significant $F(1,26)=1.74$, $p=.20$, whereas the reading effect was marginally significant $F(1,26)=3.39$, $p=.08$.

When I completed an examination of the social awareness subscale there was no significant effect of intervention $F(1,26)=.60$, $p=.45$ or any other possible significant effects that were found. Also, when I examined the relationship skills subscale there was no significant intervention main effect $F(1,26)=.83$, $p=.37$; however, there was a

significant interaction between time and intervention $F(1,26)=5.79$, $p=.02$, where the yoga group t-scores increased from pre ($M=51.07$, $SE=3.14$) to posttest ($M=52.36$, $SE=2.91$) and the reading group t-scores decreased from pre ($M=49.93$, $SE=3.15$) to posttest ($M=45.93$, $SE=2.91$). In an examination of the simple effects of this intervention it was found that the yoga effect was non-significant $F(1,26)=.68$, $p=.42$, whereas the reading effect was significant $F(1,26)=6.63$, $p=.02$. Therefore, the t-scores for the reading group significantly decreased from pre to posttest.

In an examination of the self-management subscale there was no significant effect of intervention $F(1,26)=.01$, $p=.94$ or any other significant effects. Therefore, hypothesis 2b was not supported. We did not see a significant increase in t-scores for the yoga group in any of the four subscales that were examined, however, we also didn't see a significant decrease in goal-directed behavior or relationship skills in the yoga group, which was displayed by the reading group for these two scales (See Figure 8).

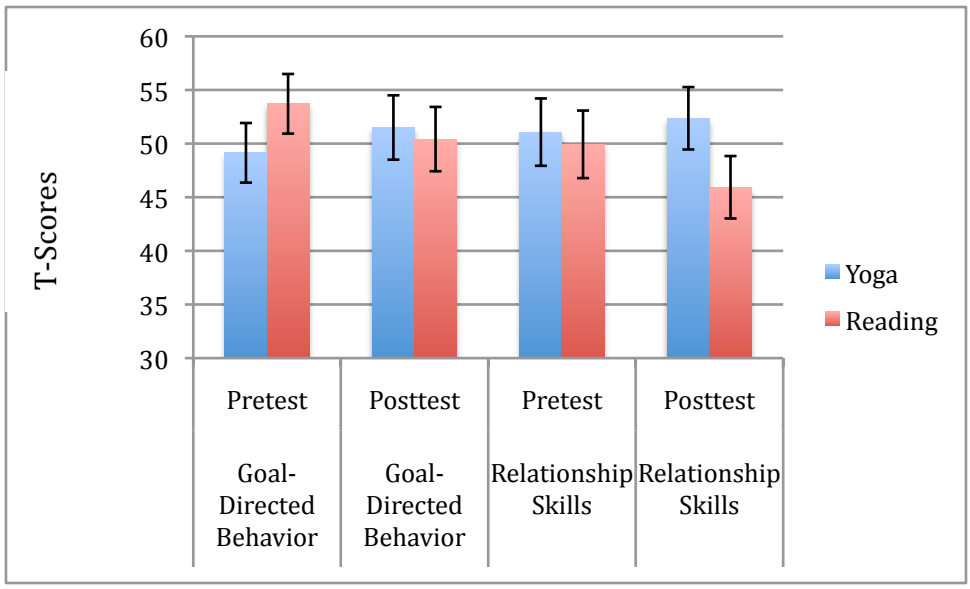

Figure 8. Goal-Directed Behavior and Relationship Skills Subscale T-Scores for the DESSA parental questionnaire at both pre and posttest for members of the school-aged yoga and reading groups. Error bars represent standard error.

Child Behavior Questionnaire (CBQ). Hypothesis 3 predicted that parents would report higher levels of effortful control displayed by their children after the completion of the yoga course. Specifically, I hypothesized that children would display higher levels of attention focusing, and attention shifting, and better inhibitory control. In order to test this hypothesis linear mixed models were conducted with each of the three subscale scores (attention focusing, attention shifting, and inhibitory control) as the dependent variables and with intervention (yoga, reading), age group (preschool, school-aged), and time (pre-,post-test) as the independent variables. In an examination of the attention focusing subscale a main effect of intervention was found $F(1,48)=5.96$, $p=.02$. Members of the yoga intervention had lower subscale scores ($M=4.75$, $SE=.18$) than the reading group ($M=5.36$, $SE=.18$). In an examination of the attention shifting subscale there was no significant effect of intervention $F(1,48)=.00$, $p=.99$ or any other significant

effects. For the inhibitory control subscale there was also no significant effect of intervention $F(1,48)=1.74$, $p=.19$ or any other significant effects. Therefore, hypothesis 3 was not supported. We did not see a significant increase in subscale scores from pre- to posttest for the yoga group for any of the three subscales that were examined. For a review of the parental measurements of social-emotional development and effortful control see Table 3.

Table 3

Social-Emotional Development and Effortful Control Parental Measurement Findings.

Task	Intervention	Time	Age Group	Intervention *Time	Intervention* Age	Time* Age	Intervention* Time*Age
DECA-Preschool (Initiative)	F(2,23)= .05, p=.82	F(2,23)= 6.69, p=.01	N/A	F(2,23)= 3.48, p=.05	N/A	N/A	N/A
DECA-Preschool (Self-Control)	F(2,23)= .11, p=.75	F(2,23)= 2.73, p=.09	N/A	F(2,23)= .14, p=.87	N/A	N/A	N/A
DECA-Preschool (Attachment)	F (2,23)= .00, p=.98	F(2,23)= 3.25, p=.06	N/A	F(2,23)= .94, p=.40	N/A	N/A	N/A
DESSA-School-Aged (Goal-Directed Behavior)	F (1,26)= .20, p=.66	F(1,26)= .14, p=.72	N/A	F(1,26)= 5.00, p=.03	N/A	N/A	N/A
DESSA-School-Aged (Social Awareness)	F(1,26)= .60, p=.45	F(1,26)= .02, p=.89	N/A	F(1,26)= 2.57, p=.12	N/A	N/A	N/A
DESSA-School-Aged (Relationship Skills)	F(1,26)= .83, p=.37	F(1,26)= 1.53, p=.23	N/A	F(1,26)= 5.79, p=.02	N/A	N/A	N/A
DESSA-School-Aged (Self-Management)	F(1,26)= .01, p=.94	F(1,26)= 1.48, p=.23	N/A	F(1,26)= .98, p=.33	N/A	N/A	N/A
CBQ-All Children (Attention Focusing)	F(1,48)= 5.96, p=.02	F(1,48)= 1.86, p=.18	F(1,48)= .97, p=.33	F(1,48)= .00, p=.99	F(1,48)= .62, p=.43	F(1,48)= .21, p=.65	F(1,48)= .33, p=.57
CBQ-All Children (Attention Shifting)	F(1,48)= .00, p=.99	F(1,48)= .03, p=.86	F (1,48)= .00, p=.96	F(1,48)= .59, p=.45	F(1,48)= .33, p=.57	F(1,48)= .08, p=.78	F(1,48)= .33, p=.57
CBQ-All Children (Inhibitory Control)	F(1,48)= 1.74, p=.19	F(1,48)= 1.21, p=.28	F(1,48)= 1.03, p=.32	F(1,48)= 1.33, p=.25	F(1,48)= 1.37, p=.25	F(1,48)= 1.13, p=.29	F(1,48)= 1.11, p=.30

CHAPTER 4

Discussion

The purpose of this current study was to examine the impact of a yoga intervention on young children's executive functioning. The goal of this study was to better understand the possibility of utilizing such an intervention to promote and support the development of executive functioning in children. In the planning and implementation of this current study, we chose to offer a yoga intervention that utilized all three areas of a yoga practice, which includes a physical element or the use of postures, an emphasis on breathing awareness, and the exploration of meditation. We chose to utilize all of the three main aspects of a yoga practice due to the fact that previous research has found positive impacts of a comprehensive yoga approach on executive functioning (Abadi, Madgaonkar, & Venkatesan, 2008; Manjunath and Telles, 2004; Peck, Kahle, Bray, & Theodore, 2005; & Prakash et al., 2010). We ensured that the course was comprehensive by having a certified yoga instructor who had experience in teaching yoga to young children teach the yoga intervention course.

The only other study that examined the effects of yoga on a preschool age group (Rich, 2011) also utilized a certified yoga instructor. However, this study only examined questionnaire data, and therefore, we wanted to expand upon this study to also utilize behavioral measurements of executive functions as a way to further understand the effects of a yoga intervention on children's behaviors. Therefore, when planning the use of measurements for this study we wanted to use both parental questionnaires, which have been utilized by the large majority of previous studies in this area (e.g. Harrison,

Manocha, & Rubia, 2004; Rich, 2011) and behavioral measurements of executive functioning in young children. Due to our goals of having a yoga intervention that was comprehensive to the practice of yoga and a study that utilized a variety of different executive function measurements, it would not have been acceptable to simply replicate a study that has previously been done. To our knowledge no such study exists that meets these requirements and that also looks at a combination of a preschool and school-aged population. Our goal was to test if participating in a comprehensive yoga intervention, children would show improvements in their executive functioning from pre to posttest as measured by both behavioral measurements and parental questionnaires.

The current findings, examining the effect of a yoga intervention on young children's executive functioning, will be discussed next. First, I will examine our findings in regards to their contribution to the current literature. Next, I will discuss how our findings may have implications for a possible intervention technique that can be used in order to improve children's executive functioning. Lastly, ideas for future research projects examining the restorative and training effects of yoga on children's executive functions will be explored. Limitations of the current study will also be discussed.

Examination of Results and Contributions to the Current Literature

This study expanded upon previous research that examined the impact of yoga on executive functioning by examining this effect in a much younger age group than previously studied (preschool-aged children). Prior research has examined the effect of yoga on a number of different executive functions (e.g. Abadi, Madgaonkar, & Venkatesan, 2008; Manjunath and Telles, 2004; Peck, Kahle, Bray, & Theodore, 2005; &

Prakash et al., 2010), in both adult populations (e.g. Kimbrough, Balkin, & Rancich, 2007; Prakash et al., 2010; Subramanya & Telles, 2009); and child populations (e.g. Abadi, Madgaonkar, & Venkatesan, 2008; Harrison, Manocha, & Rubia 2004; Peck, Kahle, Bray, & Theodore, 2005; Rich, 2011). Previously published research, however has not examined this effect in a preschool age group. Lastly, this study used a quasi-experimental design in order to examine the effect of the yoga course on children's executive functioning. By doing this we have a better chance to gather high quality evidence for our examination of the effects of a yoga course on children's executive functioning.

This current study examined three areas of executive and cognitive functioning including attention, inhibition, and spatial working memory. We also examined parental measurements regarding children's social and emotional development as well as their effortful control. We found that there were no significant differences between our two intervention groups in regards to their attention, spatial working memory, their social and emotional development and their effortful control. We did find a significant main effect of intervention group in our measurement of inhibition for our preschool age group, where it appears that the children in our yoga group had lower reaction time scores in comparison to our reading group, however, this effect did not interact with time so we can not specify that our yoga group improved more then the reading group at the end of our interventions.

Results from this study provided weak evidence of a possible effect of a yoga course intervention on preschool-aged children's inhibition. This finding is a promising

first step into understanding and determining the affect that yoga can have in this young age group. However, it is unclear if this is actually a finding of change in inhibition abilities due to the yoga course, or if this may simply be a group difference effect. We did not see a significant interaction between intervention and time in our model. Therefore, this finding could simply be a group difference, where the preschool-aged children who were signed up to participate in the yoga intervention already had higher levels of inhibition skills in comparison to the children who were signed up for our reading intervention group. In an examination of the means of our preschool sample we see that the preschool age group had faster initial reaction times (*M*=5229.67, *SE*= 635.35) in comparison to the reading group (*M*=7160.35, *SE*=635.35) for the congruent trials. By the posttest both groups had a reduction in their reaction times, but the yoga group decreased more with a difference of 876.01 in comparison to a difference of 706.01 for the reading group. As mentioned earlier, however this difference was not significant. In regards to the incongruent trials it was also found that the yoga group had faster reaction times at pretest (*M*=4225.07, *SE*=386.43) in comparison to the reading group (*M*=5343.14, *SE*=386.43). Both of these groups reaction times also decreased by posttest, however once again the yoga group had a slightly bigger decrease (836.70) in comparison to the reading group (817.15). Again, this difference between pre- and posttest was non-significant. Therefore, the difference found in this measurement may be due to the yoga group having lower initial reaction times and a bigger decrease in reaction time by posttest in comparison to the reading group, which may be a result of a group difference between these two intervention groups.

This current study did not find significant effects of the yoga intervention on other areas of executive functioning including: spatial working memory, attention (e.g. attention-focusing, attention shifting), as well as many social-emotional behaviors (e.g. initiative, self-control, attachment, goal-directed behavior, self-management, social awareness, relationship skills). Therefore, it is important to closely examine the findings of the current study and the yoga intervention that was utilized in order to fully understand why this study did not provide strong evidence that our yoga intervention influenced the executive functioning abilities of our young children.

First, it is possible that the practice of yoga does not actually promote the improvement of executive or cognitive functions. The only other noted study that examined a preschool-aged group did not find a significant difference in children's attention after participating in 20 minute yoga sessions that met twice a week for 4-weeks (Rich, 2011). Therefore, for this age group the yoga intervention may not significantly impact their executive functioning. However, the large majority of previous research has found positive impacts of yoga on executive and cognitive functioning in other age groups of children (e.g. Abadi, Madgaonkar, & Venkatesan, 2008; Harrison, Manocha, & Rubia 2004; Peck, Kahle, Bray, & Theodore, 2005). Therefore, it is important for us to explore other reasons behind why we did not find strong evidence for an impact of yoga on children's executive functioning.

One explanation for why we did not find strong evidence of an effect of the yoga intervention on young children's executive functioning (spatial working memory, and attention), or in other forms of social-emotional behaviors is that executive functioning in

the preschool age group is structured differently than it is in older age groups. Wiebe and colleagues (2011) examined four separate models of executive functions including a unitary executive function model; a dual factor model that included working memory and inhibition; a dual factor model that included spatial demands and nonspatial demands; and a dual factor model that included no performance feedback and performance feedback. Wiebe and colleagues (2011) found that the executive functioning of the preschool-age group was best understood as a unitary construct. Miller and colleagues (2012) also examined the structure of executive functioning in preschoolers and found that their data best fit a two-factor model consisting of working memory and inhibition. For children, who are school-aged, Huizinga and colleagues (2006) found that executive functions separate into three separate factors (working memory, shifting, and inhibition), whereas Lee and colleagues (2013) found that for children between the ages of 5 and 13 executive functions separate into two factors (updating, and inhibition/shifting). Therefore, it may be harder for executive function measurements to detect specific areas of executive functioning in this age group due to the fact that it is not a unitary construct and specific areas of executive functioning (e.g. working memory, attention, and inhibition) may be harder to detect in certain measurement tasks that are designed to be utilized by both age groups.

In regards to the development of executive functioning, some researchers propose that executive functions in children develop at different times (e.g. Best et al., 2009). Best and colleagues (2009) propose that executive functions develop in people in the following order: (a) inhibition; (b) working memory; (c) shifting; and (d) planning

(problem solving). Carlson (2005) also found that for their sample of children ages 2 to 6 that there was no age related changes in task demands for tasks that measured primarily inhibition abilities and those that measured primarily working memory abilities. Carlson (2005) also found that the tasks that involved inhibition and working memory were most difficult for each age in the sample. Therefore, if inhibition is in fact one of the first forms of executive functions to develop in children, this executive function should be closely examined in future research in order to further investigate the impact of yoga on young children's inhibition abilities. If Carlson's proposal is accurate and there are not differences in inhibition and working memory for this young age range and if inhibition as well as working memory tasks are one of the most hardest executive functioning tasks for young children to complete then learning how we can help improve inhibition across this age range would also be beneficial.

If inhibition does in fact develop first in children, then why did our school-age children not display the same inhibition effect that was shown by our preschool-aged children? The reason for us not finding an effect in our school-aged children may be due to the inhibition measure that we used for this particular study. The flanker task (an adaption of Rueda et al., 2004) may have been too simple for the older age group. This was the first time that this specific flanker task was utilized in a research study, and, although it was anticipated that this task would be appropriate for both the preschool and school-aged children in our sample, it is possible that it wasn't as appropriate for our school-aged children. The inappropriateness of this task for our school-aged children may have been illustrated by our finding that, contrary to previous research that found that

children have faster reaction times when completing congruent trials in comparison to incongruent trials (Rueda et al, 2004), the school-aged children in our sample did not show a significant difference between the two types of trials. This finding may support the idea that this task wasn't challenging enough for our school-aged sample.

There are also developmental differences between the preschool and school-aged children in our sample. First, according to Piaget's developmental stages preschool-aged children are part of the preoperational stage. While, in this stage preschool-aged children thinking tends to be limited due to centration, which is when a young child focuses on a single, prominent feature of an object or event while they exclude other possibly important features that are less prominent. The children who made up our school-aged population on the other hand are part of the concrete operational stage, where centration tends to no longer be a limitation to their thinking. Children in this stage are much better able to include multiple features or objects or events and hold them in mind (Siegler, DeLoache, Eisenberg, & Saffran, 2014). Therefore, when thinking about creating a yoga intervention for young children it is important to keep this in mind. When creating a course for preschool-aged children it may be worthwhile to concentrate just on one single element of a yoga practice (postures, breathing or meditation) in each class and then move on to another element in the following classes. By concentrating on just a single element in each class this may provide preschool-aged children with a better opportunity to keep in mind each element of the practice. As children get older (school-aged) and are better able to keep in mind multiple elements then creating a course that includes

covering multiple elements in each class would be less of an issue and something that could be tried.

Next, preschool-aged and school-aged children also display differences when it comes to their self-understanding. Preschool-aged children view themselves based upon concrete and observable characteristics. For example, when these children are asked to describe themselves to others they tend to say things based upon their physical attributes ("I have brown hair"), physical abilities ("I can jump really high"), their social relationships ("my sister's name is Sally") and their psychological traits ("I am sad today"). On the other hand school-aged children are better able to form higher order conceptions about themselves. This allows them to compare themselves to others around them and they tend to use these comparisons in order to self-describe themselves. The ability to compare themselves to others leads them to create a more realistic assessment of themselves (Siegler, DeLoache, Eisenberg, & Saffran, 2014). Therefore, children's self-understanding may directly influence the way they actively view and participate in a yoga intervention. Preschool-aged children may have a harder time reflecting on the practice and how it directly relates to them as a person. For example, these children may have a harder time fully understanding the importance of a meditation exercise and how it encourages the reflection of one's thoughts and feelings. School-aged children on the other hand may be better able to fully understand the meaning behind many of the elements of yoga and how each element directly impacts them personally. When conducting a yoga intervention for preschool-aged children it may be important to discuss

how the elements impact the individual child's mind and body in order to help them make these connections.

Another possible reason for our current findings could be the type of executive functions that were highlighted the most in our yoga course. Yoga emphasizes concentration and the practice of mindfulness, or bringing awareness to the here and now. This emphasis encourages individuals who practice yoga to strongly utilize his or her inhibition skills, by blocking out irrelevant information and focusing solely on the task at hand. This practice is represented in all of the three main areas of a yoga practice including (a) postures, when practicing poses the person is encouraged to focus solely on the way that their body is moving; (b) breathing, when working on breathing exercises a person is asked to focus on the flow of his or her breath and how it impacts his or her body (e.g. when a person breaths in their belly will expand and when they breath out his or her belly will become sucked in); and (c) meditation, when practicing meditation people are told to relax and to free their mind. People are also asked to bring their awareness to the present moment and not let in other distracting thoughts or feelings. Therefore, a large range of yoga practices draw upon inhibitory control. These strategies help people strengthen their inhibitory skills, which in the current study could have influenced the inhibitory abilities of the children who participated in the yoga intervention.

The yoga course that the instructor utilized in the current study also emphasized the other executive functions that were measured. For example, children's attention skills were utilized throughout many of the exercises. In particular children were encouraged

during meditative exercises to bring their attention to the current moment and concentrate deeply on their current thoughts. Children were also asked to pay close attention to the instructions of both the breathing exercises and the poses that they were taught. In regards to spatial working memory, researchers have proposed that attention has a strong influence on spatial memory. Awh and colleagues (1999; 2001) propose that spatial selective attention acts as a rehearsal mechanism in spatial working memory. In contrast, Karatekin and Asarnow (1998) propose that children who are diagnosed with ADHD also show deficits in spatial working memory. Therefore, because the practice of yoga utilizes the use of attention skills, it is likely that it would also influence the spatial working memory abilities of children, however the evidence from our current study did not find this to be true.

Lastly, the instructor of the course provided reminders of ways that the children could handle their frustration or anger. She also talked with the class about how they should treat others with respect and love as well as discussed techniques the children could use if they needed a moment to get their emotions together. This provided the children with many opportunities to help improve their social and emotional behavior skills. However, even though these executive functions and social and emotional behavior skills were emphasized in portions of the yoga course they still did not play as large of a part of the course as the executive function of inhibition, which could be seen in nearly all aspects of the course (as mentioned above). Researchers may want to more closely examine the relationship between yoga interventions and young children's inhibition abilities, due to the fact that the practice of yoga does utilize many techniques

that encourages the use of inhibitory skills. Whereas, the current study found a significant age by intervention effect in the inhibition task for our preschool sample, that showed that our yoga group had faster reaction times on both congruent and incongruent trials in comparison to the reading group, this effect was not significant with time. It is therefore possible that this effect was a group difference between our two interventions as the yoga group had lower initial reaction times and showed a higher reduction in reaction time by posttest in comparison to the reading group. Therefore, further research needs to be conducted to more closely examine the effect of yoga on young children's inhibition in order to determine if yoga does impact children's inhibitory abilities.

It is also possible that the frequency of our intervention may not have been enough to make a significant impact on executive functioning. Our yoga intervention course was a six-week course that met for 30 minutes once a week. This allotted time was chosen due to the fact that our sample included very young children. When discussing the course with the certified yoga instructor who would be conducting the yoga classes, she felt that children of this age would have a hard time participating and keeping their attention focused in a course that lasted much longer than 30 minutes. We also wanted to keep in mind the time commitment that we would be asking the families of our children to be making for this intervention. Due to the fact that many families, especially those with young children, already have many planned activities during the week we wanted to make this intervention something that would be easy to fit into their already busy schedules. We also wanted to coordinate with the yoga studio we were collaborating with and arrange the class for a time that worked with the schedule of classes that they already

had in place. With these restrictions in mind we decided that the 30-minute yoga class would meet once a week for a six-week period. Previous research has found that even a 30-minute yoga video done a couple times a week had an impact on children's attention (Peck, Kahle, Bray, & Theodore, 2005). Therefore, we hypothesized that the selected amount of time and frequency for the yoga class would be efficient and sufficient, to test the effects on our children's executive functioning.

The young children in our study, therefore, may have needed a more intense intervention in order to obtain a more significant impact. Because it was a full week between classes, children may have forgotten some of the concepts that they had learned the week before, or did not think about the techniques or exercises that they worked on during the time they were away from the class. When looking at the follow-up questions that were completed by our preschool-aged children's parents, it was apparent that this might have been true. A third of the class did not mention aspects of the class with their parents at home and half of the children did not practice the techniques they learned in the yoga class at home. Therefore, having a shorter amount of time between classes may have helped these children remember and retain what they learned in each of the classes and perhaps also incorporate what they learned in the class into their everyday lives. It may have been beneficial to have the class meet two to three times a week instead of simply once a week.

It may have also been beneficial if the yoga classes lasted for more than a half hour. Whereas a longer class may have been difficult to complete with such a young age group, it may have been possible to conduct a longer yoga class (45 minutes to an hour) if

children were given short breaks in between some of the yoga lessons (e.g. taking a short break when transitioning from a set of yoga poses to a breathing exercise). Having the longer classes would provide the children with more time to practice their yoga and to learn about the elements of yoga in a more in-depth way. This longer class would provide the children with more exposure to the practice of yoga, which may have a longer lasting impact on their memory of each yoga class. Future research studies need to further examine the frequency and amount of allotted class time for yoga interventions in this age group in order to better understand what type of yoga intervention would have the most positive results on children's executive functioning.

It is also possible that the length of time between the yoga intervention and when we measured the children's executive functioning was too long. We chose to conduct a pretest measurement of the children's executive functions and social-emotional behaviors one week prior to the yoga and reading interventions and conduct a posttest one week after the end of each intervention. Another option would be to test the children immediately following the end of each week, which for the yoga intervention could have possibly been completed after each of the weekly yoga classes at the yoga studio.

Logistically, measuring the children immediately following each yoga class would have been extremely difficult for this current study due to the fact that one of our measurements (our spatial working memory task) utilized a very large touch screen, which would have been tremendously difficult to move to another location for measurement purposes. Members of the reading intervention group would also have needed to come into the laboratory each week, which may have been difficult due to the

families of our participants' busy schedules. However, by measuring the children at the end of the intervention and by allowing a week to pass before we conducted our posttest, it is possible that the effect of the intervention may have worn off between the time the course ended and when we measured these children's executive functions. By measuring each week, after each of the yoga classes, we would have been able to examine the possible short-term effects of the intervention. By examining the short-term effects of the intervention we could have examined the question of whether or not there is a wearing off period following this type of intervention. However, we may also be inviting possible practice effects into our examination due to frequent measurements. It is important for researchers to experiment with different lengths of time between intervention and measurement in order to determine how long the effect of a yoga intervention lasts. It is also important to understand how long the effect of yoga may last in other age groups as well as if the length of this effect changes with development in order to better understand how the impact of yoga changes across the lifespan.

Participation is also vital for the success of an intervention. Therefore, it is important that the children who participate in the intervention complete the large majority of the tasks or activities that are associated with the program. Some of the children in our intervention were able to come to all of the six yoga classes in the course, however others were unable to attend all of the classes. In order to be used in our sample the children had to have attended at least half of the yoga classes. When examining our sample of children who made up our preschool-aged yoga course, two children missed three classes, five children missed two classes, one child missed one class, and three children were able to

attend all six of the yoga classes. For our school-aged group we had much better attendance; as ten children missed only one class, and four children were able to attend all six of the yoga classes. Therefore, it should be noted that the reason we may have not found significant effects is due to the lack of full participation in our intervention.

As mentioned previously, our yoga course was asking the families of our participants to make quite a big time commitment. Some of our families could not attend classes due to things such as already planned vacations or trips, another commitment or activity that was already scheduled, and unexpected illness of the child. Therefore, to expect that there would be 100 percent attendance by all children is unrealistic. However, in the future, researchers who are planning to implement such an intervention should take the necessary steps in order to make the time commitment that goes along with an intervention goes as smoothly as possible. One step that we took in order to help with participation was we made reminder calls to families of children who had missed the prior yoga class. We made these calls to families a day before the next scheduled class. We could have taken this one step further and conducted reminder calls to all families regardless of whether or not they missed the previous class. By making these calls all families would have had that extra reminder to attend the yoga classes. Another step that could be taken would be to ask families, prior to starting the intervention, if they had any plans already in place for the time period of the intervention. Asking for families schedules prior to starting the intervention would allow a researcher to be able to anticipate any classes that the children may be missing and based on that information the researcher may decide to expand his or her sample size.

Lastly, conducting the intervention in a location that is easy for families to access may also help with increasing attendance. One place that could work very well for a location of a yoga intervention study would be the school that the children in the sample attend. If a researcher were able to coordinate with a school, in the area where the study is being conducted, this would help parents from having to make trips to another location in town in order for their child to participate in the intervention. Some possible ideas would be to work with the physical education teacher at a local school or an early childhood program and coordinate with a certified yoga instructor to come in and teach once or twice a week for a few weeks in a school semester. Another possibility would be to work with an after school program to see if once again you could have a certified yoga instructor come teach the children a few days a week for a few weeks out of a semester. By creating a yoga intervention that is designed to be both beneficial for children's executive functioning and convenient to participate in, I believe researchers would be better able to detect the impact of the intervention on children's executive functioning and have high levels of participation.

Finally, the children who made up our comparison group also participated in another type of intervention. By asking the parents of the children in our comparison group to read an additional 30 minutes a week with their child/children for the six week duration of the intervention we aimed to ensure that we were matching the amount of adult time that the children in our yoga intervention were receiving through participating in the yoga course. Whereas we accomplished this goal through creating a reading intervention for our comparison group, it is also important to note that research

examining the impact of executive functioning has found that it is related to the reading ability of children. For example, Lillard and Else-Quest (2006) found that children who attended a Montessori school and who had higher executive functioning skills than their peers performed better in reading. Gathercole and colleagues (2008) also found that executive functioning in children predicted reading competence throughout the school years. Whereas, these findings suggest that there is a relationship between executive functioning and the reading abilities of individuals, it is difficult to determine which direction this relationship occurs (i.e. does reading affect executive functioning or does executive functioning affect reading). Therefore, it is possible that one reason we did not see a significant difference between our comparison group and our yoga intervention group could be that both of these groups' executive functions were positively impacted by their separate interventions. Although the effects did not interact with intervention, our findings found many significant effects of time. For our d prime analysis for our continuous performance task we found significant main effects of time. For our error direction analysis for our spatial working memory task we also found a significant main effect of time and a significant time by age interaction. Because these effects did not interact with intervention, it is possible that these significant findings may be due to practice effects. These findings could also suggest that there was an influence of both types of interventions on the attention and spatial working memory abilities of the children in our sample.

Implications for Utilizing a Yoga Intervention Technique

Overall, the current study is an excellent first step toward better understanding the impact that participating in a yoga intervention can have on young children's executive functioning. This current study provides evidence that yoga can be used as an intervention for young children, including preschool-aged children. Based upon video observation the children in both our preschool-aged group and school-aged group were equally able to participate in and complete a yoga course that utilized a certified yoga instructor and included a comprehensive yoga curriculum. This comprehensive approach has been found to improve dimensions of executive functioning in previous research (Abadi, Madgaonkar, & Venkatesan, 2008; Manjunath and Telles, 2004; Peck, Kahle, Bray, & Theodore, 2005; & Prakash et al., 2010). In the current study it is believed that by utilizing this approach children were introduced to exercises that allowed them to use their executive functioning abilities in a number of areas (spatial working memory, attention, and inhibition; as mentioned above).

Future research studies, therefore, should more closely examine the effect of a number of different yoga interventions on young children's executive functioning abilities. For example the use of yoga videos, yoga courses taught by certified yoga instructors, and practicing yoga on one's own. Future research in this area could help provide parents, educators, and other child caregivers with an intervention to utilize in order to help young children who may be struggling to self-regulate either in the home, at school, at daycare, or in other environments that make up their world.

It was apparent through the video observation, as well as the follow-up questions, (completed by the parents of our preschool-aged sample) that the children clearly enjoyed the classes that made up their yoga course. Children actively and energetically participated in the exercises that were introduced to them by the certified yoga instructor. When asked by the instructor what parts of the course that they liked best, the children in our school-aged sample noted that they found many areas of the course to be fun, including completing postures, practicing their breathing, and completing the meditation techniques.

The yoga instructor in our intervention took a number of different steps in order to ensure that the children were having fun while participating in the yoga classes, which included utilizing toys (e.g. balloons, noise makers, Chinese finger traps), having the children color as part of a meditative exercise, and creating story lines that went along with the postures that the children were completing (e.g. the children were surfing and saw a seal and therefore they had to complete a seal pose in order to blend in). This approach resulted in an intervention that was enjoyable for the children who participated in the classes. A yoga intervention for young children needs to be enjoyable for them, so that they want to attend and actively participate in the techniques involved in the intervention.

One benefit of utilizing yoga as an intervention is that yoga is a mindfulness practice that a person can participate in throughout their life. There are a great number of yoga courses that are offered for parents and their children to take together starting when the child is a toddler. There are also a number of courses that are offered for the elderly,

which are designed to fit the physical needs of older individuals. Often yoga studios will offer "chair yoga" courses, which allows people to be more comfortable when participating in the yoga exercises. This type of course is designed to allow all exercises (postures, breathing, and meditation) to be completed while sitting in a chair.

Not only is yoga a practice that can be utilized across a large age range, but it is also very easy to implement. First, a person may choose to participate in a yoga course that is offered at a local gym or yoga studio in order to have a certified instructor work with them on their practice. For a person who is just beginning to practice yoga this may be a particularly good option for him or her. A certified yoga instructor is trained to help an individual learn all three elements that make up a yoga practice (postures, breathing exercises, and meditative techniques) and can also teach those who are taking their courses the background and history of the practice of yoga. Many people enjoy learning the history behind yoga and may find that by knowing more about the background of yoga that they are better able to connect to their own individual practice. Choosing to participate in a group course also allows people the opportunity to participate in yoga with others who are interested in the practice. This may provide individuals with friends with whom they can complete yoga with and who may also encourage them to attend their yoga classes and continue on with their practice.

Individuals may also choose to practice yoga on their own (for example in their own home or in a nearby park). A person who chooses to practice yoga on his or her own may choose to practice what they have already learned through participating in a yoga course, or by reading about the practice. Another option would be to utilize a number of

yoga videos that are available by completing them either on-line or by watching them on one's own television. These videos offer step-by-step instructions for completing the exercises and can be completed in an individual's own home. Completing yoga on one's own also allows people the opportunity to practice yoga based upon their own schedule and when it is convenient to them. To participate in a yoga practice on one's own a person may want to initially acquire the proper equipment that is utilized in the practice, including: a yoga mat; a meditative pillow or bolster; a yoga block (used to help assist in postures that may be too difficult for a person to complete); and a yoga strap (used to help assist in stretching). However, these items are not required in order to complete a yoga practice and therefore, when deciding to practice on your own, yoga can be very cost effective. The low cost to starting the practice of yoga will make it easily assessable to a large number of individuals no matter their financial situation.

Future Directions

The current study is a good initial step to gaining a better understanding of the impact that yoga may or may not have on young children's executive functioning. However, there are still many questions that are left unanswered, which provides an opportunity for a number of different future research studies. First, due to the results of the current study that showed a possible effect of yoga on preschool-aged children's inhibition it would be important to do follow-up research that examines this effect more closely. Further research in this area would help us understand whether or not yoga in fact impacts young children's inhibition or if what we saw in our current study was simply a group difference effect between our two intervention groups. I plan to do a

follow-up study that would examine a large preschool-aged population of children who participated once again in a yoga course that is taught by a certified yoga instructor. I plan to expand upon the current study to include more behavioral measurements of inhibition (e.g. flanker task; go-no go task; delay of gratification tasks), as well as parental questionnaires in order to see if an effect of inhibition can be detected utilizing one of these other measures of inhibition. Because, the practice of yoga utilizes a large number of exercises that encourages the use of inhibitory skills it would be beneficial to better understand the impact of a yoga intervention on the inhibitory abilities of young children.

One main area of yoga intervention research that needs to be more closely examined is to explore what is the best type of yoga intervention that can be implemented. One main question that needs to be answered includes: How frequently and how much time needs to be spent practicing yoga in order to see an impact on a person's executive functioning? Future research should test different lengths of possible yoga interventions in order to further understand what amount of time is needed to be spent practicing yoga in order to see an impact on executive functioning. Because our current study did not find significant effects of the yoga intervention on our measures of executive functions other studies may want to examine a longer yoga intervention approach, which could include conducting longer, and more frequent classes for a longer period of time (e.g. 1 hour long classes that meet 3 times a week for 10 weeks).

Another important research question that could be examined is: Do younger children need to spend more time practicing yoga in order for it to impact their executive

functioning in comparison to older children or adults (or vice versa)? Future studies may want to examine how yoga interventions impact different age groups. Therefore, future research in the area of the effect of yoga on executive functioning should utilize cross-sectional research designs in order to determine the differences of the impact of yoga on the executive functioning abilities in a number of different age groups. By examining the frequency and length of different yoga interventions, researchers will better understand what type of yoga intervention will have the biggest impact on children's executive functioning. This information will provide researchers, educators, health care professionals, and parents with the best yoga intervention to provide to children who may be suffering from lower levels of executive functioning.

There is also a need for research that examines first if there is an impact of yoga on young children's executive functioning and if so, how long this impact lasts. It is possible that the reason we did not see many instances where our yoga intervention positively impacted our young children's executive functioning (e.g. spatial working memory, attention) is due to these effects wearing off by the time the children reached their posttest measurement occasion (completed one week after the end of both the yoga and reading intervention). Future research studies, therefore, need to further examine the lasting impact of yoga on executive functioning. For example, researchers should conduct studies that include the examination of a number of different yoga intervention approaches including: yoga courses that are taught by a certified yoga instructor; the utilization of yoga videos; or yoga that is completed individually (by those who already have experience with the practice). Longitudinal studies are also greatly needed in order

to examine the long lasting effects of practicing yoga. Participants in yoga interventions need to be tested often and over a long period of time to determine when the effects of certain yoga interventions may wear off and to determine how to sustain the beneficial impacts of such interventions.

Lastly, there are a number of other mindfulness practices that have been found to impact executive functioning in individuals, which include things such as meditation and tae kwon do (for a review see Diamond and Lee, 2011). However, similar to the area of yoga, research examining these practices in children is lacking. Therefore, researchers who are interested in the impact of mindfulness practices on executive functioning should also examine other alternative mindfulness techniques. With research in the area of mindfulness being so new there is the opportunity for researchers to design and test new interventions centered on the different practices of mindfulness (e.g. yoga, tae kwon do, meditation, the teachings of mindfulness). Therefore, researchers have the opportunity to design and test interventions that could help children strengthen their executive functioning skills.

Limitations

There are some limitations of the current study that should be noted. First, the parents of the children in our study voluntarily signed their children up to be either a participant in the yoga course or a participant in the reading intervention. Therefore, true random assignment was not something that was accomplished within this current study. Random assignment became difficult in this study due to the time commitment of the yoga course. Our desire to have a yoga course that could be done at a single location (at a

yoga studio instead of at the families' homes) and that would be taught by a professional yoga instructor (instead of giving parents yoga practices to complete at home with their child or having the children complete a yoga video while at home), required the parents of the children who participated in our yoga course to drive their child to the yoga studio once a week at the scheduled class time. This scheduled time had to also fall in line with the already scheduled yoga courses that the yoga studio already had in place. For the preschool-aged group this meant holding the courses on a Monday evening at 5:00 pm and for the school-aged group we held the class on Wednesday afternoon at 4:30 pm. Having the course in the late afternoon or early evening may have discouraged some families from participating in the intervention due to parents not having a way to get their child to the yoga classes because they were still at work. Therefore, this extra commitment may have introduced bias into our intervention groups by impacting who was able to sign up for each of the interventions.

The reading intervention on the other hand asked for less of a time commitment from our parents. Parents were asked to find a half hour of extra time per week to read to or with their child. The extra reading could be done at any time that was convenient for the family and could be done at different times each week. Reading is something that most families in this group already did regularly. When we asked the parents of our preschool group how often they read with their child, most parents said either once daily or at least four times a week. Therefore, simply adding an additional 30 minutes a week of extra reading to the families schedule was not asking families to do something that was radically different from their everyday routine. Thus, although the reading group also had

an additional time commitment, the differences in time commitments of these interventions may have resulted in differences between these two groups.

The next limitation that should be noted for the current study is that not all of the children who made up our yoga group, attended all six yoga classes. Therefore, we have quite a range of different intervention exposure in our sample and this could be a possible reason why we may not have seen a positive impact of the yoga intervention on our children's executive functioning.

In follow-up phone calls made to the participants of the preschool-aged reading group it was found that most of the parents stated that they did participate in the extra 30 minutes of reading time throughout the six week intervention, with only one parent stating that there may have been some weeks where they were unable to read the additional 30 minutes. Therefore, it seems that the participants of our reading group participated more in the intervention. However, because our knowledge of their participation depended on a parental report these responses may be skewed to show stronger participation then what actually occurred.

Lastly, the large majority of the children, who made up our study, were from white, middle class families, who were from the small Midwest city where the study took place. Due to the lack of diversity in our sample it is hard to determine if the results of our study could be generalized to other populations and locations. Therefore, future research should examine a wider range of diverse populations of children in a number of different demographic areas in order to determine the generalization of the effects of yoga on children's executive functioning.

Conclusion

The current study was a first step into examining the effect of a yoga intervention on young children's executive functioning. Many steps were put into place in order to ensure that this yoga intervention expanded and improved upon previous research in this area: (a) we worked closely with a certified yoga instructor in order to ensure that the children were able to participate in a high quality yoga course; (b) we utilized both parental questionnaires and behavioral measurements in order to encompass a wide range of information regarding the children's executive functioning; and (c) we expanded the research in this area to a younger population than previous published research has examined (preschool-aged children). Our findings showed a possible effect of a yoga intervention on preschool-aged children's inhibition, however, we were did not find an interaction between intervention and time and therefore it is unclear if the children in our preschool sample's inhibition actually improved from pre to posttest or if what we found was a group difference between our two intervention groups.

There is a definite need for future research to examine if yoga interventions can help improve young children's executive functioning. Future research projects could help influence the way that we help children improve their executive functioning. I believe it is crucial to begin to explore alternative interventions to helping children improve their executive functioning. These alternative interventions would also create a fun and beneficial way to strengthen children's executive functions. Yoga and other mindfulness practices may be the alternative approach that is needed in order to help strengthen the executive functioning abilities of young children.

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Appendix A

Background Questionnaire

Database ID: _____	Age Group _____

DATE_____/_____/_____ Staff Initials: _____

Phone Numbers Home:_____ Cell:_____ Work._____

Best Time to Call _____

First, I would like to ask you a few questions. This information will be used to make sure we enroll families from a variety of backgrounds.

What is your child's date of birth? _____/_____/_____ (child is _____ years _____months now)

What is your child's sex? M F Race/Ethnicity (optional):

_____

Is your child right- or left-handed? RH LH

(They can participate in the study if they are right- or left-handed, but we need to know ahead of time so we can roughly balance the number of right- and left-handed children in each condition.)

Now I have some questions about your child's medical history.

Was your child was born early, before your due date? Y N *If yes*, how many weeks early? _____ What was your child's birth weight? _____

How long was your child hospitalized after birth? _____

Has your child ever been screened/tested for lead exposure? Y N *If yes,* what was the level? _____

At what age did your child first do the following?

Sat Alone _____ (months) Spoke First Word _____ (months)

Walked alone _____ (months) Toilet Trained _____ (years)

Next, I am going to read you a list of medical conditions. Please tell me if your child has experienced, or currently is experiencing, any of these medical conditions.

Check	Illness or Condition	Age	Check	Illness or Condition	Age
	Visual problems If yes, ask if they have corrected-to-normal vision (Glasses or contacts are okay)**			Intraventricular or brain hemorrhage/disorder	
	Learning Disability			* Autism or other Pervasive Developmental Disorder	
	* Fetal Alcohol Syndrome			*Developmental Delay Mental Retardation	
	Attention Deficit/ Hyperactivity Disorder			Conduct, Oppositional, or Behavioral Disorder	

* Excluding condition **Excluding condition if not corrected *Screener: For any condition checked, ask if the child was diagnosed by a pediatrician or psychologist, if the child received any treatment or intervention, and note the child's age(s).*

Thank you for your interest. *If child does not have fetal alcohol syndrome, Autism or other Pervasive Developmental Disorder, Mental Retardation, or non-corrected vision problems schedule child for session.*

Additional notes:

Appendix B

Follow-Up Questions

Experiment Group

1.) Did your child seem to like the yoga course they participated in?

2.) Did they talk at all about aspects of the course with you at home?

3.) Did they practice any of the yoga techniques while at home?

4.) How often do you usually read with your child?

5.) Did you notice any changes in your child's everyday behaviors since participating in the yoga class?

Control Group

1.) Has your child ever participated in a yoga class?

2.) Did your child enjoy reading with you every week?

3.) How often do you usually read with your child?

4.) Were there any weeks across the 6 week period when you did not read to your child the extra 30 minutes that we requested? "

5.) "Did you notice any changes in your child's everyday behaviors since you began to read with them more?"

Socio-economic Status Questions (asked to both groups)

1.) “Does your child live in a two-parent household?"

2.) "What is your marital status?"

3.) "Mother's Educational Level?" (provide them with the following options) a.) some high school b.)completed high school c.)some college d.)completed college: number of years _____ (ex: 2 year degree or 4 year degree) e.) graduate degree

4.) “Father’s Educational Level? (provide them with the following options) a.) some high school b.)completed high school c.)some college d.)completed college: number of years _____ (ex: 2 year degree or 4 year degree) e.) graduate degree

5.) "Does your family qualify for free or reduced lunch status?"

6.) "What is your family income" (provide them with the following brackets to choose from) a.) Under $10,000 b.) $11,000-$30,000 c.) $31,000-$50,000 d.)$51,000-$70,000 e.)$71,000-$90,000 f.)$91,000-$110,000 g.)$111,000-$130,000 h.)$131,000-$150,000 i.)$151,000-$170,000 j.)$171,000-$190,000 k.)Over $190,000

7.) "Do you participate in any federal funding program? "(ex: receive food stamps)

8.) "Do you feel comfortable having your child play outside in your neighborhood?"